THURSDAY, JANUARY 23, 1879

GAS VERSUS ELECTRICITY

THE gas companies are at last awakening to the peculiarity of their position, and gas-shareholders are recovering their confidence in the stability of their property. It is interesting to observe how steadily the shares in all the great gas companies have during the last few weeks been rising, and unless any untoward event occurs there is no reason why in a short time they should not recover the position they so singularly lost in August of last year. Looking dispassionately upon the events that have occurred, it is difficult to understand how such a panic and scare could have arisen. Nothing of any sort or kind has been discovered either in the laws of electricity or in their application to electric lighting to account for it. We know no more of the electric light now than we did in 1862, when as great a display was made in our Exhibition of that year as was made in the French Exhibition of last year. There is no doubt, however, that the enterprise of our neighbours on the other side of the Channel in lighting up so brilliantly one of their grand new streets produced a sensation that will not easily be forgotten. Englishmen never like to be beaten. We are accustomed to be startled by inventions from the other side of the Atlantic, but we are not accustomed to be beaten either in commercial enterprise or in inventive skill by our neighbours on this side of the Atlantic. Hence, all of those, whose name is legion, who visited Paris last year came back with exaggerated ideas of the effect of the electric light in the Avenue de l'Opéra, and spread through England a profound opinion of the value of electricity as a means of illumination.

It seems to be forgotten that only three years ago a competitive trial of gas and electricity was made in the clock tower of the Houses of Parliament. Each of these lights were tried for several months, the electric light being a Serrin lamp lit by a Gramme machine; and that, after a very careful examination, gas was successful, was adopted, and is now used by the Office of Works.

Again, it seems to be forgotten that the Elder Brethren of the Trinity House have been experimenting upon this question ever since 1857, and that the results of their experiments have only led to the adoption of the electric light in three of their lighthouses. If the electric light had had the wonderful advantage over gas or oil that its projectors profess for it, surely the governors of such an institution as the Trinity House would have fitted up all the lighthouses upon our coasts with this wonderful light.

The recent experiments, however, have shown both the strength and weakness of the position of the gas companies. Their strength consists in their being in possession of the ground; their weakness consists in their producing only a poor light—and a very poor light—when compared with electricity. But is there any reason why this weakness should continue? Is there any reason why gas should remain such an indifferent light? There is none but that of expense, and expense will not deter people from having a better light if they can only get it. The Phœnix Company has taken the question in hand, and has shown in the Waterloo Road what can be done with gas when the question of expense is not considered. Indeed, it would almost seem, from the experiments that have been made, that the quantity of light to be produced by gas is only a question of the quantity of gas consumed in a given space. There are now burning in the Waterloo Road two brilliant gas lamps, giving a light of 500 candles, and this is greater, in point of fact, than the intensity of the light developed by any one of the electric lights that are now on trial in the thoroughfares of London. There is, however, a defect in gas light which remains to be eradicated, and that is the colour of the light. The one great advantage which the electric light has over gas is that the electric light, owing to its very high temperature, produces rays of every degree of refrangibility, and therefore, as an illuminating power it is equal to that of the sun. But gas light, owing to the lowness of its temperature, is deficient in blue rays, and is therefore not so effective in discriminating colours as the electric light.

A very marked advance towards perfection in this direction in gas lighting has been made in the albo-carbon process, by which the gas burnt is enriched with the vapour of naphthaline—a refuse of gas manufacture. This process is being introduced by Mr. Livesey, and, to judge by the experiments that have been shown, it is very promising indeed. The intensity of the light of a gas burner is improved at least five times, and in some experiments witnessed by the writer the improvement was as much as twenty times.

The tentative trials that are being made with the electric light in London cannot be said to be very successful. That at Billingsgate was certainly a fiasco, that on the Embankment is very brilliant, but we have yet to learn its cost, and there is no doubt whatever that the efficiency of the light is very much less than that usually ascribed to the electric light. The trial on the Holborn Viaduct is not a success. The experiment seems to be conducted by some one who is not experienced in the working of electric circuits, for occasionally all the lamps are found extinguished, on other occasions only a portion of them are burning, and frequently they are very dull. It is quite difficult even at the distance of the Post Office to distinguish the gas from the electric lamp. The same effect is observed on crossing Blackfriars Bridge and looking towards the Houses of Parliament when there is the slightest mist in the air, and it is quite evident that the electric light has no more—if as much—penetrative power than gas.

A most complete and careful inquiry into the working of the electric light has been made by Mr. Louis Schwendler for the East Indian Railway Company, and his results are extremely interesting. He has recommended the introduction of the light into certain railway stations where no gas exists, and the system he proposes to use is the Siemens dynamo-machine and one Serrin lamp, and thereby save that waste which the multiplication of the light unquestionably produces. He proposes to distribute this single light by diffusion on a plan originally suggested by the Duke of Sutherland. His investigation has been conducted in a thoroughly scientific spirit, and when his report is published it will be a very valuable addition to our knowledge of the theory of the electric light. It has been shown by the writer that the full effect of the current can only be obtained by one lamp on a short circuit, and that when adding to the lamps by inserting more of them on the same circuit, or on a circuit so that the current is subdivided, the light emitted by each lamp is diminished in the one case by the square, and in the other case by the cube of the number of lamps so inserted. Dr. Siemens maintains also the concentration of the power on one light, but other experimenters are endeavouring to partially multiply the light. For instance, M. Rapieff, in the *Times* office, very successfully distributes six lights about the office, and Ladd and Co., with the Wallace form of machine, also distribute six lights over the Liverpool Street Station. Although there is undoubtedly a loss of power in this distribution of the lamps, there may be an advantage in such distribution in cases like printing offices and railway stations. A successful experiment has been made by the British Electric Company in lighting up some of the stations of the Metropolitan Railway Company, and the India Rubber and Gutta Percha Company have been successful in lighting up the London Bridge station of the London Brighton and South Coast Railway Company. In all these cases we have scarcely emerged from the sphere of experiment. The electric light has not yet been permanently introduced on any large scale. Many are trying it, many are captivated by the brilliancy of the light, and many in their eagerness to keep up with the spirit of the age, are introducing it, as, for instance, the London Stereoscopic Company, and the Messrs. Nichols, the clothiers in Regent Street, where, however, the light does not appear to give very great satisfaction through its fluctuation.

We were led to expect very much from the experiments of Mr. Werdermann, but his attempt to subdivide the light seems to have subsided, for we have heard nothing of it for some time past. Again, we have heard no more of M. Arnaud's discovery, and the accounts that reach us from America of the doings of the Sawyer-Mann light, and of the supposed discoveries of Mr. Edison, are unworthy of attention.

The present state of the electric light question may therefore be said to be a tentative one, and the gas companies are with much enterprise now giving their retort courteous by showing that they are in a position—if people choose to pay for it—to give quite as powerful a light as the electric light; and, let us hope, before long that it will be quite as perfect. There can be no doubt that the use of electricity for the production of light is a very wasteful as well as a costly process, for the energy that is generated in the machine is not all consumed in the lamp, but is proportionately distributed over the whole circuit. It is therefore not utilised only in the place where it is wanted, as in the case of gas. If we are using a certain amount of energy in an electric lamp to light a street, we are wasting as much if not more energy in the street in maintaining the current to produce that light.

There are three points which all electric lights for general purposes should be required to attain. The first is a brilliancy far exceeding that of any known lamp; the second is a durability greater than that which would be required for night operations in England; and the third is absolute steadiness, to enable work to be conducted without affecting the eyes. There is no electric light that has yet been introduced which supplies us with these desiderata.

W. H. PREECE

THE "NOVUM ORGANUM"

Bacon's Novum Organum. Edited, with Introduction, Notes, &c., by Thomas Fowler, M.A., Professor of Logic in the University of Oxford. (Clarendon Press, 1878.)

THE writings of Lord Bacon, and especially the "Novum Organum," possess a fourfold interest. They have a direct bearing upon the history of philosophy, literature, logic, and physical science; and whatever estimate we may form of their influence upon each of these branches of knowledge, we think that few will fail to admit that Bacon threw a bridge over that vast and deep gulf which separates the ancient from the modern modes of thought, and directly opened a way to our present philosophy and science. Those who would make him the Founder of a sect, the Inventor of induction, or the Father of experimental philosophy, know nothing of his writings. Many had written against Aristotle before his time, many had advocated the collection of positive facts, and the application of a just induction, but they had offered on their part no system which could replace that of Aristotle. When the Scholastics began to abandon their leader, some took refuge in the meagre philosophies of Ramus, of Telesius, of Aconcio, of Nizolius, of Campanella, and of minor men. But when Bacon gave to the world a vast and definite system, and for the first time pointed out the fallacies of the old methods, and suggested new means of interrogating Nature, the scattered refugees from Scholasticism were glad to unite their forces under his banner.

We must bear in mind at the outset that Prof. Fowler approaches the editorship of the "Novum Organum," from the logical and philosophical, rather than from the scientific side. It is improbable that any one man could combine the very exhaustive knowledge of logic, literature, philosophy, and science, necessary for the complete and thorough editing of the work. The main object on the part of our author has been to show that the "Novum Organum" marks an epoch in the history of logic. At the same time he has by no means neglected the other aspects of the work. He has added copious notes, which from every point of view are admirable. It is only here and there that one detects that some of the notes relating to the scientific matters so largely discussed in the second book, were not written by a man of science. Playfair and Whewell are quoted among the older authorities, while Prof. H. G. S. Smith, Mr. Kitchin, and Prof. Clifton, have lent a willing hand in the elucidation of the more knotty points. The most recent ideas on scientific subjects are introduced: such as the kinetic theory of heat, and the conservation of energy. The liquefaction of oxygen and hydrogen is noticed, although much of the work must have been in type when these discoveries were made. Altogether we have no fault to find with the treatment of the work from a scientific point of view.

There have been wide differences of opinion concerning Bacon's influence on the rise and progress of physical science. While Voltaire and the Encyclopedists on the one side call Bacon "the father of experimental philosophy," Sir D. Brewster asserts that he had no influence whatsoever on the development of our modern experimental method. As to the most recent attacks—those of Liebig and Tchihatchef—they are based on such a very shallow acquaintance with Bacon's works, and are couched in such a pitiful and contemptible spirit, that they are quite unworthy of notice. The true estimate of Bacon's influence on modern science is no doubt to be found between the extremes of the Encyclopedists on the one hand, and of Brewster on the other. Bacon certainly was not the father of experimental philosophy, but most surely he had much to do with our modern scientific method.

Prof. Fowler discusses the nature of Bacon's influence on the progress of science, under nine separate headings. (1) "He called men, as with a voice of a herald, to lay themselves alongside of nature, to study her ways, and imitate her processes. . . . In one word he popularised science." (2) "He insisted, both by example and precept, on the importance of experiment as well as observation." (3) He thus recalled men to the study of facts; and (4) in order to do this it was necessary to free them from the subjection to authority, to which they had so long submitted. "Nor can I doubt," says our author, "that his utterances on this subject had far more influence in producing the intellectual revolution which followed than the utterances of any one of his predecessors, or perhaps than those of all taken together." (5) "The emancipation of reason from the bewitching enchantments of imagination," which he effected (6) by asserting the claims of "a logic of induction which shall do for the premisses, what the old logic, the logic of deduction, does for the conclusions." (7) "The manner in which he insisted on the subordination of scientific inquiries to practical aims, the furtherance of man's estate, and the increase of his command over the comforts and conveniences of life." (8) The "hopefulness" of Bacon, as regards the future of the human race; and finally (9) "the marvellous language in which Bacon often clothes his thoughts."

Taken in connection with all this, the charges which have been brought against Bacon, as a man of science, appear very trivial. It is urged against him that he did not accept the Copernican theory, and that it was fully accepted more than fifty years before the "Novum Organum" was written; but we must remember that the system was by no means firmly established before the discovery of the satellites of Jupiter in 1609. Prof. Fowler remarks that "it is possible to draw up a long list of eminent men, astronomers and others, anterior to, or contemporary with, Bacon, who adopted and taught the Copernican theory; but we believe there were only ten Copernicans in the world, when the "Novum Organum" began to be written. Moreover, we must remember that the anti-Copernicans could boast the great name of Tycho Brahé, while Riccioli, five-and-twenty years after Bacon's death, pretended in his "Almagestum Novum" to refute fifty-seven arguments in favour of the theory. It has also been urged that Bacon did not fully recognise the value of the discoveries of Galileo. Liebig boldly tells us that he was ignorant of the discoveries of Jupiter's satellites, of the ring of Saturn, of mountains in the moon, of the law of the motion of planets, and of the spots of the sun, while in the 39th Aphorism of Book 2 of the "Novum Organum," we read "Secundi generis sunt illa altera perspicilla quæ memorabili conatu adinvenit Galilæus; quorum ope, tanquam perscaphas aut naviculas aperiri et exerceri possint propiora cum cælestibus commercia. Hinc enim constat, galaxiam esse nodum sine coacerrationum stellarum parvarum, plane numeratarum et distinctarum; de qua re apud antiquos tantum suspicio fuit. Hinc demonstrare videtur, quod spatia orbium (quos vocant) planetarum non sint plane vacua aliis stellis, sed quod cœlum incipiat stellescere antequam ad cœlum ipsum stellarum ventum sit; licet stellis minoribus quam ut sine perspicillis istis conspici possint. Hinc choreas illas stellarum parvarum circa planetam Jovis (unde conjici possit esse in motibus stellarum plura centra) intueri licet. Hinc inæqualitates luminosi et opaci in luna distinctius cernuntur et locantur; adeo ut fieri possit quædam seleno-graphia. Hinc maculæ in sole, et id genus: omnia certe inventa nobilia, quatenus fides hujusmodi demonstrationibus tuto adhiberi possit."

If we compare Bacon's writings solely as regards their scientific aspect with those of the greater number of his contemporaries, we find a decided balance in favour of the former; at the same time it must be admitted that men like Gilbert and Galileo were far in advance of our philosopher, both as experimentalists and as discoverers Among Bacon's experimental achievements we may mention, however, the experiment which simultaneously proved the slight compressibility of water, and the porosity of the densest solids, usually alluded to as "the celebrated experiment of the Florentine academicians." Bacon made use of a sphere of lead filled with water, while the Florentines employed a sphere of silver, but this was the only difference. Bacon's experiment was tried more than thirty years before the establishment of the Accademia del Cimento, and was published ("Nov. Org.," lib. ii. aph. 45) nearly fifty years before Megalotti, the secretary of the Academy, made it known in the "Saggi di Esperienze." Mr. Ellis speaks of this as "perhaps the most remarkable of Bacon's experiments."

We may also mention that Bacon endeavoured (we believe for the first time) to determine the relationship between the volume of a vapour and that of the liquid producing it ("Nov. Org.," lib. 2, aph. 40; also the tractate, "Phenomena Universi"). Furthermore, he determined the specific gravity of seventy-three substances, taking gold as the standard. It is true that the method was clumsy, but the table was, at least, far more extensive than that of any previous writer.

In the "Historia Soni et Auditus" Bacon suggests the method for determining the velocity of sound which was employed with so much success by the French nearly two centuries later; and in the same treatise he compares "visibles and audibles" with great acuteness. Again, in the second book of the "Novum Organum," the inquiry into the nature of heat often displays, not only great observational powers, but an elegant application of logical inference.

All this, and much more, Prof. Fowler has pointed out in his exhaustive notes. His work has been, to a great extent, a labour of love; he has bestowed upon it an infinite amount of care and pains, and he has been unwearied in his endeavours to sift everything to the bottom, and in giving an opinion to act as a just judge; moreover, he has brought to bear upon every part of it his own logical habit of mind. It will be welcomed as a valuable addition to Baconian literature, and to the history alike of philosophy, literature, logic, and science.

G. F. RODWELL

THE AMERICAN CYCLOPÆDIA

The American Cyclopædia: a Popular Dictionary of General Knowledge. Edited by George Ripley and Charles A. Dana. 17 vols. (New York and London: Appleton and Co., 1873-1878.)

IT was not to be expected that so eminently practical a nation as the United States would be long behind the stereotyped peoples of Europe in so indispensable an article as an encyclopædia. It is indeed many years since such a work was published in the States, and that so recently completed by the enterprising firm of Appleton is really a new edition of what some of our readers may remember as "The New American Cyclopædia." On the very surface the present issue is a vast improvement on the old, with its black funereal covers and unpleasant type. Indeed, the present edition may be regarded as really a new work, brought up to date in all departments. Ten years had elapsed between the completion of the old edition and the commencement of the new, and between 1863 and 1873, advances of vast importance had been made in nearly all departments of science. That Messrs. Appleton made competent provision to take account of these advances is evident from the list of men whose services they were able to obtain in bringing out the new edition. Besides the editors-in-chief, Messrs. Ripley and Dana, and four "associate editors," there was a large staff or "revisers," and a "corps" of contributors containing most of the well-known scientific workers of the States. The organisation of the work of the new edition appears to have been excellent, and from a description of the extensive premises devoted to the staff, it seems to have been a British Museum in miniature, with greatly improved arrangements.

The "American Cyclopædia" can scarcely be compared with any existing Cyclopædia in this country. It is not on so extensive a scale as the "Britannica," but is considerably larger than "Chambers'." It is indeed a kind of compromise between these two well-known works of reference; the information is not so conglomerated into huge articles as in the former, nor is it quite so subdivided as the latter—a feature which renders the latter so satisfactory from a purely "reference" standpoint. The "American" has, however, on the whole, stronger affinities with "Chambers'" than with any other; for while there are longish articles on some of the leading departments, still as a rule the great subjects are broken up into their subdivisions. Thus the article "NATURAL PHILOSOPHY" is little more than a reference to the various departments included under the wide term; under "CHEMISTRY" some of the main principles and data of the science are given, with copious references to subordinate heads. Some of these latter, in the two great divisions of physical science, are treated at considerable length, as AFFINITY, ATOMIC THEORY, HEAT, LIGHT, MAGNETISM, and so on, the last-mentioned having been written by the late Joseph Henry. GEOLOGY is a moderate-sized article by Sterry Hunt, and BOTANY is rather short, with, however, a good bibliography appended; the author's name is not given. Prof. Cleveland Abbe contributes a model article on METEOROLOGY, and many kindred subjects are written by the same able hand. One feature which the "American" has in common with "Chambers'" is the giving biographies of living men, a feature the advisability of which we do not care to discuss. Happily the "American" confines itself mainly to a statement of facts in the life and work of living men; eminence in any direction is sufficient to gain admission to these pages, and all sorts of names will be found therein, from "Boss" Tweed to Charles Darwin.

The geography in this new edition is specially well done, one of the largest and best articles in the work being that on the United States. Japan is well done by Prof. Griffis of Tokio, the language being by Dr. Hepburn, of Tokio, and the literature by Mr. Satow, our Secretary of Legation there. We are glad to find that in most cases where it is desirable, satisfactory bibliographies are appended to the articles. Perhaps one of the most distinctive features of the Cyclopædia is the copious index, occupying the whole of the seventeenth volume, which has been prepared for the whole work. This, indeed, doubles the value of the Cyclopædia as a book of reference. Although, as we have said, the great subjects are, as a rule, subdivided into their leading branches, still, throughout the greater number of articles are incidental references containing scraps of valuable information which can find no place of their own. In this way much useful knowledge would be buried but for a good index, and the index prepared for the "American" by Dr. Conant, is one of the most thorough and best planned we have seen. It covers 800 pages, is simple in its method, easily consulted, and admirably adapted not only to bring out all that is in the work, but to enable any one who might desire it, to follow out any subject to completeness. The bold clear type in which the index is printed adds greatly to its usefulness, and, altogether, it is a feature which those who are in the habit of consulting cyclopædias in earnest will know how to value.

The maps and illustrations in the "American" are, on the whole, faithful and good, and ample in quantity, and the type and paper are excellent. In short, in all the features distinctive of a cyclopædia the "American" will hold its own with any in the Old World. It would no doubt be possible to pick faults in plan and criticise some of the particular articles, but this we are not disposed to do where the work as a whole is so eminently satisfactory. The only objection we feel inclined to make is to the price. The volumes are almost the same size as those of "Chambers'," but each is more than double in price, and not very much less than the price of a volume of the "Britannica." This may have been rendered necessary by the great expenses of preparation, but we doubt if at such a price it would command any great sale here. We are surprised to find that the work is sold, not through the regular "trade," but by what is known here as the "canvassing" system. We should have thought that so high-class a work would not have had to depend on any such system for sale. Of course the articles are mainly written from the American point of view; but to an English reader this adds little that seems peculiar, and were it not for the price of the work, it might very well be put into the English market. Altogether it is highly creditable to publishers and editors, as well as to American enterprise.

OUR BOOK SHELF

The Fairy-Land of Science. By Arabella B. Buckley. (London: Stanford, 1878.)

THE modest preface which Miss Buckley has prefixed to her attractive-looking volume almost disarms criticism, her desire being, she states, simply to awaken a love of nature and of science, while giving pleasure to young people. In this aim Miss Buckley will, we have no doubt, fully succeed.

The substance of this volume was given as a series of lectures to children last spring, at St. John's Wood, and it is at the request of friends who were then present, that the lectures have been printed. We could wish that there were some one in every town equally gifted in rendering science attractive to young people and thus inciting them to a farther and deeper study of natural knowledge.

It would be easy to find fault with some things in this book if we simply regarded it from the narrow standpoint of the scientific critic, without taking into consideration the aim of the author; but as a reading-book to inspire children with a love for nature, which is all the author claims for it, we do not know of a more interesting nor useful gateway to science. The really admirable illustrations with which the book abounds and the pleasant, light manner in which the author carries her readers along from one subject to another will make the "Fairy-Land of Science" a welcome and useful addition to juvenile literature.

In the opening lecture Miss Buckley introduces us to her fairies, showing how things far more wonderful than those related in fairy-tales are daily happening around us, and also how this fairy-land of science may be entered by any one with eyes and with a wish to use these eyes.

In concluding the series of lectures, after showing how it is but the outskirts of this fairy domain which has been touched, the results of a study of science are thus summed up:—

"Pleasant and happy thoughts may thus be conjured up at any time, wherever we find ourselves, by simply calling upon nature's fairies and asking them to speak to us. Is it not strange, then, that people should pass them by so often without a thought, and be content to grow up ignorant of all the wonderful powers ever active in the world around them?

"Neither is it pleasure alone which we gain by a study of nature. We cannot examine even a tiny sunbeam, and picture the minute waves of which it is composed, travelling incessantly from the sun, without being filled with wonder and awe at the marvellous activity and power displayed in the infinitely small as well as in the infinitely great things of the universe. We cannot become familiar with the facts of gravitation, cohesion, or crystallisation without realising that the laws of nature are fixed, orderly, and constant, and will repay us with failure or success according as we act ignorantly or wisely; and thus we shall begin to be afraid of leading careless, useless, and idle lives. We cannot watch the working of the fairy 'life' in the primrose or the bee, without learning that living beings as well as inanimate things are governed by these same laws of nature; nor can we contemplate the mutual adaptation of bees and flowers without acknowledging that it teaches the truth that those succeed best in life who, whether consciously or unconsciously, do their best for others."

This extract will be sufficient to show the happy way in which Miss Buckley addresses her young hearers and readers. At the same time the author would, in our opinion, have done better had she not attempted to travel over so wide a range of subjects as is embraced in her lectures, for we skip from chemistry to physics, then to meteorology, physical geography, and geology, thence to the life of a primrose, afterwards to coal, then to bees, and finally to the fertilisation of plants. This discursiveness leads to occasional looseness of statement, as, for example, employing the terms positive and negative to express the poles of a magnet; it also causes a slurring over difficulties, as in the attempt to explain the measurement of the wave-lengths of light which, with the subject of diffraction, had better have been omitted in a child's book like the one before us.

More durable and equally interesting information might have been given by selecting some one branch of science, examining carefully a few simple phenomena, and regarding them under various aspects; Faraday's juvenile lectures at the Royal Institution—his lectures on a candle, for instance—are the best illustrations of what we mean.

In the study of nature there are very many statements which a child must take simply on the assertion of his or her teacher, with the explanation that their verification is only possible when the child has grown older and wiser; regions are thus opened up beyond its present powers, and the first lesson in education has been learnt—the consciousness of ignorance. We have no doubt, however, that this lesson Miss Buckley would wish to convey as much as we ourselves.

New Commercial Plants, with Directions for their Growth and Utilisation. By Thos. Christy, F.L.S. (London: Christy and Co., 1878.)

THIS is the second of what is evidently intended to form a series of pamphlets on plants either of entirely new economic interest or those whose uses have been extended or developed or are capable of being developed. It is a matter of notoriety that numerous products of the vegetable kingdom require only to be more generally or better known to become more largely used. New products which reach our markets often fall entirely through, simply for the want of a proper appreciation of their value or of some one to take them up and properly test them. This task Mr. Christy seems to have set himself to do, for in his preface he asks for information upon new drugs or plants, such as notes bearing upon their properties and uses, and what is a very valuable point indeed, he appeals to residents in tropical countries for flowers, leaves, and fruits of any useful plant, all of which can be sent any distance in perfect condition in jars or bottles filled with salt and water. This advice is well worthy of consideration by those in distant lands who have opportunities for sending home such specimens, for it often happens that much time, trouble, and expense are thrown away by sending home specimens in such a manner that they rot on the voyage.

As an illustration of what is a "new commercial" product so far as this country is concerned, but which has been known and used in India for a long time, we may mention the Chaulmugra (*Gynocardia odorata*), a full description of which, accompanied by a figure, is given by Mr. Christy. It is not a little remarkable the rapidity with which the oil from the seed of this tree has become adopted by the medical profession in this country for consumptive and cutaneous diseases. Amongst the other plants treated of in the pamphlet under review are *Urostigma vogelii*, Miq., a new source of india-rubber from West Africa, the Mahwa tree (*Bassia latifolia*, Roxb.), a native of the East Indies, the flowers of which are produced very abundantly and yield a large quantity of spirit.

A glance through the pamphlet will give an idea of what kind of products different parts of the world are yet capable of supplying.

LETTERS TO THE EDITOR

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

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

American Weather

I INCLOSE you a cutting from the *Manitoba Weekly Free Press* of December 14, 1878, containing a record of what I cannot but think is a phenomenon unsurpassed in the annals of meteorology. For a month to exceed its average temperature by the amount of twenty-five degrees is scarcely credible even in such a continental climate as that of Manitoba. An editorial paragraph from the same paper which I also inclose will show that the fact has not been overlooked by the Manitobans, and that their attention has also been drawn to the occurrence of the reverse characteristics in the weather over here. Surely the moral of all this is universal synoptic weather charts. The whole thing at present is worked on far too small a scale. The daily papers contain a weather chart which comprises scarcely a quarter of Europe, and of what goes on outside the limits of this we are practically ignorant, unless we hunt up reports when the atmospheric conditions they refer to are long past. Even granting the impossibility of drawing the daily isobars over the North Atlantic, except hypothetically, would it not probably have thrown much light on the proximate causes of, and probable duration of, our recent cold weather here, had we been able to secure a daily synoptic chart of the isobars over America, as well as those over our own islands and the countries immediately adjacent? Surely the valuable results which would follow such an extension of our present system would quite compensate for the extra outlay incurred. E. D. ARCHIBALD

January 11

"*Weather Record for November*

"The following is Mr. Stewart's monthly record of the weather:—

"The highest reading of the barometer in the month was 29·650 at 7 A.M. on the 7th; the lowest reading was 28·643 on the 26th, showing a monthly range of 1·007 inches. The mean barometrical pressure for the month was 29·1377 inches. The highest temperature in the month was 53·3 on the 17th; the lowest temperature was 10·3 on the 30th; the warmest day was the 17th, the mean temperature being 44·10; the coldest day was the 29th, the mean temperature being 18·25. The mean temperature of the month was 30·75, being 25·73 *higher than the average of the month for the past seven years.* The mean monthly pressure of aqueous vapour was 0·148, and the mean humidity of the month was 83. The mean amount of sky clouded was 0·45. The highest wind in the month occurred at 8 A.M., on the 14th, the force being at the rate of 24 miles per hour. The most windy day in the month was the 14th, the average daily force being 15·92 miles per hour; the least windy day was the 7th, the average daily force being 2·42 miles per hour; the mean monthly velocity was 7·89 miles per hour. The prevailing direction of the wind was south. The total amount of rain that fell during the month was 0·070 inches; total amount of snow, 1·45. Total precipitation of rain and melted snow, 0·220 inches. The Red River opened again on the 18th. On the same day the steamboat *Lady Ellen* arrived from Lake Winnipeg; on the 23rd the steamer *Cheyenne* arrived from Pembina. The Red River was finally frozen over on the 27th. Two auroras and two lunar coronas were seen in the month."

The following is the editorial comment referred to:—

"The peculiar freaks of the weather during the last year or wo have defied the most ingenious efforts of the weather prophets to foreshadow its complexion with any degree of truthfulness. It is a comparatively easy task to depict the general characteristics of a season under ordinary circumstances, when the seasons for a number of years have shown no marked deviation from their usual regularity, but the abnormal nature of the weather of late has set the prophets completely at sea. The predictions of those wise-acres who, a month or two ago, told us the present season was to be excessively severe, and cited the musk-rats, the beavers, and the cornshucks, to support the prognosis, have not been verified up to the present, and without attempting the prophecy business ourselves, we would remark that the indications are against any unusual severity this season. *November has been mild to a marked degree*, and indeed the whole fall, which has just passed into winter, has been exceptionally pleasant. There has been severe weather both in Europe and Asia, and heavy frosts have fallen in England, Austria and Italy—and it has been remarked that when the winters in the Old World are very cold, they are very moderate in America."

The Microphone

IN a recent letter (NATURE, vol. xix. p. 221) Dr. Bleekrode mentions the fact that a microphone through which a strong current is sent emits an audible sound; the electro-dynamical action of the current on its movable part is considered the origin of it.

The experiment is a very interesting one, and is nearly related to the facts I published in NATURE, vol. xviii. p. 642. But I cannot agree with Dr. Bleekrode in the interpretation. It is my opinion that no electro-dynamical action is in play, but only a dilatation at the points of contact.

In a circuit were placed a battery, a tangent-galvanometer, and two pieces of carbon, which supported a third one. A sound was heard and sparks were seen. The galvanometer showed that the intensity of the current increased, the deflection increasing from five to ten degrees. This proves the influence of the clouds formed at the points of contact.

The pieces of carbon were then inclosed in very flat sheets of platinum, and the experiment repeated. No sound was heard; the deflection of the galvanometer rose to 28°. When a rough sheet of platinum was taken the intensity of the current fell again, sparks were seen, and a sound was heard.

Dr. Bleekrode believes that, the coefficient of dilatation of carbon being small, the sound cannot be caused by dilatation at the points of contact. But the temperature of those points is very high, a great part of the heat generated in the circuit being produced here.

I cannot see that his experiment is a true demonstration of the repulsive action between the subsequent parts of a current. In my opinion the experiments of von Ettingshausen (*Sitzungsberichte der Wiener Akademie*, lxxvii. p. 109) are considerably more convincing. Von Ettingshausen found that, with a current which was somewhat stronger than the one I made use of, the influence of the earth-magnetism was almost as great as that of the electro-dynamical action. Moreover, this action depends upon the relative position of the movable part and the other parts of the circuit. Now I have not been able to detect the slightest variations in the sound by changing the position of the movable piece of carbon in relation to the direction of the dipping needle, or in relation to the other parts of the circuit.

I therefore hold to the explanation of the acting of the microphone as a receiver, which I believe I was the first to propose. In my opinion it depends upon the varying dilatation at the points of contact by the varying intensity of the current.

Breda, Holland, January 13 V. A. JULIUS

The Formation of Mountains

THE quotation given by Mr. Wallace from the English Cyclopædia affords a sufficient basis to prove "the more rapid [present] cooling of the interior of the globe than of the crust." I will add a passage from Sir W. Thomson's "Secular Cooling of the Earth," of a like tendency: "I think it cannot be denied that a large mass of melted rock, exposed freely to our air and sky, will, after it once becomes crusted over, present in a few hours or a few days, or at most a few weeks, a surface so cool that it can be walked over with impunity. Hence, after 10,000 years, or, indeed, I may say a single year, its condition will be sensibly the same as if the actual lowering of temperature experienced by the surface had been produced in an instant, and maintained constant ever after." [1]

[1] *Trans.* R.S. Edin., 1862; also Thomson and Tait's "Nat. Phil.," App. D.

This constant temperature of the surface having been once established, the internal parts would be hotter than the crust, and their heat must then necessarily, by the law of conduction, pass from the hotter to the cooler region, and so into and through the crust, and be radiated away from the surface into space, the kind of action which I illustrated in my former letter by the dispersion of a crowd. Thus the interior would tend to fall to the already established temperature of the surface, and thenceforth tend to cool more rapidly than the "crust." For the nearer a stratum lies to the surface, the less cooling will be requisite to bring it down to the temperature of the surface. To take the extreme case; after the lapse of an infinite time the whole globe would eventually become of the temperature which the surface assumed at that already far-distant epoch, and has maintained ever since.

When the superficial strata had early assumed their nearly permanent temperature, they will concomitantly have attained a corresponding permanent volume, which will afterwards have proved too large for the cooling interior, so that they must, in subsiding, have become wrinkled. To this extent, then, I think Mr. Wallace's objections are untenable. Here, however, enters the question, so difficult to answer in nearly all geological problems, of "How much?" For my part, I think I have proved that the mere cooling, though a *vera causa*, would not be of itself a sufficient cause to account for the inequalities existing now, at what must be, judging by the enormous store of heat still within the earth, a comparatively early stage of the cooling.[1] O. FISHER

Harlton, Cambridge, January 18

Leibnitz's Mathematics

IN NATURE, vol. xix. p. 196, I see there is a letter respecting the claims of Newton and Leibnitz to the discovery of the differential calculus. In view of any future discussion of this matter it seems to me that the following extract from a letter of Leibnitz to James Bernoulli is worth the consideration of the advocates of both claimants:—

"Ego qui semper hoc habui eximium, ut essem mortalium docillimus, sæpeque luce ex unius magni viri verbis pauculis hausta innumera mea meditata nondum matura delevi; statim arripere monita summi mathematici."—Ex epistola Leibnitii ad Jac. Bernoullium, April, 1703, data.

The sense of this passage may, I think, be fairly rendered into English as follows:—

"I [am one] who ever regarded this as most important, that I should be most apt of mortals to receive instruction, and frequently light having been drawn from a very few words of a great man, my countless meditations not yet ripened I have blotted out forthwith to seize upon the hints of the most eminent mathematician." JAMES BOTTOMLEY

Lower Broughton, near Manchester, January 13

I HOLD myself prepared to make good my own assertions, and to respond to Mr. A. B. Nelson's call as soon as I know whether Prof. Tait has abandoned his position, or, if not, what he has to say in justification of his proceeding in denying Leibnitz to be a mathematician and affirming him to be a thief.

I am sure the editor will allow me to reply to his postscript. It is certainly not to be presumed, as a matter of course, that when Prof. Tait "lets pass such a challenge he has given up his point." But I do insist upon it that this "hard-worked scientist" had no right to pass it by after having provoked it. He put himself in the wrong, and I left him there.

But as to this being a question of merely "antiquarian interest," I take leave to deny it. I revere the name and intellect of Leibnitz, and I, for one, have a human interest in clearing that name from a foul slander. Nor should we pass by the main issue to discuss the collateral question which the editor raises in respect of Gregory's series. C. M. INGLEBY

Valentines, Ilford

German Degrees

IT having come to the certain knowledge of the Faculty of Philosophy in the University of Erlangen that a fraudulent trade is carried on in England under a pretence of procuring doctor diplomas of the said Faculty, I consider it in the interest of the public hereby to make it known that promotions *in absentia* are not conferred in that faculty, and that no one in England, or elsewhere, is, or has ever been, authorised to confer or negotiate for the conferring of such diplomas.

E. LOMMEL,
Dean of the Faculty of Philosophy,
Erlangen, January 14 University of Erlangen, Bavaria

Feeding a Python

THE following details of a recent attempt to feed a python now at the Raffles Museum, Singapore, may be of interest as upsetting previous ideas as to the certainty of that reptile's attack:—

The python in question is a fine specimen caught on the island, for the sake of the reward given by the police in such cases, and measures about 22 feet in length. It has been in my charge for about two and a half months, during which time it has not been fed. About ten days since it commenced casting its skin, and, as is usual after that proceeding, was unusually lively, snapping at a stick put into the cage, and in one or two instances narrowly missing the attendant's hand. The reptile, I should mention, escaped from its cage just before casting, but having taken refuge beneath some odds and ends of timber near the museum, was recaptured without difficulty, and was then placed in a cage about 5 feet square every way.

A pariah dog having been obtained, it was introduced, muzzled, into the cage, the muzzle being then slipped. While entering, the snake struck twice at the dog's hind-quarters, but without seizing it. The dog crept into a corner and sat down. Two or three more blows were then made by the snake, but, as before, without gripping, and the dog was then seen to have been struck by the teeth on the fore-quarters, the punctures slightly bleeding. *For nine successive times* the snake struck at the dog with the same ill-success, and as it was then growing dark, the shutter of the cage was closed. Early next morning the snake was found coiled round the dog, which it had killed and commenced to swallow; but a Malay attendant having touched the python with a rod, it untwined itself and retreated to a corner of the cage, refusing to again touch its prey.

I may be misinformed, but have always understood that snakes of the python or boa tribe seldom renew their attacks if the first fails; and I shall be glad if you can direct me to any published experience on the subject. The python in question is a male.

Singapore, November 25, 1878 N. B. D.

Shakespeare's Colour Names

I FEAR it would be somewhat rash to convict Shakespeare of colour-blindness, or even vagueness in the use of colour-names, solely on the evidence of the Nurse in "Romeo and Juliet"—a lady who is the Mrs. Malaprop of the play, and whose extraordinary faculty for the confusion of terms may perhaps have contributed somewhat to the "merriness" with which she credited her husband. It is possible that the Nurse—in the passage quoted by Mr. J. J. Murphy (NATURE, vol. xix. p. 197)—meant to convey the idea of a *hazel* eye, which would not be far removed in colour from that of an eagle, but also often has a slight tendency to a greenish hue. The nurse, not being particular as to the precision of her descriptions in general, refers to it as green.

It is likely besides that Shakespeare deliberately intended the incongruity, just as in the "Midsummer Night's Dream" he makes the bumpkin who acts Thisbe in that piece of "very tragical mirth," *Pyramus and Thisbe*, lament

"Those lily brows,
This cherry nose,
These yellow cowslip cheeks,

His eyes were green as leeks."

This passage indeed shows that Shakespeare knew perfectly well the chromatic meaning of green.

A very cursory glance through Shakespeare will show innumerable lines where colours are referred to in their true and exact sense.

Here are a few passages selected with special reference to the colours green and blue.

Prospero's description of the witch Sycorax:—

"This blue-eyed hag."—*Tempest*, i. sc. 2.

(The ideal Scandinavian witch.)

[1] Cambridge *Phil. Trans.*, vol. xii. part 2.

"... white and azure, laced
With blue of heaven's own tint."
Cymbeline, ii. sc. 2.

"Whose ranks of blue veins."—*Lucrece*.

"Those blue-veined violets."—*Venus and Adonis*.

"Where fires thou find'st unraked, and hearths unswept
There pinch the maids as blue as bilberry."
Merry Wives of Windsor, v. sc. 5.

"And *Hony soit qui mal y pense* write
In emerald tufts, flowers purple, blue, and white,
Like sapphire, pearl, and rich embroidery."—*Ibid.*, v. sc. 5.

Here there is no confusion. The comparisons are exact and beautiful. Again we have—

"When wheat is green, when hawthorn buds appear."
Midsummer Night's Dream, i. sc. 1.

The season indicated shows there was no confusion between green and *brown*.

We must not forget the well-known song—

"When daisies pied and violets blue,
And lady-smocks all silver white,
And cuckoo-buds of yellow hue
Do paint the meadows with delight."
Love's Labour Lost, v. sc. 2.

And to conclude our comparisons of green and blue—

"... I will rob Tellus of her weeds
To strew thy green with flowers: the yellows, blues,
The purple violets, and marigolds,
Shall as a chaplet hang upon thy grave."
Pericles, iv. sc. 1.

Returning to the colour of eyes. Shakespeare not only knew a blue eye, but could discriminate, and appreciate the beauty of a grey eye—a shade which often does duty for blue. The lovely rivals Julia and Sylvia are so endowed—

"Her eyes are grey as glass—and so are mine."
Two Gentlemen of Verona, iv. sc. 4.

"... Thisbe, a grey eye or so."
Romeo and Juliet, ii. sc. 4.

I think the above quotations afford good proof of the poet's correctness of colouring with regard to green and blue. It is true that he occasionally uses a small degree of licence with purple and blue, in the case of violets; but clearly not from unconsciousness of the difference. I cannot remember any instance where he confuses green with blue except purposely and humorously.

In the use of other colours Shakespeare is in most instances I am acquainted with equally true to nature. To give examples would occupy too much space; but if there are exceptions I have no doubt that your correspondents—now that the matter is broached—will be able to furnish them.

Sligo, January 10 EDWARD T. HARDMAN

Intellect in Brutes

THE following incident may interest some of the readers of NATURE, as affording evidence of the possession and exercise of reasoning power by a brute. During the present frost the window-sills of my drawing-room are supplied with bread for the benefit of the birds, who, finding food there, are constantly fluttering about the windows. One day a large water-rat was seen on the window-sill, helping himself to the bread In order to reach the window he had to climb to a height of about thirteen feet: this he did by the help of a shrub trained against the wall. Neither instinct nor experience will easily account for his conduct: since he never found food there before. If neither experience nor instinct, what save reason led him? His action seems to have been the result of no small observation and reasoning. He seems to have said to himself—I observe the birds are thronging that window all day; they would not be there for nought; it may be they find there something to eat: if so, perhaps I too might find there something which I should like. I shall try.

Bardsea EDWARD GEOGHEGAN

OUR ASTRONOMICAL COLUMN

OLBERS' COMET OF 1815.—On March 6, 1815, Olbers discovered a small comet at Bremen, in about 49° right ascension, and 32° north declination, or between Perseus and Musca; it had an ill-defined nucleus and was not visible without telescopic aid. The first parabolic elements were calculated by Olbers himself, and he was followed by Bessel, Gauss, Triesnecker and others in the determination of similar orbits. Ephemerides founded upon them showed that the comet would be observable for a considerable period, and as the result proved observers were not negligent of this circumstance. Gauss, writing to Bode on April 24, alludes to the long visibility of the comet, and the probability that elliptical elements would be found, but this remark apparently was merely intended to imply that the grasp which a long course of observation would afford upon the orbit, might lead to an ellipse, not that Gauss had remarked any sensible deviation from parabolic motion; indeed he mentions that he had not then reduced his April observations. The first detection of the inadequacy of the parabola to represent accurately the comet's course, is due to Bessel: he had calculated parabolic elements from observations on March 11, April 11, and May 20, which, while agreeing well with the positions employed, gave the right ascensions sensibly too small from March 11 to April 11, and between April 11 and May 20, as decidedly too great, even to as much as 4′, and on May 26, the calculation was again many minutes in defect; these differences naturally induced Bessel to relinquish the parabolic hypothesis, and after some disappointment from the failure of the first method he employed, he communicated to Olbers on June 23 the elements of an elliptical orbit, in which the period of revolution was a little over 73 years. At the end of June Gauss deduced an ellipse with a period of 77 years, and soon afterwards Nicolai, then assistant to von Lindenau at Gotha, added a further confirmation of the elliptical character of the orbit, assigning a revolution of 72½ years. On July 22, being in possession of observations to the middle of the month, Bessel improved upon his first calculation, and now found an ellipse with a period of 73·8968 years, which was made the foundation for his subsequent investigations, of which we have presently to speak. Thus was the periodicity of the comet established, and Bessel, after remarking upon the importance of the addition to the system (at that time Halley's comet was the only one that could be considered certainly periodical) he proposed that it should bear the name of its discoverer—Olbers.

Besides a long series of observations taken by Olbers himself, the comet was observed by Gauss at Göttingen, Bessel at Königsberg, Triesnecker at Vienna, Struve at Dorpat, Oriani at Milan, Lindenau at Gotha, Maskelyne at Greenwich, and Bouvard at Paris. Its distance from the earth continued pretty nearly constant (about 1·45) during the greater portion of the time it was visible, and at no period was it a conspicuous object; its nucleus was pretty bright at the beginning of May, and it then had a tail about 1° in length.

On the disappearance of the comet Bessel collected the observations which extended to August 25, the last having been made by Gauss at Göttingen; indeed, he was the only observer after July 25. He then commenced the work which is incorporated in his great memoir upon this comet, published in "Abhandlungen der königlichen Akademie der Wissenschaften in Berlin, 1812–13," a volume which was not published until 1816. He formed ten normal positions, in which all the observations appear to be brought to bear, excepting those at Greenwich and Paris, which were doubtless unknown to him. He corrects these normals for the effect of perturbations from the action of Venus, the Earth, Mars, Jupiter, and Saturn, during the comet's visibility, and by a fine series of observations of the sun at Königsberg between March 8 and August 29, 1815, he applies corrections to the sun's places obtained from Carlini's first tables. Equations of condition were then formed and solved on the method of least squares, and thus the following definitive elements of the comet's orbit in 1815 were obtained:—

Perihelion Passage, April 25·99867, M.T. at Paris.

Longitude of the perihelion	149° 1′ 55″·9	1815·0
,, ,, ascending node	83 28 33·6	1815·0
Inclination of the orbit to ecliptic... ...	44 29 54·6	1815·0
Excentricity	0·93121968	
Semi-axis major	17·63383	
Logarithm of perihelion distance	0·0838109	
Period of revolution	74·04913 years.	

Motion—direct.

These elements represent the normals upon which they are founded very closely, considering that observations of comets in 1815 did not pretend to the degree of precision which is now sought to be attained, and, moreover, were subject in the reductions to errors in the places of the comparison stars.

But Bessel's labours did not stop here. With a special interest in the comet of 1815, not, it may be presumed, alone due to its exceptional character, but in no small degree to the circumstance of its having been detected by his most intimate and revered friend, Olbers, Bessel undertook, and in the year of its appearance accomplished, the laborious task of computing the perturbations of the planets Jupiter, Saturn, and Uranus upon the motion of the comet during the present revolution, and so determining the epoch of the next perihelion passage. The principal details of this work are comprised in the memoir to which we have already referred. The masses of Jupiter and Uranus were Laplace's, while the mass of Saturn was taken from Bouvard's tables. The whole period is divided into three sections, the first extending from August 4, 1815, to July 30, 1833; the second from the latter date, with new values of the semi-axis and excentricity to July 21, 1869, and the second from July 21, 1869, to the next perihelion passage. The action of each of the three planets tends to accelerate the comet's return, that of Jupiter by upwards of two years; the final result indicating an acceleration of 824·51 days, with reference to the period belonging to Bessel's definitive ellipse for 1815; it was thus found that the duration of the actual revolution would extend to 26222·4 days, and consequently the next perihelion passage is fixed to February 9·4, 1887. This conclusion will be affected not only by the imperfect values of the planetary masses which were available when Bessel undertook the investigation, but in a greater degree by the uncertainty which still remained as to the precise length of the revolution at the last appearance; this Bessel found to extend to ± 0·27657 of a year, or 101 days.

With such an amount of probable error attaching to Bessel's result it must soon be a matter for the consideration of the astronomer, whether a nearer approximation may not be yet attained. We have much more accurate values of the masses of Jupiter, Saturn, and Uranus than Bessel possessed, and are able to take into account the influence of Neptune, though this is not likely to be very material. Fortunately, in several series of observations, the observed differences of right ascension and declination between the comet and the comparison stars are preserved to us, and thus we can reduce the observations anew, with much improved positions of many of the stars and with modern elements of reduction. The series of observations thus available include the long one of Olbers (*Berliner astronomisches Jahrbuch*, 1818), and those of Greenwich, Paris, and Dorpat. It is a work which, together with the recalculation of the perturbations to the next perihelion passage, may perhaps be made the subject of a prize by one or other of our scientific academies; on the last return of Halley's comet, the first approximation to the epoch of arrival at perihelion was due to action of this kind on the part of the Academy of Turin, and though a much higher degree of interest attached to the reappearance of that famous body, we do not despair to see Olbers' comet deemed worthy of a new and more refined calculation.

If these cometary bodies wandering into the confines of the solar system from the stellar spaces are fixed therein by the action of one or other of the planets, it will have been owing to a very close approach to the planet Mars that Olbers' comet presented itself in 1815, moving in an ellipse of moderate dimensions. The nearest approach of the two orbits in that year was 0·07 in 86°·4 heliocentric longitude, but this distance must have varied in successive revolutions through the perturbations of the other planets, and at some past time there may have been an intersection of the orbits and a close encounter of the two bodies.

METEOROLOGICAL NOTES

BEFORE the commencement of the summer rains this year Mr. Eliot, the officiating meteorological reporter to the Government of India was called upon for a report on the prospects of the season. His reply, to which we have already referred in the "Notes," consisted of a short *résumé* of the most important characteristics of the south-west monsoons of recent years, from which the following conclusions were deduced:—"1. The persistent excessive pressure over Northern India at the present time (June, 1878), tends to diminish the baric gradient between Southern Asia and the Mid-Indian Ocean, and if this is not compensated by increased pressure over the sea area to the South of India, the monsoon current will be below its average strength. 2. There appear to be no strongly-marked abnormal variations of pressure over Northern India. It is therefore probable that the rainfall will be much more equally distributed than last year. 3. Comparing the present year with 1865, it is probable that the heavy rainfall during the cold weather, and more especially in May, will slightly retard the advent of the monsoon in Upper India. 4. The probable effect of the low pressure along the Bombay coast cannot be determined except by comparison with last year. It appears to promise fairly abundant rain over that portion of the country." These conclusions have now been subjected to the test of experience and are found to have been verified in almost every particular. The southerly current from the Indian Ocean has been decidedly below its normal strength; the rains set in from a fortnight to a month after the usual time; every district in the country has received a moderate supply of rain, though the average rainfall for the whole country has been less than usual, and over the Bombay Presidency, from Belgarum to Kurrachee, the rainfall has been in excess of the average for previous years. The only peculiarity of the monsoon of 1878, that was not predicted, was the frequent recurrence of heavy falls of rain over a few small and well-defined areas; but this would seem to be the character of the rainfall of every year in which the monsoon current is of less than the usual strength. The percentage of verifications reached by Mr. Eliot has thus been as great as that attained by the American observers, and the predictions in his case were made months, not days or hours, in advance. The same meteorologist has recently made a discovery which promises to be of the greatest possible value in connection with the system of storm-warnings to the ports round the Bay of Bengal. It is that a cyclonic vortex, when generated in the middle of the Bay, always travels towards that part of the coast where the wind velocity for the time being is least in comparison with the average velocity for the same place and time of year. This law has been verified by almost all the cyclonic disturbances that have occurred in the Bay since a chain of meteorological observatories was established round it, and it lends a great deal of support to the theory that a cyclonic vortex is developed through the accumulation, concentration, and condensation of aqueous vapour over a region of comparative calm. All that appears now wanted to render cyclone prognostications for the Bay of Bengal almost absolutely certain is a submarine cable to the Andaman and Nicobar Islands, by which the meteorological stations on these islands, near the place of origin of all the great cyclones of the Bay, would be brought into telegraphic communication with the rest of the empire.

IN his "Tenth Contribution to Meteorology," which appears in the *American Journal of Science and Arts* for the present month, Prof. Loomis gives the results of an examination he has made as to the course of seventy-seven storms after leaving the eastern coast of the United States, these storms having occurred from March, 1874, to November, 1875. Of these seventy-seven storms he was able to follow thirty-six of them entirely across the Atlantic Ocean, eight of them, however, becoming merged in other storms before reaching Europe. The annual average of storms which are found to cross the Atlantic from the United States to Europe is eighteen, and nearly all of these storms pursued a course north of east, passing in their eastward course considerably to the north of Scotland; indeed, in only four of the storms did the centre pass as far south as the north of England. Prof. Loomis concludes that, when a storm with a centre depression at least below 29·5 inches leaves the coast of the United States, the probability that it will pass over any part of England is only one in nine; that it will occasion a gale anywhere near the English coast, one in six; and that it will give rise to a fresh breeze, one in two. A characteristic feature of these storms is the slow rate of their onward progress in crossing the ocean, as compared with their rate over the United States—a feature of the utmost possible importance in attempting to predict the time of their descent on the shores of Europe of those American storms which cross the Atlantic. About half of the whole number of the storms originated in the neighbourhood of the Rocky Mountains, five in or near Texas, and four were distinctly traced to the Pacific coast. Of six West India cyclones which occurred in the same time only two could be traced across the Atlantic, and even one of these became blended with another storm. The rest of the paper is taken up with a discussion of the fluctuations of the barometer on Mount Washington, 6,285 feet, and Pike's Peak, 13,960 feet, as compared with what takes place on the level ground at the base of these mountains. As regards Mount Washington, the valuable result is arrived at that the diurnal maxima and minima of the barometer occur more than three hours later at the summit than at the base, showing an average retardation of one hour for each 900 feet of elevation. In the case of Pike's Peak, the rate of retardation is one hour for an elevation of 1,380 feet. It is evident from these figures that the law of the rate of retardation is yet to be sought, one of the most important factors, in all probability, being the absence or presence of high plateaux and their extent near the high station, to which must be added the latitude of the place. Observations of the wind at these high levels show, just as at places near sea-level, a circulation about a low centre, the movement of the wind being approximately at right angles to the direction of the low centre; and further, that at the height of Mount Washington, the low centre of storms sometimes lags behind the low centre at the surface of the earth as much as 200 miles. This last result is so vital in the theory of storms as to demand a much more extended examination, the most special care being taken that the retardation of the time of occurrence of the diurnal barometric minima be allowed for in the discussion.

IT is with extreme satisfaction we learn that at a recent meeting of the Council of the Scientific Association of France, M. Mascart, Director of the Meteorological Department, submitted a proposal from the Departmental Commission of Vaucluse, for the establishment of an observatory on the top of Ventoux, situated to the north-east of Carpentras, and rising above all the surrounding summits to a height of 6,300 feet above the sea. This observatory in the south of France, along with the observatories of Puy de Dôme in the north, and of Pic du Midi in the south-west, may be regarded as furnishing France with an enviable system of elevated observatories for meteorological observations such as no other country possesses, thus putting French physicists in possession of the essential data whence the more difficult meteorological problems may be attacked, and the systems of weather-warnings for navigation and agriculture more rapidly developed and improved. It is estimated that 150,000 francs will be required to establish the station, of which sum there are already subscribed by M. R. Bischoffsheim 10,000 francs, by the Commune of Bédoin, situated at the foot of Mt. Ventoux, 10,000 francs, the Council of the Scientific Association 500; and as the Meteorological Commission of Vaucluse has opened a subscription-list, the General Council of the Department has promised to aid in forming the roadway up the mountain, and a subsidy is looked for from the Minister of Public Instruction, the establishment of this important observatory will doubtless soon become an accomplished fact.

GEOGRAPHICAL NOTES

WITH reference to the reports that Prof. Nordenskjöld's vessel had got shut in by the ice near East Cape, in Behring Strait, the Committee for Promoting Russian Trade and Industry have resolved to apply to the Governor-General of Eastern Siberia, requesting him to assist in instituting a search for Prof. Nordenskjöld, and in obtaining more certain information as to the situation of the expedition. Mr. W. H. Dall, the well known U.S. Alaska explorer, has written a letter to an acquaintance in Stockholm, mentioning the previously-reported statement of whalers, from which it is supposed that the *Vega*, has been stopped by ice east of Cape East. Should this be the case, Mr. Dall entertains no fears for the fate of the expedition. If these suppositions be correct, he says, "the breaking up of the ice next July will leave open water for the *Vega* to proceed to Behring Strait. Vessels pass to westward of East Cape every year. There is a creek there. (The letter here gives a sketch map describing a bay, with a small island in the middle of it, and an anchorage inside.) A river with fresh water runs into the bay, and on the coast is a native village. This is not marked in the ordinary maps and charts, and it is just here that the vessel, according to the repots of the natives, must be lying. She can safely winter there. There is a large village, inhabited by Tchuktchees, who would be able to supply fresh meat. This place is situate not more than 200 English miles from the white men's trading station at Plover Bay. If the *Vega* is lying there, the success of the operation is practically achieved, because, as I said, the bay is open every year, and does not get closed by ice until October. Vessels sail there, and carry on trade every summer."

THE last number of the *Isvestia* of the Russian Geographical Society contains an interesting paper by M. Grigorieff, on the temperature and density of water in the Arctic Ocean, along the coast of Russian Lapland, and in the White Sea, being the result of observations carefully made on board the schooner *Samoyede*, by means of good instruments. As to the Arctic Ocean, M. Grigorieff confirms the existence of a warm branch of the Gulf Stream which flows along the coast as far as Gavrilovskiye Islands, and thence turns due east to the Kanin Peninsula and Kolgueff Island, and further, to the Moller Bay on Novaya Zemlya. Beneath this warm current there is a cold one flowing in an opposite direction at some depth. When it meets with a rising bottom, and especially with the deep bank of less than 100 fathoms under 71° N. lat., this denser and cold current is compelled to change its direction, and makes its way between the Gulf Stream and the shore; hence the low temperatures and great density of water at the Lapland coast, in the space between Svyatoy Nos and the Seven Islands. The density of the eastern (North Cape) branch of the Gulf Stream (1·025 to 1·026, figures which correspond to a percentage of salt of from 3·28 to 3·41), seems to be smaller than that of the Spitzbergen branch, where Nordenskjöld has found a percentage of salt as high as 3·625. As to the White Sea, M. Grigorieff denies the entrance of a branch of the Gulf Stream into that sea, as was supposed some years ago by Prof. Middendorff; the Gulf Stream does not penetrate further than the Gulf of Mezen, and the warm temperatures observed by Middendorff are due to purely local causes. On the contrary, a cold polar current enters the White Sea along the Tersky coast, whilst the current which flows out of the sea into the ocean, follows the Winter and Kanin Coasts. The water of the White Sea on the whole has a very low temperature, especially in the deeper parts; on depths more than 100 fathoms the temperature is always below 32° Fahr., and this, because of the great loss of heat during the long winter. Altogether, the observations having been made and computed very carefully, and published *in extenso* in the *Isvestia*, are a real acquisition to science.

TWO new expeditions to Central Asia are planned in Russia for the next spring. The first, by Col. Prjvalsky, to Hlassa in Thibet, and thence to Afghanistan; and the other, by M. Blumenfeld, a German *savant* who has studied in Russia, for botanical and geological explorations; M. Blumenfeld will follow nearly the same route as that proposed by M. Prjvalsky.

UNDER the title of "D'Orenbourg à Samarkand" Madame de Ujfalvy has commenced in the *Tour du Monde* an illustrated account of her travels in Ferghanah and Western Siberia. Leroux, of Paris, has just brought out the first volume of M. de Ujfalvy's account of the results obtained during his mission. These results are mainly ethnological, and contain many observations and careful and detailed measurements of a large number of individuals representing the various races of that part of Central Asia visited by the traveller and his wife.

DURING the year 1878 the following accounts of Russian exploration were published in Russia: that of Col. Prjvalsky to Lob-Nor, now translated into English; of M. Wojeikoff in India and Japan; rather literary than scientific is that of M. Minayeff on his journey to India, which contains very interesting observations on Buddhism; of M. Ogorodnikoff to Persia, giving among other data an account of the trade-routes to Persia and Afghanistan; and of M. Skalkofsky to Eastern Asia and California.

AS Sir H. Rawlinson has announced his intention of delivering an address at the next meeting of the Geographical Society, on the road to Merv from the Caspian, it will not be without interest to note some particulars respecting the earlier part of the route, as far as the Tekké fort of Kizil Arvad, from an account lately furnished to the *Moscow Gazette* by a writer who appears to have been attached to General Llamakin's staff. The party were obliged to strike eastwards from the Chikishliar littoral by a road which has never yet been described, but which is the most practicable route to the Attrek, the bank of that river, from its mouth at Hassan-Kuli Bay almost to Balt Adji, being bordered by inapproachable morasses. The ground traversed was at first covered with shells, but soon presented the appearance of a salt marsh petrified by the sun; then, after a stretch of sand, firmer soil was met with. No water was found until the wells of Karadji-Batyr were reached. About twelve versts from the wells the party arrived at the gates, as it were, of an enormous wall, which bore a greater resemblance to an artificial structure than to a natural conformation of the soil. Three versts further on the valley of the Attrek appeared in sight, with the river itself winding between high and verdant banks. Here is Bayat-Adji, a name which is also applied to the whole of the surrounding country. From this spot the party proceeded up the Attrek to Chat or Chad, following an excellent road. About ten versts before reaching Chat the road turned to the left, leaving the Attrek at a point where there are large *auls*, or settlements of the Atabai tribe. At length Chat was reached, and it is described as the most repulsive place along the whole Attrek, although from a strategical point of view the most important, because it is here that the River Sumbar (which Capt. Napier calls the Sunt) flows into the Attrek, and the delta might be made an impregnable position. Fifty versts above Chat two enormous rocks rise out of the Attrek, forming a sharp delimitation of the geological structure of the country. This place is called Su-Sium; after this point the road is impassable for camels, and 10 versts further on is difficult even for horses; 100 versts beyond Chat the course of the Attrek can only be followed on foot, and it would take three months to make the road practicable. In consequence of the difficulties mentioned, the party was obliged to abandon the course of the Attrek at Su-Sium, and to strike a new road. After making the necessary surveys they turned to the left at a place called Alun-Yak, and proceeded over the high Sugundag chain. The ascent and descent of the Sugundag extends over a distance of 16 versts, the descent terminating at the small River Chandyr, which falls into the Sumbar. Twenty-five versts from Chat the party crossed the Sumbar, and marching between that river and the Chandyr, reached an elevated mountain called Bek-Tépé, belonging to the spurs of the Kurindag. Leaving the Sumbar they proceeded through the waterless defiles of the Ters Akon, and through the Morgo defile (belonging to the Kaplandag range), and reached the ruins of Hadjan-Kala, near the Tekké fort of Kizil Arvad. The road through the defiles presents many difficulties, and only two horses can proceed along it abreast, but it is thought that a good road could be made without much trouble or expense.

THE Society for Promoting Christian Knowledge publishes a very excellent small wall-map of Africa, by Stanford, containing all the most recent discoveries and useful both for teaching and general purposes.

ON January 25 the Geographical Society of Paris will hold a public reception in the large hall of the Sorbonne, in honour of MM. de Brazza and Ballay, the two French Ogowé explorers. The great medal for 1879 will be delivered on this occasion by Admiral La Roncière le Nourry, the president of the Society.

NO. 78 of the *Zeitschrift* of the Berlin Geographical Society contains a careful geographical and statistical study on the Brazilian province of Rio Grande do Sul, by M. Bescharn. Botanical students will be interested in Dr. Klunzinger's elaborate paper on "The Vegetation of the Arabian Desert near Koseir." This number contains a carefully arranged, most complete, and valuable bibliography of geographical literature and cartography for the year from November, 1877, to November, 1878.

NO. 3 of *Globus* of this year contains a fine illustration of the wonderful reclining statuary figure of Chac-Mool, unearthed in Yucatan some time ago by M. le Plongeon. The same number contains the sixth contribution of Herr Zehme to a *résumé* of recent exploration in Arabia.

THE GEOLOGICAL HISTORY OF THE COLORADO RIVER AND PLATEAUS[1]

II.

IN the Pliocene period the climate of the region gradually experienced a great change. Miocene times were characterised by a moist and ordinary sub-tropical climate; the Pliocene by developing an arid one, like that which now prevails there. Let us look at the causes which make this climate what it is. In whatever rectilinear direction we may undertake to pass from the Pliocene Country to the ocean we shall be compelled to cross some of the loftiest barriers of the Continent. It is hemmed in by range after range of high mountains. The winds laden with moisture are wrung dry long before they reach the plateaux in the heart of the province. The prevailing wind throughout the year is from the westward, and must cross the Sierra Nevada. Sweeping across the great basin it blows over many ranges, and at last strikes the Wasatch and the chain of high Plateaux which form the

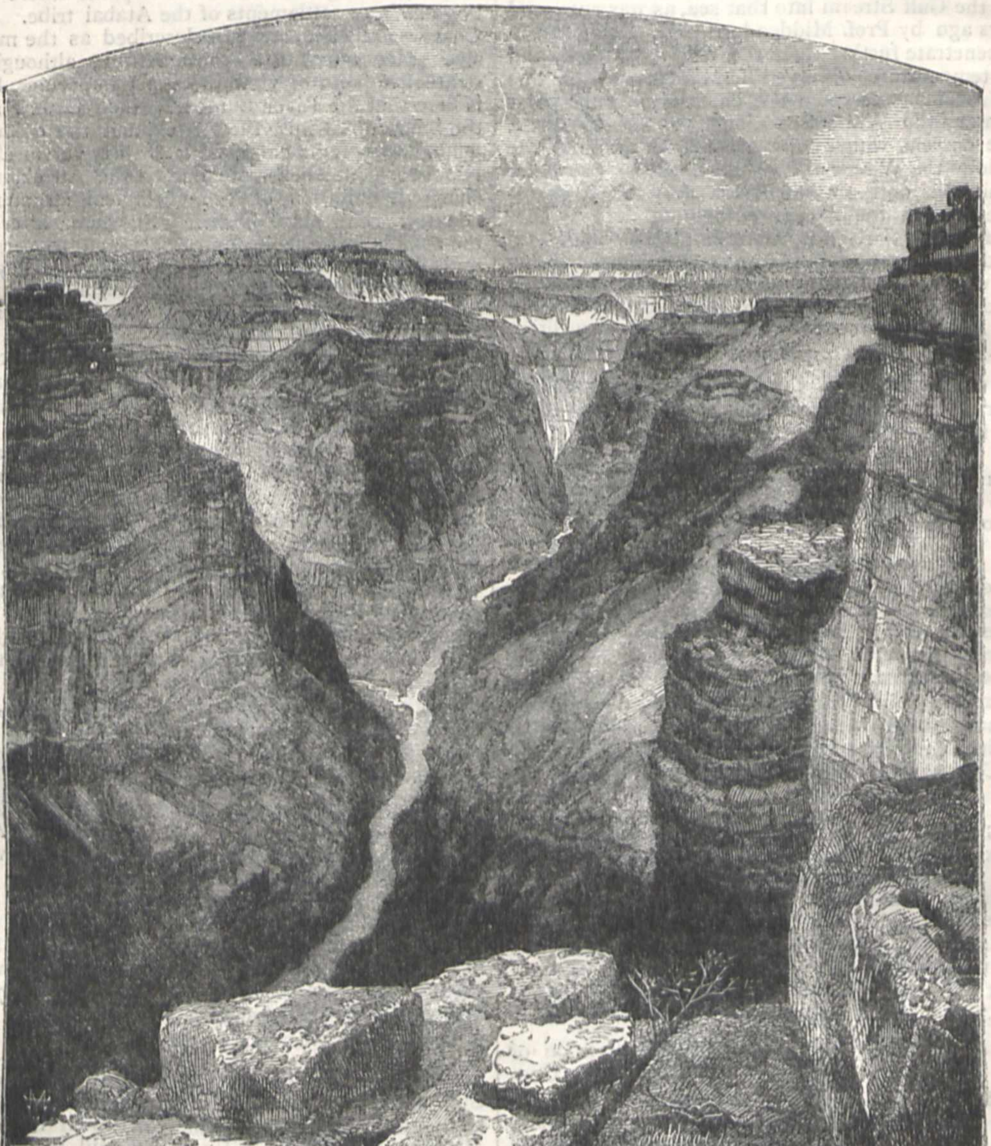

FIG. 3.—Grand Cañon, from the Middle Terrace.

western wall of the Plateau Province. Here it is suddenly projected upward more than a mile and flings down moderately copious rains. Descending into the Cliff and Cañon Country, its humidity is so much exhausted that it can yield but the scantiest pittance of snow and showers. Thus the country is a desert. Now the strange forms impressed upon this land—its cliffs and cañons, with their myriads of wonderful shapes and their astounding architecture—are due, as we shall presently find, in great part to the aridity. The aridity is due to the great barriers which surround it, and above all to that great barrier of high plateaux which lies upon its western verge. Here, then, we may look for another key which may unlock another door within the vestibule. The search will not be fruitless.

The district of the high plateaux has been during the last four years a field of special study by myself, and has

[1] By Capt. C. E. Dutton, U.S. Army, Assistant-Geologist U.S. Survey of the Rocky Mountain Region, under Prof. J. W. Powell, in charge. Continued from p. 252.

been investigated as thoroughly as circumstances and my very limited qualifications would admit. Its original attraction consisted in the enormous displays of volcanic energy there in former times, to which I cannot here venture to allude any further. The structure of the district is also otherwise very interesting, and has been worked out with much care and patience, and in great minuteness of detail. It will be possible at present to give nothing more than a categorical statement of certain results. To master the evidence would require the handling of a large amount of detail, and unwarrantably protract discussion.

The structure of these plateaux is identical with what Prof. Powell has described as Kaibab structure, being in fact a northward continuation of the same belt which he has described and delineated in his well-known section of the Grand Cañon which cuts across this series of displacements at a right angle. The faults which have blocked out the plateaux and intervening valleys are of prodigious length, and the amounts of dislocation are very great—greater in the high plateaux than in the Kaibabs. The age of these displacements is an important landmark in the history of the country, and that age can be fixed with confidence as late Pliocene, and continuing into the Quarternary, and probably down to the present time.

With this fact in our possession as a datum we come now to the history of the cañons. The Grand Cañon first makes its appearance in the epoch of the faults. It suddenly bursts into view as a less than half-formed thing, with walls ranging from 2,000 to 2,700 feet high, late in Pliocene times. But it presents itself under somewhat unexpected circumstances, for it had been in the condition in which we first find it for a considerable period. The work of vertical erosion had long been suspended, the channels had ceased to grow deeper, and the energies of the river had for an unknown period been employed in another kind of occupation to which rivers have been frequently known to betake themselves under certain common conditions. It was widening its cañon and making a flood plain in which to meander. This any river will inevitably do when it has sunk its channel to the limiting depth which local circumstances prescribe for it. When that limit is reached it will attack its own banks whether they be walls of rock or nothing but gravel and loess, and will thereafter meander or squirm from side to side. There are numerous places along the Upper Colorado and its tributaries where this is abundantly exemplified. From local causes the fall of the river has for a space been diminished, the flow has been sluggish, sediment has been deposited, the river has ceased to erode its bottom, it has attacked its walls, and the cañon has been widened.

If now the reader will look at the section of the Grand Cañon (Fig. 3) he will perceive that it is a cañon within a cañon. The walls are in two leaps with an intermediate terrace. The upper or outer cañon is usually from three to six miles wide, and the inner cañon meanders within the upper, sometimes close to one upper wall, sometimes to the other, but usually with a middle terrace on both sides. The inner and the outer cañon represent two periods, the outer one of course being formed first—formed no doubt originally as a narrow gorge—which was widened while the river was unable to cut vertically. The middle terrace is the final flood plane of the old cañon. And now the faults come to our assistance in determining the two periods. The outer cañon is older than the faults; the inner one is coeval with them. The reasoning by which we determine this is of the simplest order. If we were to see a fault cutting a particular stratum we should know that the stratum was older than the fault. By parity of reasoning we know that the outer cañon is older than the faults because they cut its trough and dislocate its floor transversely. If the faults were older the river would have

FIG. 4.—Pa-ru-nu-Weep Cañon, Virgin River, a tributary of the Colorado.

planed an even grade across them regardless of the dips of the strata just as it is doing to-day 3,000 feet below. As it is—if the side gorges would permit us to travel along the middle terrace—we should be compelled every time we crossed a fault to clamber up or down its face.

Thus, then, as we draw near the close of the Pliocene period only the outer cañon was completed. When was it commenced? At present we cannot give an answer, though I hope we may soon be able to do so; but I should be surprised to find its commencement dating beyond Pliocene time. The best conjecture which I am at present able to frame would place the birth of the Grand Cañon since the middle of that epoch. The commencement of the cutting of the inner cañon was contemporary with the commencement of a new uplifting of the Kaibabs—an uplifting which extended as far north as the Wasatch, and southward to unknown regions in Arizona, through a belt having its maximum width just where the Grand Cañon crosses it. The amount of this uplifting was very variable, ranging from 2,000 to 4,000 feet. It was during this period of elevation that the faulting took place. The level of the river's bed was at once disturbed; its old energies were reawakened, and its ancient labours resumed. From that epoch to the present day the river grinding like "the mills of God" has slowly but resistlessly sunk itself to solemn depths in the earth.

Wonderful and impressive as are the great cañons, they are no more so than some other features. Chief among the objects of special interest is the vast array of colossal cliffs, which stretch across the country with seemingly interminable length in a grouping which is half order half disorder. The number is indeed very great, their altitudes generally impressive—1,500 feet being common, and 2,000 feet not very uncommon, while the distant view of cliff rising above cliff, one beyond another, yet seeming to be united, is often seen. Each stratigraphical series has a series of cliffs, planned, sculptured, and painted in a style peculiarly its own, and the several styles differ, as decidedly and constantly as human architecture among distinct races of men. These distinguishing characters developed under one homogeneous process can be traced to the lithological composition and texture of the rocks which are powerfully contrasted between any two series. The constancy of result in any given series may also be traced to the constancy with which that series preserves one set of characters over a great extent of country. I may be mistaken—perhaps from the circumstances it is more apparent than real—but I imagine no region in the world hitherto explored exhibits rocks where the texture and lithological characters are so strongly pronounced, so strongly contrasted among themselves, and yet where there is so little horizontal variation in the characters of each group over vast areas.

In the Plateau Country we have to do with an arid region, and the aridity tends to reduce the amount of disintegration. On the other hand it is a lofty country giving a rapid descent to all its waterways, and their transporting power is of a very high order—the rocks are swept bare of *débris* and kept naked to the attacks of the elements. This tends powerfully to quicken the disintegration. The number of inches of annual rain is less than one-sixth the number in the Mississippi valley, but every inch in the plateaux may do sextuple work. Probably, however, the rate in the plateaus is on the whole slower, but the disproportion is much less than might have been anticipated if we had considered the rainfall alone.

To comprehend the origin and perpetuation of cliffs it is necessary to expand these general relations into some detail. I have stated that the attack of erosion is directed against the edges of the strata and but slightly against the horizontal surfaces. These surfaces being but little inclined, water has but little energy, as it courses over them, either to erode or to transport. But in the myriads of gulches the steepness of their sides enables the water to keep the edges of the strata naked, and the water is assisted powerfully by the aridity of the climate and the absence of vegetation. Now when the edges of a thick series of vertically heterogeneous strata are exposed, there will always be some stratum softer or more readily disintegrated than the others. The elements attack it, and soon a long under-cut is formed, and the rocks above robbed of a part of their support, cleave off vertically, and a great slab falls in ruins. The fallen fragments and rubble form a talus, but being now in a comminuted state, they become a much easier prey to dissolution than when in the solid wall, and they gradually moulder away. All that is necessary is that the talus should dissolve fast enough to keep the perishable stratum exposed to attack, and this is almost universally the case. The great cliffs are massive beds of sandstone and limestone, resting upon perishable calcareous and gypsiferous shales. The rapidity with which the cliff wastes away and recedes by erosion is measured by the power of resistance to weathering in the shales below and not by the massive beds on its face. By further analysing the details of erosive action, we have no difficulty in explaining the origin and causes of the different styles of architecture, the sculpture of the repetitive forms, and all their train of phenomena, both normal and abnormal.

And now a few words about the cause of cañons. This problem has been so admirably and satisfactorily solved by Messrs. Powell and Gilbert that I have no better excuse for saying anything about it than a desire to fill what would otherwise be a serious gap in the discussion.

The fall of the Colorado through the cañons is between seven and eight feet per mile—nearly twenty times as great as that of the Ohio and Mississippi and nearly seven times as great as that of the Missouri below the Yellowstone. It is a fierce torrent—a series of quickly-recurring rapids. Its lateral gorges have usually a greater descent. The tools with which the river works are sand and gravel held in suspension by the water, hurled along at race-horse speed, and scouring like a sand-blast machine the naked rocks of its bed. But there is one thing more, and it is a crucial point. The Platte has about the same fall through the plains as the Colorado through the cañons; it has its sources high up in the same mountains; it flows through a desert; it carries a huge load of sand, but from Denver to Plattesmouth has not the semblance of a cañon. The trouble with the Platte is that it carries *too much* sand. A river of given volume and velocity can carry in suspension only a definite load of sediment of given coarseness. When that limit is exceeded the excess will be precipitated upon the bottom protecting it from the scour of the gritty particles which are carried in suspension. But if the supply of sand be not in excess of the power of the current to keep it in suspension, none will be deposited except locally, and the bed-rock will experience the full attrition of the sand-blast. The Platte is the case of an overloaded stream while the Colorado is slightly underloaded and in a condition to produce the maximum erosion.

The study of the Plateau Country has during the last nine years been the work of the Survey under Prof. J. W. Powell. Comparatively little has been published about it because it has been felt by him that until the subject could be presented in systematic and thoroughly intelligible form it would be a mistake to accumulate fragmentary literature and encumber a splendid subject with a chaos of unconnected observations. But the work approaches completion and has developed into form in the minds of the workers, and it is hoped that the results will soon be before the world. If the geology of the Plateau Country shall therein be set forth in a manner commensurate with its importance, and full justice done to the revelations it affords, I believe that physical geology will have received important additions. I cannot close without paying a just tribute to Prof. Powell, the director of their work. His direction of the Survey has not been limited to the perfunctory duties of an administrative officer. On the contrary he has furnished those whom he has called to his assistance with methods of observation and principles which have worked like a master-key in opening to our understanding the meaning of this wonderful region. Without those methods and principles it would have been of comparatively little utility to attempt to solve the problems of such a region. Those whose privilege it has been to carry them into practice will ever be glad to acknowledge how great is their indebtedness.

INCLINATION OF THE AXES OF CYCLONES AND ANTICYCLONES

I HAVE during the last seven years endeavoured, though apparently without much effect, to direct the attention of meteorologists to a law which I conceive to be of very high importance in relation to the theory of the movements of the atmosphere. The law to which I refer is this:—The movements of the upper-currents prove that the axis of a progressive cyclonic circulation is commonly inclined, so that the extremity nearest to the earth's surface is considerably in advance of that in the higher regions of the atmosphere. A barometric minimum consequently occurs at any locality on the earth's surface some hours before the corresponding minimum in the higher regions passes over the same spot ("Laws of the Winds Prevailing in Western Europe," pp. 156 to 162, 1872; *Meteorological Magazine*, vol. x. pp. 92 to 93, 1875; *Quarterly Journal of the Meteorological Society*, October, 1877, pp. 440 to 445). I have also pointed out that the axis of an anticyclonic circulation has, at least in some instances, a similar inclination; a point which will be discussed more fully in a future paper.

I hope that the results, strongly confirmatory of this law, which Prof. Loomis has recently derived from his examination of the wind and barometer reports from Mount Washington, Mount Mitchell, and Pike's Peak, will attract more attention than my own deductions from upper-current observations have done. In his tenth paper of "Contributions to Meteorology" (*American Journal of Science and Arts*, January, 1879), Prof. Loomis shows that with very few exceptions the barometric minima occur at the base of a mountain considerably earlier than at the summit, the retardation amounting to about one hour for an elevation of from 900 to 1,300 feet, and that the maxima appear to follow the same law.

Other points of agreement between the results of cloud observations in Europe, and those obtained from the reports of the mountain observatories in America, seem to me to be of great interest. I would especially call attention to the substantial coincidence of these results as regards, first, the rarity of easterly upper-currents, as compared with easterly surface-winds; and secondly, the higher, and also less variable, value of the angle made by the northerly, than that made by the westerly upper-currents, with the direction of the centre of lowest pressure at the earth's surface. W. CLEMENT LEY

BARTOLOMEO GASTALDI

SINCE the last anniversary of the Geological Society many distinguished men among its members, both in this and foreign countries, have been removed by death. We regret to have to add to the sad list the name of Prof. Gastaldi, the well-known head of the Italian Geological Survey.

Bartolomeo Gastaldi was born at Turin, in the year 1818, and was originally destined by his father for a legal career; his fondness for geological studies, however, proved too strong to be repressed, and he was eventually entered as a student at the École des Mines at Paris. Here, and throughout his subsequent career, he enjoyed the friendship of Quintino Sella, who afterwards became so distinguished alike in Italian scientific and political circles.

Gastaldi had reached the age of twenty-eight before his first scientific memoir was published, and his earliest essays in this direction were devoted to anatomical and palæontological questions. Before long, however, he seems to have discovered that the true bent of his genius was towards physical geology. In his studies in this department of science he was greatly aided by his powers as a pedestrian, and he soon made himself familiar with all the southern spurs of the Alpine chain. In company with his friend Sella he founded the Italian Alpine Club, of which he was the second president.

He succeeded Sella as Professor of Geology at the Engineering School of Turin, and subsequently became Professor also at the University. During the later years of his life the work of the Geological Survey, of which he was made director by the Italian Government, occupied much of his attention, and to his energy and capacity much of the success which has already attended that important work is due.

No less than thirty papers on various branches of geological science have proceeded from Gastaldi's pen. He was an advocate, during his later years, of extreme views upon glacial subjects, and many of the views which he propounded on this and on other questions of Alpine geology have not been generally accepted by the geologists of other countries. In some of his speculations, indeed, his boldness seems to have outrun his caution. Those who had the happiness of a personal acquaintanceship with Gastaldi describe him as a most sanguine and earnest student and a warm-hearted friend.

Prof. Gastaldi was a Corresponding Member of the Geological Society of London, and received similar honours from the academies of many other foreign countries. In Turin, where he spent the greater part of his life, and where he occupied the position of a Common Councillor, he was very greatly respected and beloved; this fact is testified to by the circumstance that at his funeral more than three thousand people followed his remains to the cemetery.

ON THE DETERMINATION OF ABSOLUTE PITCH BY THE COMMON HARMONIUM[1]

THE methods described depend upon the principle that the absolute frequencies of vibration of two musical notes can be deduced from the *interval* between them, *i.e.*, the *ratio* of their frequencies, and the number of beats which they occasion in a given time when sounded together. For example, if x and y denote the frequencies of two notes whose interval is an equal temperament major third, we know that $y = 1{\cdot}25992x$. At the same time the number of beats heard in a second, depending upon the deviation of the third from true intonation, is $4y - 5x$. In the case of the harmonium these beats are readily counted with the aid of a resonator tuned to the common over-tone, and thus are obtained two equations from which the absolute values of x and y may be found by the simplest arithmetic.

Of course, in practice, the truth of an equal temperament third could not be taken for granted, but the difficulty thence arising would be easily met by including in the counting all the three major thirds which together make up an octave. Suppose, for example, that the frequencies of c, e, $g\sharp$, c' are respectively x, y, z, $2x$, and that the beats per second between x and y are a, between y and z are b, and between z and $2x$ are c. Then,

$$4y - 5x = a,$$
$$4z - 5y = b,$$
$$8x - 5z = c,$$

from which

$$x = \tfrac{1}{3}(25a + 20b + 16c),$$
$$y = \tfrac{1}{3}(32a + 25b + 20c),$$
$$z = \tfrac{1}{3}(40a + 32b + 25c).$$

[1] Abstract of a paper read before the Musical Association, December 2, 1878, by Lord Rayleigh, F.R.S.

In the above statements the octave $c-c'$ is for simplicity supposed to be true. The actual error could be readily allowed for, if required; but in practice it is not necessary to use c' at all, inasmuch as the third set of beats can be counted equally well between $g\sharp$ and c.

Although at first sight the method just sketched looks satisfactory, it is not practical in the case of the harmonium, in consequence of the pitch of the various notes not being sufficiently constant for the purpose, even when the blowing is carefully conducted with the aid of a pressure-gauge. A small variation in the absolute pitch of a chord when sounded under slightly varying pressures, would not be of much importance, but the slightest change of *interval* is fatal to the success of the method, and such a change actually occurs.

In order, therefore, to apply the fundamental principle with success, it is necessary to be able to check the accuracy of the interval which is supposed to be known, at the same time that the beats are being counted. If the interval be a major tone (9 : 8), its exactness is proved by the absence of beats between the ninth component of the lower, and the eighth component of the higher note, and a counting of the beats between the tenth component of the lower and the ninth of the higher note completes the necessary data for determining the absolute pitch.

The equal temperament whole tone (1·12246) is intermediate between the minor tone (1·11111) and the major tone (1·12500), but lies much nearer to the latter. Regarded as a disturbed major tone, it gives slow beats, and regarded as a disturbed minor tone it gives comparatively quick ones. Both sets of beats can be heard at the same time, and when counted give the means of calculating the absolute pitch of both notes. If x and y be the frequencies of the two notes, a and b the frequencies of the slow and quick beats respectively,

$$9x - 8y = a$$
$$9y - 10x = b,$$

whence

$$x = 9a + 8b$$
$$y = 10a + 9b.$$

The application of this method in no way assumes the truth of the equal temperament whole tone, and in fact it is advantageous to flatten the interval somewhat by loading the upper reed with a minute fragment of soft wax, so as to make it lie more nearly midway between the major and the minor tone. In this way the rapidity of the quicker beats is diminished, which facilitates the counting.

It is impossible, of course, for the same observer to count both sets of beats, and the counting of even one set without the aid of resonators would present difficulties to most unpractised persons. Great assistance may be obtained by the choice of a suitable position. A room in which a pure tone is sounded is traversed by surfaces at which the intensity of sound is very much reduced in consequence of the superposition of vibrations reflected from the walls and ceiling. By choosing as the place of observation a position where the intensity of the beats which are not to be counted is a minimum, and with the aid of a resonator tuned to the pitch of the beats which are to be counted, the listener is able to work with ease and certainty.

The course of an experiment is then as follows:—The notes C and D are sounded, and the listeners begin counting the beats at a given signal, whose pitch is about d'' and e'' respectively. At the expiration of a measured interval of time a second signal is given, and the number of both sets of beats is recorded.

In my experiments the interval of time was ten minutes (in one case eleven minutes), and the rapidity of the beats was about four a second. The listeners counted up to ten only, after each set of ten making a stroke with a pencil on a piece of paper. The number of strokes was afterwards counted, multiplied by ten, and added to the number which the listener was saying at the instant of the second signal. The following are the details of the actual observations:—

September 16, 1878.—Period of observation ten minutes. Numbers of beats 2392 and 2341.

$$a = \frac{2392}{600},\ b = \frac{2341}{600},\ \text{giving}\ x = \frac{9 \times 2392 + 8 \times 2341}{600} = 67·09,$$

for the frequency of the lower note C.

September 17.—Period of observation ten minutes.

$$a = \frac{2423}{600},\ b = \frac{2302}{600},\ \text{giving}\ x = 67·04.$$

September 18.—Period of observation ten minutes.

$$a = \frac{2476}{600},\ b = \frac{2261}{600},\ \text{giving}\ x = 67·29.$$

September 19.—Period of observation eleven minutes.

$$a = \frac{2663}{600},\ b = \frac{2547}{600},\ \text{giving}\ x = 67·19.$$

The discrepancies are hardly greater than may be attributed to errors in giving the signals, by which the intervals may have been unduly lengthened or shortened by about a second. On each day after the counting of the beats between C and D, the harmonium was compared with a Kœnig fork whose nominal frequency was 64. In order to obviate any objection arising from a mutual influence of the notes of the harmonium, *both* C and D were sounded at the same time as the fork. The beats between C and the fork were counted for about ninety seconds, during which time the fork was not bowed. In this way the pitch of the fork came out on the four days respectively as 64·06, 64·07, 64·17, 63·98, that is somewhat sharper than its nominal pitch, a result in agreement with that obtained by other methods.

The object of the experiments referred to was rather to prove the practicability of a method so unusually independent of special apparatus, than to obtain a result competing in point of accuracy with those of Prof. Macleod and other experimenters on this subject. Nevertheless it is believed that very accurate results might be obtained by the introduction of certain modifications. Ten minutes is near the limit of time over which beats can be conveniently counted by a single listener, but experiment proved that it is perfectly possible for one listener to relieve another without any break in the regularity of the counting. Even without an extension of time a more accurate result would be obtained if the listeners were able to fix the time for themselves, as they might do for example if they could conveniently observe the swinging of a clock pendulum. In this way the error in the time interval might be reduced to $\frac{1}{4}$ second, which would amount to but one part in 2400 in the case of a ten minutes' observation. In consequence, however, of the imperfect constancy of the pitch of the harmonium notes, even when the blower is assisted by a pressure-gauge, further attempts at accuracy would be useless unless the comparison with the fork were simultaneous with the other observations. In that case the result would be entirely independent of variations in the harmonium notes, and no difficulty would be experienced in carrying out the method excepting the necessity for more observers.

THE FISSURES OF THE CEREBRAL HEMISPHERES IN UNGULATA

An important memoir by Dr. Krueg on the cerebral hemispheres of Ungulata has recently appeared in the *Zeitsch. wiss. Zool.* After a review of the previous papers that have appeared on this subject—but few in number—Dr. Krueg describes his method of investigation.

He made drawings of the hemisphere of each species; compared, first, line for line the hemispheres of different individuals of the *same* species, and then took as characteristic of that species every sulcus that was constantly present in all the individual hemispheres.

The different species in a genus and the different genera in the order were compared in the same way, so that by elimination he at last obtained a schematic drawing of the sulci constant throughout the order. In his drawings he represents those sulci peculiar to the individual, species, &c., by variously dotted lines, those running through the whole order by thick black lines.

Since the most constant or chief sulci are the first to appear in the course of development, he gives drawings of fœtal brains of the sheep, cow, and pig. With regard to these fœtal brains, it is highly important to note that in no instance were transitory or temporary sulcus markings met with; Meckel himself admits that he did not find these temporary sulci in brains of other animals, though he described them in the human fœtus. Dr. Krueg regards them as entirely artificial. The following, then, are the chief fissures or sulci (*Hauptfurchen*) constant throughout the Ungulata, and of these the first six are the most important in relation to those of the Carnivora :—

1. Fissura sylvii, ant., post., processus acuminis.
2. „ splenialis.
3. „ supra-sylvia, ant., post., supr.
4. „ coronalis.
5. „ præsylvia.
6. „ lateralis.
7. „ diagonalis.
8. „ postica.
9. „ genualis.
10. „ rostralis.
h. „ hippocampi.
rh. „ rhinalis.
C.ca. Corpus callosum.

The earliest fœtus he possesses shows two fissures, namely, F. sylvii and F. splenialis. The sylvian fissure develops radially, just as Ecker has shown in the human fœtus, and since in the latter, the parieto-occipital fissure appears almost contemporaneously with the sylvian fissure, he considers the Fissura splenialis of Ungulates to be the homologue of the human parieto-occipital. This view derives some strength from the fact that as development proceeds, the anterior extremity of the Fissura splenialis turns upwards and gains the median border. Moreover, here it is opposite to the processus acuminis Sylvii, which is homologous with the posterior or horizontal ramus of the human Sylvian fissure.

The positions of the fissures are shown in the accompanying diagrams. As regards the fœtal forms it is noteworthy that in the Suillidæ, from its earliest appearance the posterior process of the F. supra-Sylvia is directed downwards as well as backwards; this we shall find is a family characteristic of importance.

Before enumerating the slighter distinctive characters of the families, or comparing the Ungulata with the Carnivora, it will be well to mention the results which are of more general importance. Dr. Krueg believes that he has established the following propositions :—

1. That the forerunners of the adult fissures are never transitory radial markings, but always present (though incompletely) the adult form.

2. That the two important fissures (F. hippocampi and F. rhinalis) common [to all mammals, are the first to appear, and that next those characteristic of the Ungulata commence.

It is remarkable that the fissures peculiar to the individual, may appear contemporaneously with, or even precede, the last few of the chief fissures. This fact of itself would cast some doubt on the morphological value of these later chief fissures, and comparison with the Carnivora also diminishes their importance as diagnostic marks.

3. On no occasion was a fissure once formed ever broken up by a bridging convolution. The reverse of this may and often does occur, viz., that two originally distinct fissures may, by extension of their neighbouring extremities, so mingle as to form one large fissure. From this fact he concludes that when in adult brains we meet with a well-known fissure bridged over, originally this fissure was developed as two distinct ones. This would certainly explain the remarkable cases lately published by

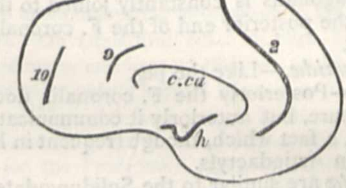

FIG. 1.—Median surface of typical hemisphere.

Henschel, in which the fissure of Rolando was bridged over, and such a state of things would be due to atavism.

4. The influence of the size of the animal on the shape of the hemisphere and its details is very important, and may be regarded as threefold.

(*a*) The number of accessory fissures increases with the size of the brain and the size of the animal.

(*b*) The shape of the hemisphere differs. Thus, in the larger animals it is broader, and more rounded, whereas, in the smaller animals it is distinctly narrower, and tapers more to a point anteriorly.

(*c*) In the smaller animals it is noticed at once that fissures (such as the splenialis), which in the schematic brain are situated on the median surface, in these smaller individuals, often appear on the upper. Such a condition may be supposed to result from a rotation of the upper or median border around the Island of Reil as a centre. This rotation Dr. Krueg has named "supination," and that in the opposite direction and occurring in the larger animals "pronation." The posterior extremity of the F. coronalis almost always presents a "horn" (Bügel) directed inwards. This branch becomes of importance, as it often joins the F. splenialis, and offers a homology with the fissura cruciata of the Carnivora.

The following are the main family characteristics :—

Tragulidæ.—Supination marked. F. coronalis communicates with the processus anterior supra-Sylvii. The Tragulidæ (like the antelopes) present strong elephantine characters as regards their fissures.

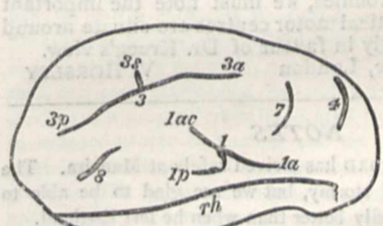

FIG. 2.

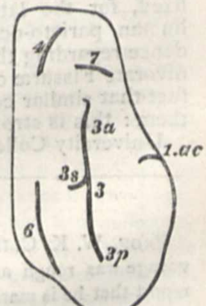

FIG 3.

FIG. 2.—Lateral outer surface of typical hemisphere. FIG. 3.—Upper surface of typical hemisphere.

Elephants.—F. coronalis communicates with the processus anterior supra-Sylvii, and also either with the F. splenialis or ends just behind it.

The *Giraffes* present no generic characters.

Cavicornidæ.—In the majority the F. coronalis does *not* communicate with the F. supra sylvii, the exception being *Bos taurus.* The processus acuminis Sylvii is broken by "individual" fissures, and, moreover, the angle formed between its anterior and posterior extremities is raised, and into this space a small accessory branch from the Fissura rhinalis is directed.

Tylopoda.—Pronation is so marked that the F. lateralis is actually situated on the median surface. The F. coronalis is directed from the middle line forwards and outwards.

Suillidæ present several characters in common with the Carnivora. The processus anterior Sylvii is continued into the F. rhinalis, as is also the F. præsylvia.

The F. diagonalis is constantly joined to the F. supra Sylvia, and the posterior end of the F. coronalis joins the F. splenialis.

Hippopotamidæ.—Like the pig.

Tapiridæ.—Posteriorly the F. coronalis does not join any other fissure, but anteriorly it communicates with the F. præsylvia, a fact which, though frequent in Perissodactyls, is rare in Artiodactyls.

Nasicornidæ are similar to the Solidungulates.

Solidungulata.—The peculiarities are very constant. Thus there are cross-fissures between F. Sylvii and F. supra Sylvii. Further, there is an accessory longitudinal and parallel fissure on either side of the F. lateralis. Pronation is marked. The F. coronalis is united to the F. supra Sylvii, and the posterior "horn" of the F. coronalis is not united to that fissure, but commencing behind and above the anterior end of F. splenialis, runs forwards and outwards, ending before reaching F. coronalis.

Comparison of the convolutions of the Ungulata with those of the Carnivora shows that in the latter order the first six chief sulci of the Ungulata have undoubtedly their homologues. The question as to whether a F. diagonalis can be said to exist must still be left open, and the remaining three certainly do not always exist in the brain of the Carnivora, and when present are accessory only.

Dr. Krueg thinks that possibly the posterior "horn" (Bügel) of the Fissura coronalis is homologous with the Fissura cruciata in the Carnivora, but this is very uncertain, for it is questionable whether in the Cavicornia the posterior limb of the F. coronalis is homologous with the distinct one described above in the Equidæ. Certainly that of the Perissodactyl is very similar to the Fissura cruciata as regards its relation to the F. coronalis; but while in the Perissodactyl the posterior extremity begins *above* the F. splenialis, in all Carnivora it begins *below*. Further, the anterior end of the F. splenialis turning up to the median border has a plausible homology itself with the Fissura cruciata. It would be very interesting to have the time of appearance of the Fissura cruciata fixed, for the latter theory would compare it to the human parieto-occipital fissure. As confirmatory evidence regarding the homology of the Ungulate and Carnivorate Fissuræ coronales, we must note the important fact that similar cortical motor centres are situate around them: this is strongly in favour of Dr. Krueg's view.

University College, London V. HORSLEY

NOTES

PROF. W. K. CLIFFORD has arrived safely at Madeira. The voyage was rough and stormy, but we are glad to be able to report that he is markedly better than when he left England.

A SUBSCRIPTION has been opened by the Dorpat University for the erection at Dorpat of a monument to the late K. von Baer.

ON January 10 the Imperial Russian Academy of Sciences at St. Petersburg held its annual meeting, which was largely attended this year. The meeting was opened with the reading of the long list of deaths of members, foreign and Russian, during last year, and among whom we notice Regnault, Claude Bernard, Granville, and Bienaimé, at Paris; Hugo Hildebrandt, of Jena; Friis, of Upsala; Tornberg, of Lund; Lers, of Königsberg; and the well-known Russian archæologist Polyenoff; Kovalsky and Khanykoff, orientalists; and Davydoff, mathematician. Count Orloff-Davydoff, Baron Bühler, and Col. Prjvalsky were elected honorary members; and General Maiefsky, mathematician; General Stebnitzky, geodesist at Tiflis; Mr. Hind (as noted last week), Dr. John Muir (Edinburgh), Clausius (Bonn), Boisier (Geneva), Lavrofsky and Veselago were elected correspondent members of the Academy. The report on the museums of the Academy showed several most important acquisitions, among which we notice the immense and very rich collections of birds, fishes, and reptiles brought in from Central Asia by Col. Prjvalsky, during his second journey; a collection of skulls and bones of Steller's sea-cow, which inhabited, during the last century, the shores of the White Sea, but is now extinct, the collection being made by M. Phillipens on the shores of Behring Strait; and a complete skull of an Elasmotherium, presented by M. Knoblauch. There were, until now, only some teeth of this immense quaternary horse-like rhinoceros at the museum of the Academy, and a part of a skull at the British Museum, which had offered, we are told, a large sum of money to M. Knoblauch for the rarity. The skull was found close by Sarepta, on the banks of the Volga River. The Academy proposes to open next year for the public a large anthropological museum, the materials for which are already in the hands of the Academy; we heartily commend this step, as the museums of the Academy, when open to the public each Monday, are visited by masses of people (as many as 12,000 persons daily on holidays). The report on the works of the philological and historical branch of the Academy was presented by Prof. Suklomlinoff, who dwelt at length on the works of Prince Vyazemsky; and a very interesting paper on the correspondence between Catherine II. and Grimm was read by Prof. Groth. In this branch we notice a great undertaking by the Academy for the next year, being a dictionary of the Kurd language. This language has been very well studied, but there are no dictionaries of it. Now, the Academy will publish a complete one, the materials for it being given by the French orientalist, M. Szabo, and completed by M. Yulpi, who will be intrusted with this important publication.

WE notice an interesting work, just issued in Russia, by Prof. Rumishevich at Kieff, being a complete catalogue of all the medicinal and veterinary literature published in Russia during 1876.

WE learn that the St. Petersburg Academy of Sciences has intrusted M. Keppen with the publication of a complete catalogue of animals living in European Russia.

LORD DUFFERIN, Lord Rosse, and Prof. Roscoe received the degree of LL.D. from Trinity College, Dublin, on Tuesday.

THE "Telectroscope" is the name of a new apparatus, the plan of which was, *Les Mondes* states, recently submitted to MM. du Moncel and Hallez d'Arros by M. Senlecq, intended to reproduce telegraphically at a distance the images obtained in the camera obscura. This apparatus is based on the well-known sensitiveness of selenium to various shades of light.

PROF. EDWARD S. MORSE, we learn from the New York *Nation*, has written an interesting paper on the "Traces of an Early Race in Japan," which throws light on a subject hitherto wholly obscure. A race of men called Ainos are believed to have come down from Kamtchatka and to have taken possession of Japan, which they held until displaced in their turn by the Japanese from the south. Of the two races, the Ainos and the Japanese, authentic records exist, but nothing has been known concerning the ancient people whose territory was appropriated by the Ainos. The only knowledge obtained of them has been ingeniously acquired by Mr. Morse by a careful study of "shell-heaps" in all respects similar to those found along the shores of Denmark, New England, and Florida. The deposit discovered by Mr. Morse near Tokio contained pottery and broken bones, many of which were human. It is generally admitted by ethnologists that a people that has once acquired the art of pottery will always retain it; but as neither the Esquimaux, the Kamtchatdales, nor the Ainos are essentially earthen-pot-makers, these remains naturally point to the former existence of a race in Japan who preceded the Ainos. Again, both the human and the deer bones found in this shell-heap were broken in a manner to facilitate the extraction of the marrow or to enable them to be placed in a cooking-pot, a circumstance which points to the existence of cannibalism among the people by whom the shell-heaps were made. On consulting Japanese scholars and archæologists Mr. Morse learned that the Ainos were not only not cannibals, but were of an especially gentle disposition. The existence of an ancient race of cannibals in Japan, before the occupation of that country by the Ainos, is therefore made very probable. We hope to see another paper before long containing an account of Prof. Morse's later researches.

PROF. HUMPHRY, F.R.S., of Cambridge, will deliver the biennial oration in memory of John Hunter in the theatre of the Royal College of Surgeons on the 14th proximo.

MR. THOMAS SOPWITH, M.A., F.R.S., F.G.S., who died at Westminster, on Thursday last, was born in 1803, at Newcastle-on-Tyne. He was for nearly fifty years extensively engaged as a civil engineer in mining, railway, and other works, both in this country and on the Continent, and was the author of several works on architecture, isometrical drawing, and mining. In 1838 he was appointed Commissioner for the Crown under the Dean Forest Mining Act, and in the same year a communication made by him to the British Association led to the establishment of the Mining Record Office. He was a member of many of the leading scientific societies, and one of the early members of the Institution of Civil Engineers.

IN connection with our article last week on a proposed Scottish observatory, it may be interesting to state that one day last August Mr. Milne Home, chairman of the Meteorological Society for Scotland, accompanied by Mr. Colin Livingston, headmaster, Public School, Fort William; Mr. Thompson, student; and Mr. David Doig, contractor, ascended Ben Nevis and made several observations with the view of erecting a station on the summit. They found the top enveloped in a mantle of snow—a circumstance which rendered it an extremely difficult task to select suitable spots for the erection of a dwelling-house and observatory. After a careful survey Mr. Home came to the conclusion that the plateau immediately beyond the spring affords the best site. The recommendation this spot has is its contiguity to the water-supply. But it might be questioned whether, as accurate observation is the thing required, it would not be better to erect the observatory on the plateau on the very summit, as there must, no doubt, be a difference between the temperature of the two places, the first-mentioned plateau being 350 feet lower. It is proposed to construct the buildings after the following plan: first, a wall of stone with an inside lining of wood and an inner coating of felting, and the outside of the wall to be covered with corrugated iron. An external wall of stone would also be erected to serve as a protection from the blast. The estimated cost of the structure is 500*l.*

WE learn from the *Colonies and India* that rich discoveries of copper have been made at Howe Sound, a few miles from New Westminster in British Columbia, and that the ore resembles that of the famous Australian Burra Burra mine.

THE Royal Society of Arts and Sciences of Mauritius has recently lost its secretary, Mr. L. S. Bouton, the only surviving founding member of the Society. This society was founded on August 24, 1829, under the name of Société d'Histoire Naturelle de l'Ile Maurice, by a few lovers of science; its first secretary was Julius Desjardins, who contributed many papers on the fauna of Mauritius, and also formed a good collection of specimens, which were afterwards given up to Government by his heirs, and became the nucleus of the present museum. The volumes published by the Société during a period of ten or fifteen years contain much interesting information on the natural history of Mauritius. On Desjardins' death in 1840, Mr. Bouton was appointed secretary, and kept up the post till his death; during that long period he chiefly applied himself to the investigation of the flora of Mauritius, and though he never published any complete works he contributed specimens and notes to Prof. Decandolle for the Prodromus, and to Kew, for the Flora of Mauritius by Baker. He wrote a paper on the medicinal plants of Mauritius, and a very interesting paper on the forests of Mauritius, besides a great quantity of notes in the Society's *Transactions*, and in the newspapers of the colony. In 1846 the Society was allowed by Government an annual subsidy of 200*l.*, which has been continued up to this day. Mr. Bouton was also curator of the Museum, but he was, we believe, though completely devoted to his duties of secretary, a rather bad curator. The Museum, although containing some very interesting specimens of the natural history of Madagascar, and of the extinct fauna of Mauritius, was allow to decay rapidly. No exchanges were carried on to increase the collections, and the space being too limited, the existing specimens are so crowded as to be of no use whatever to the public. The subject attracted the attention of the late much-esteemed governor, Sir Arthur Phayre, and he applied for a Report from the Council of the Society, and on its recommendation the following decisions have been come to by the Council of Government:—That a proper building be provided for the transfer of the Museum now heaped up in a room at the Royal College; that the funds allowed by Government each year be applied to the formation of a local museum, fully illustrating the fauna and flora of the Mascarene Islands, Madagascar, and the islands along the east coast of Africa; that a general collection, of which the present museum should be the nucleus, be gradually formed by means of exchanges to illustrate only the principal genera in each branch of natural history, and give to the public a general view of the natural world; that on vacancy (which is now come) a competent curator be provided from home, who will be at the same time Professor of Natural History at the Royal College, receiving a salary of Rs. 5,000 per annum; that the staff of the Museum be composed of an assistant, who will be also a collecting naturalist, sent round every year to Madagascar or some other place, receiving a salary of Rs. 2,000 and his travelling expenses, a taxidermist, a clerk, and servants; that, as a good taxidermist does not now exist in Mauritius, the services of a proper person be secured from home for two years, to instruct people in stuffing and set up the first collection, receiving Rs. 2,000 and passage-money. We hope that these changes will be insisted upon and that competent men will apply for the vacant posts to the Government at home, and give them a better opportunity of making a good choice. Mauritius is an admirable place for studying the riches of the sea, and a sort of zoological station, like the one at Naples would make many interesting discoveries. Prof. Möbius, of Kiel, who spent some months at Mauritius, said that several years would be necessary for him and many assistants to work up the collections from these seas. Evidently a good opportunity is presented for the promotion of important departments of natural history, and we trust all concerned will seek only to advance the interests of science and the true interests of the colony.

THE Commission of the Municipal Council of Paris has drawn up a report on the working of the electric light, which has been printed, and was discussed on the 14th instant. A certain number of important facts are stated. A Jablochkoff lamp may be said to give a quantity of light equal to eleven gas lamps, consuming each 140 litres per hour. The quantity of gas consumed to produce the same quantity of illumination would be 1,540 litres per hour. The price paid by the city to the gas company for 1,000 litres being 0 fr. 15c., the expense would be of 0 fr. 23 c. The expenses of each Jablochkoff lamp are officially stated as follows, for 62 candles per hour of light, 77 horse-power:—Machinery, 3 fr. 20 c.; coals for working the several steam engines used, 6 fr. 64 c.; oil for lubricating, 1 fr. 23 c.; pay of men for changing candles and superintending illumination, 3 fr. 20 c.; expenses of 62 candles at 0 fr. 50 c. each, supposed to last during an hour, 31 fr. Total, 45 fr. 27 c., or 73 c. for each candle. The Commission proposes to pay to the Jablochkoff company—which accepts 0 fr. 30 c. per candle during one year—for 62 candles at the Avenue de l'Opéra, 15 on the Place de la Bastille, and 6 in a pavilion of the Halles Centrales: in all 83. The total number of burning hours is estimated at 2,073 for each of the street candles, and 4,000 for each of the pavilion candles: altogether, 55,000. The expense paid to the gas company for illuminating the same places is 21,041 fr. The excess of expense for the city will be 34,044 fr. But this credit is asked for in the interest of science. It is hoped that during one year the Jablochkoff company will realise material improvements, and it is supposed that other electric light companies will tender some fresh propositions for comparison. In the meantime, the Commission proposes to accept a tender made by the gas company to improve the illumination of the Rue du Quatre Septembre, Place du Château d'Eau, and a pavilion of the Halles Centrales, with an excess of consumption of 260,000 cubic metres. At the sitting of the 14th, the gas company refusing to accept the price offered to them as a compensation for their expenses, proposed to supply the gas gratis, which was agreed to. Consequently a regular competition will be carried on between gas and electricity before the Parisian public during one year, on a grand scale, at the expense of only 34,044 fr.

IT was recently affirmed in the French Academy that chromic acid might be substituted for vanadic acid in the manufacture of aniline black. An industrial chemist of Rouen, M. Witz, now points out to the Academy (by recommendation of Prof. Girardin) that this is an illusion, and that vanadium is absolutely necessary. Chromium gives a greenish product quite different. M. Witz insists on the small quantity of vanadium which suffices to develop the reaction. It appears that the black is produced in presence of a weight of vanadic acid equal to only the *hundred millionth* part of the weight of the aniline employed. In practice, a thousandth of this weight is quite sufficient, and it will be seen that notwithstanding the high price of vanadium, the use of it in such small quantities is quite practicable for manufacture.

THE Anthropological Exhibition which will be held at Moscow next summer promises to be a highly interesting one. A large series of graphic illustrations of the life of prehistoric man will be supplemented by numerous models of caves, skeletons, and other prehistoric objects. So-called "kurgane" (prehistoric tombs) will be represented containing models of the skeletons and other objects found in them, their various positions being exactly reproduced. Prehistoric skulls will form a separate department of the Exhibition.

WE have received the *Proceedings* of the Cleveland Institution of Engineers, containing the address of the president, Mr. John Gjers, at the annual meeting of November 11. The address refers to various topics of much interest to engineers and even to men of science. Among other things Mr. Gjers, speaking of the variation in the production of the soil, gives it as his opinion that it is undoubtedly connected with the variation in the number of sun-spots. The December number of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland contains a paper by Mr. James Howden, "On the Action of the Screw Propeller," followed by a long discussion, and another by Mr. W. G. Jenkins, "On the Scientific Form of Harbours as applied to the Port of Melbourne."

A FOREIGNER, who fears the disappearance of bears in the Alps, the killing of these animals being largely paid for in Switzerland by the State and by the communes, and several wild animals having already disappeared in Switzerland in this way, proposes to form a society which will pay for each disaster caused by bears, and prohibit the hunting of them.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. D. Orpen; a Black-faced Spider Monkey (*Ateles ater*) from South America, pre ented by Earl Brownlow, F.Z.S; a Common Seal (*Phoca vitulina*) from Scotland, presented by the Earl of Hopetown; a Dufresne's Amazon (*Chrysotis dufresniana*), a Yellow-Fronted Amazon (*Chrysotis ochrocephala*) from South America, presented by Mrs. T. Smith; a Noddy Tern (*Anous stolidus*) from Ascension Island, presented by Morris H. Smyth Long, Lieut. R.N.; a Tuberculated Lizard (*Iguana tuberculata*) from the West Indies, presented by Dr. Stradling; a Superb Tanager (*Calliste fastuosa*), a Yellow-winged Blue Creeper (*Cœreba cyanea*) from South America, two Merrem's Snakes (*Liophis merremi*) from Monte Video, deposited; two Cuming's Octodons (*Octodon cumingi*), born in the Gardens.

ON THE LAVAS OF HEKLA, AND ON THE SUBLIMATIONS PRODUCED DURING THE ERUPTION OF FEBRUARY 27, 1878

BUNSEN in a Memoir "On the Processes which have taken place during the Formation of the Volcanic Rocks of Iceland," published in Poggendorff's *Annalen* in 1851, classifies the rocks of the island into two principal groups, which he calls respectively the *normal trachytic*, and the *normal pyroxenic*. The one possesses the largest proportion of acid, and the other of base, and their composition may be approximately stated in the following analyses:—

	Normal trachytic Composition.	Normal pyroxenic Composition.
Silica	76·67	48·47
Alumina and protoxide of iron	14·23	30·16
Lime	1·44	11·87
Magnesia	0·28	6·89
Potash	3·20	0·65
Soda	4·18	1·96
	100·00	100·00

The trachytic rocks represent a mixture of bisilicates of alumina and of the alkalies potash and soda, while protoxide of iron, lime, and magnesia are almost wanting. On the other hand, the pyroxenic rocks are basic silicates of alumina and protoxide of iron, in combination with lime and magnesia, and insignificant quantities of potash and soda. In the trachytic rocks the percentage of alumina is from 10 to 12, and that of protoxide of iron from 2 to 4; while in the pyroxenic rocks the percentage of alumina is from 10 to 18, and that of protoxide of iron from 12 to 20. Normal trachytic rocks are found in great abundance on the banks of the Laxá, at Laugarfjall, near the great geyser, and at Krafla in the north-east of Iceland.

The normal pyroxenic rocks are found on and around Hekla, on the banks of the Thjórsá, and at Thingvellir. Bunsen by an admirable induction, supported by a number of analyses, has proved that the rocks of Iceland which do not closely approximate in composition either to the normal trachytic or the normal pyroxenic, are intimate mixtures of these two classes of rocks, and that hence in all probability there are but two separate volcanic foci.

Dr. Genth examined the various lavas from the western slope of Hekla, among them the lava erupted in 1845, which was found to contain—

Silica	56·76
Alumina and protoxide of iron	27·47
Lime	6·75
Magnesia	4·04
Potash...	2·63
Soda	2·35
	100·00

The lavas of Hekla are trachytic rather than pyroxenic. In the geological map of Iceland which appears in von Leonhard's *Vulkanen Atlas*, a broad strip, including more than half the area of the island, is designated trachyte. It is inclosed by lines running approximately north-east by south-west,—that on the west from Skjalfandik to Reykjavik, and that on the east from Héraðsfloi, to the Orœfa Jökull.

I was surprised when I visited the scene of the eruption of February 27, 1878 (*vide* NATURE, vol. xviii. p. 596), to find how precisely the lava of this eruption resembled a very old lava in close contiguity to it, but flowing from a distant crater. Moreover the lava of 1845, on the other side of the mountain, and more than four miles from the craters of 1878, was observed to be quite the same in character as the most recent lava, which undoubtedly possesses a composition differing but little from that of the analysis given above.

The most notable feature of the last eruption appears to be the quantity of hydrochloric acid evolved from the beds of lava, and the considerable sublimations of sesquichloride of iron. Bunsen asserts that hydrochloric acid plays a less important part in the volcanic phenomena of Iceland than at Vesuvius and Etna.

"The hydrochloric acid fumaroles," he writes, "which not unfrequently occur on a large scale near the Italian volcanoes, and are then generally accompanied by a very considerable sublimation of chloride of sodium, appear to be of less importance in Iceland. I was only able to detect traces of hydrochloric acid in a free state in the crater fumaroles a few months old, which owed their origin to the last eruption of Hekla" (in 1845), "as well as in the exhalations of vapour from the lava which was then erupted."

For the future we must recognize hydrochloric acid as one of the products of the volcanic action of Hekla. During the last eruption it was produced in considerable quantity.

I had not proceeded far by the side of the lava of 1878, erupted five months previously, before I saw patches of brilliant red and yellow sublimations on the lava. These I naturally mistook for sulphur, but on a closer approach, warm vapours of hydrochloric acid were found to be issuing from the lava, and the sublimations when removed from the lava speedily deliquesced, forming an intensely acid and corrosive solution of sesquichloride of iron. I only succeeded in bringing one specimen of this sublimate to England, and this can scarcely be wondered at, when we remember that it had to be carried over 150 miles of very rough and pathless country before reaching the sea-coast. Moreover, as ill-luck would have it, the pony which was carrying my minerals, took fright during the last hour of a journey of many days, and within a few miles of Reykjavik our final destination; the box containing the specimens was broken to pieces, and they were scattered on the ground, but fortunately without much injury.

The specimen of chloride of iron sublimate has been qualitatively analysed in our school laboratory, by H. M. Elder, who finds it to contain in addition to sesquichloride of iron and free hydrochloric acid, chloride of aluminium, and very small quantities of the chlorides of ammonium, sodium, and calcium.

During our journey to the scene of the eruption of 1878, we frequently saw large patches of this sublimate, and near one of the new craters, in an inaccessible portion of the lava field, an area of several hundred square yards was covered with it. Most clearly therefore a notable feature of the eruption of 1878 has been the emission of large quantities of hydrochloric acid.

The formation of this substance during the eruption is easy to account for. Sublimations of a white substance were frequently visible in the crevices of the new lava. These, according to Herr Nielssens of Eyrabakki, consist of chloride of sodium, not of chloride of ammonium. Professor Silvestri found in different sublimations in the lava of Etna, erupted in 1865, quantities of chloride of sodium which varied from 50 to 90 per cent. (*I Fenomeni vulcanici presentati dall'Etna nel* 1863-6, page 139-142). Chloride of sodium, if it be heated in contact with silica and steam, undergoes decomposition, silicate of sodium and hydrochloric acid being formed. Bunsen has pointed out the fact that hydrochloric acid fumaroles can only exist when the high degree of temperature necessary for the decomposition of the chloride of sodium, has not receded far below the surface. For if it has so receded, the hydrochloric acid before reaching the surface will necessarily act upon the contiguous rocks, with the formation of chlorides which do not possess a sufficient degree of volatility to be brought to the surface. In the case of the sublimations in the lava of 1878, I noticed both free hydrochloric acid and sublimated chlorides, but the former was small in quantity, and no doubt the sublimations are receding deeper into the mass as the lava cools, and the next observer may find no trace either of the hydrochloric acid, or the sublimate of sesquichloride of iron.

G. F. RODWELL

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

IN addition to the regular course of instruction in the principles and practice of weaving at the Weaving Branch of the Glasgow Technical College, the Directors have made arrangements for three special courses of lectures which are now in course of delivery. These comprise a series on the history and development of the power loom, by Mr. John Watson, author of a "Treatise on Weaving"; another on Dyeing, by Mr. Noble; and a third series on Vegetable Fibres, by Mr. James Paton, F.L.S., Curator of Kelvingrove Museum.

THE Government of St. Petersburg, as we learn from the annual report just issued, had on December 1, 1878 (exclusive of the capital) 53 primary schools of the Ministry of Public Instruction, with 2,262 boys and 1,022 girls; 295 schools depending upon the School Boards, with 10,023 boys and 3,519 girls, and 21,975*l.* yearly expenses; and about 30 schools of separate institutions, with 1,380 boys and 1,533 girls.

WE learn that a Russian lady, Mme. Berladskaya, has just received the degree of Doctor of Medicine at the University of Paris, after having defended at a public meeting her thesis, "On the Structure of Arteries." This paper was spoken of in the highest terms by Prof. Charcot. Mme. Berladskaya is the second lady who has received the degree of Doctor of Medicine at Paris, the first having been Mme. Goncharoff.

SCIENTIFIC SERIALS

THE *Proceedings of the Linnean Society of New South Wales*. Vol. ii. part 4, and vol. iii. part 1. Part 4, vol. ii. contains: Prof. R. Tate, descriptions of three new species of helix from South Australia; Rev. J. E. Tenison-Woods, on the extra-tropical corals of Australia, three plates; the same, on the Echini of Australia, supplementary; W. Macleay, on the fishes of Port Darwin, four plates; John Brazier, on the mollusca of the Chevert expedition; the same, on some recently-found mollusca from Port Jackson and New Caledonia; E. P. Ramsay, on a new species of Rhipidura and of Eopsaltria from the Rockingham district, with remarks on some rare Queensland birds; the same, on a specimen of *Arses telescophthalmus*, on *Arses kaupi*, and on the young of *Cracticus quoyi;* the same, note on *Casuarius australis*, one plate; W. Stephens, the President, the annual address. Part 1, vol. iii. contains: E. P. Ramsay, on a new species of Ptilotis from Torres Straits; on a species of Myolestes from Fiji; notes on list of Australian birds; and descriptions of five new species of birds from Torres Straits and New Guinea; Rev. J. E. Tenison-Woods, on an Australian variety of *Neritina pulligera;* on a new genus (Arachnopora) of Milleporidæ; on a new species of Passamoseris; on a new species of Desmophyllum, and on a young stage of *Cycloseris sinensis;* on some Australian Littorinidæ; W. Macleay, note on a species of Therapon found in a dam at Warialda; on some new fishes from Port Jackson and King George's Sound; on a new species of Hoplocephalus; on the powers of locomotion in the Tunicata; C. Jenkins, on the geology of Yass Plains; Count de Castelnau, on the fishes of the Norman River.

SOCIETIES AND ACADEMIES

London

Royal Society, January 9.—"On the Electromagnetic Theory of the Reflection and Refraction of Light," by George Francis Fitzgerald, M.A., Fellow of Trinity College, Dublin. Communicated by G. J. Stoney, M.A., F.R.S., Secretary of the Queen's University, Ireland.

I have thrown the expressions for the electrostatic and electrokinetic energy of a medium given by Prof. J. Clerk-Maxwell in his "Electricity and Magnetism," vol. ii. part iv. chap. 11., into the same forms as M'Cullagh assumed to represent the potential and kinetic energy of the ether, in "An Essay towards a Dynamical Theory of Crystalline Reflection and Refraction," published in vol. xxi. of the *Transactions* of the Royal Irish Academy. Following a slightly different line from his, I obtain, by a quaternion and accompanying Cartesian analysis, the same results as to wave propagation, reflection, and refraction, as those obtained by M'Cullagh, and which he developed into the beautiful theorem of the polar plane. Of course, the resulting laws of wave propagation agree with those obtained by Prof. Maxwell from the same equations by a somewhat different method. For isotropic media, the ordinary laws of reflection and refraction are obtained, and the well-known expressions for the amplitudes of the reflected and refracted rays.

In the second part of the paper I consider the case of reflection at the surface of a magnetised medium, adopting the expressions Prof. J. Clerk Maxwell has assumed in "Electricity and Magnetism," vol. ii. part iv. § 824, to express the kinetic energy of such a medium.

I show that the method adopted in my former paper on Magnetic Reflection in the *Proceedings* of the Royal Society for 1876, No. 176, is justified, and that it is legitimate to consider an incident plane polarised ray as composed of two oppositely circularly polarised rays, each of which is reflected according to its own laws. I consider next the cases of the magnetisation being all normal to the surface, and all in the surface and the plane of incidence, and obtain the following result: When the incident ray is plane polarised, and the plane of polarisation is either in or perpendicular to the plane of incidence, the effect of magnetisation is to introduce a component into the reflected ray perpendicular to the original plane of polarisation, which vanishes at the grazing and normal incidences, and, in the case of iron, attains a maximum at about the angle of incidence $i = 63° 20'$.

I do not obtain any change of phase by reflection in any case; and this is to be expected, as this change of phase probably depends on the nature of the change from one medium to another, which, following M'Cullagh, I have uniformly assumed to be abrupt. Apart from this question of change of phase, my results conform completely to Mr. Kerr's beautiful experiments on the reflection of light from the pole of a magnet, as published in the Philosophical Magazines for May, 1877, and March, 1878.

"On Dry Fog," by E. Frankland, D.C.L., F.R.S., Professor of Chemistry in the Royal School of Mines.

January 16.—"Concluding Observations on the Locomotor System of Medusæ," by George J. Romanes, M.A., F.L.S. Communicated by Prof. Huxley, Sec. R.S.

The principal bulk of the paper is devoted to a full consideration of numerous facts and inferences relating to the phenomena of what the author terms "artificial rhythm." Some of these facts have already been published in abstract in the *Proceedings* of the Royal Society" (vol. xxv.), and to explain those which have not been published would involve more space than it is here desirable to allow. The tendency of the whole research on artificial rhythm, as produced in various species of Medusæ, is to show that the natural rhythm of these animals (and so probably of ganglio-muscular tissues in general) is due, not exclusively to the intermittent nature of the ganglionic discharge, but also in large measure to an alternate process of exhaustion and restoration of excitability on the part of the responding tissues—the ganglionic period coinciding with that during which the process of restoration lasts, and the ganglionic discharge being thus always thrown in at the moment when the excitability of the responding tissues is at its climax.

Light has been found to stimulate the lithocysts of covered-eyed Medusæ into increased activity, thus proving that these organs, like the marginal bodies of the naked-eyed Medusæ, are rudimentary organs of vision.

The polypite of *Aurelia aurita* has been proved to execute movements of localisation of stimuli somewhat similar to those which the author has already described as being performed by the polypite of *Tiaropsis indicans*.

Alternating the direction of the constant current in the muscular tissues of the Medusæ has the effect of maintaining the make and break stimulations at their maximum value; but the value of these stimulations rapidly declines if they are successively repeated with the current passing in the same direction.

In the sub-umbrella of the Medusæ waves of nervous excitation are sometimes able to pass when waves of muscular contraction have become blocked by the severity of overlapping sections.

Exhaustion of the sub-umbrella tissues—especially in narrow connecting isthmuses of tissue—may have the effect of blocking the passage of contractile waves.

Lithocysts have been proved sometimes to exert their ganglionic influence at comparatively great distances from their own seats—contractile waves, originating at points in the sub-umbrella tissue remote from a lithocyst, and ceasing to originate at that point when the lithocyst is removed. A nervous connection of this kind may be maintained between a lithocyst and the point at which the waves of contraction originate even after severe forms of section have been interposed between the lithocyst and that point.

When the sub-umbrella tissue of *Aurelia* is cut throughout its whole diameter, the incision will again heal up, sufficiently to restore physiological continuity, in from four to eight hours.

Chemical Society, January 16.—Dr. Gladstone, president, in the chair.—The following papers were read: On the action of isobutyric anhydride on the aromatic aldehydes, by W. H. Perkin. The author has studied the action of isobutyric anhydride on cuminic aldehyde, hydride of benzoyl, cinnamic aldehyde paroxybenzoic and anisic aldehydes. The bodies formed are respectively β isopropylbutenylbenzene, β butenylbenzene, butenylcinnamene, parabutenylphenol, and β parabutenylanisoïl.—On two new methods for the estimation of minute quantities of carbon and their application to water-analysis, by Drs. Dupré and Hake. The first consists in burning the substance in a current of oxygen in a combustion tube with oxide of copper, absorbing the carbonic acid in a Pettenkofer tube with baryta water, filtering off the barium carbonate with great care, converting it into chloride, then into sulphate, and weighing; in the second, the carbonic acid passes into a 2 per cent. solution of basic acetate of lead, and the turbidity compared with that produced by a solution of carbon of known strength in a Mills colorimeter.—On stannic ethide, by Dr. Frankland and Mr. A. Lawrance. By treating zinc ethyl with successive quantities of fused stannous chloride, the authors have prepared stannic ethide with great facility, they have also examined its properties, and specially investigated the action of sulphurous acid.—On aurin, by R. S. Dale and C. Schorlemmer. The authors have prepared pure aurin with great care, and confirmed the formula which they have already assigned to it. They have also studied ammonia aurin, tetrabromaurin, and the compounds formed by aurin with acetic, sulphuric, hydrochloric, and nitric acids.—On the derivatives of diisobutyl, by W. Carleton Williams.—On the action of chlorine upon iodine, by J. B. Hannay. The author confirms his previous conclusion, viz., that a body containing one atom of iodine and four atoms of chlorine does not exist.

Geological Society, January 8.—Henry Clifton Sorby, F.R.S., president, in the chair.—Charles Barrington Brown, Carl Fischer, M.D., F.L.S., William Coles Paget Medlycot, were elected Fellows; and Dr. F. V. Hayden, Washington, and M. Jules Marcou, Salins, Foreign Members of the Society.—The following communications were read:—On some tin-deposits of the Malayan Peninsula, by Patrick Doyle, C.E. (Communicated by the Rev. T. Wiltshire, F.L.S.) The tin-ore of the Malayan Peninsula is obtained from "stream-works" in an alluvial plain extending between a range of granitic mountains and the sea. The author describes the mines of the district of Larut Perak. The ore is got in open workings at an average depth of about 10 feet. The tin-bearing stratum has an average thickness of 4·87 feet; it is overlain by stratified sand and clay, and rests upon either porcelain clay or, sometimes, a sandstone. The ore varies from a fine sand, near the sea, to a coarse gravel, near the mountains, and is mixed with quartz, felspar, mica, and schorl. The author is of opinion that the stratum of ore has been derived from the granite of the mountain range, in which it still occurs in veins, by denudation, and under conditions which still exist, though in a modified form.—Description of fragmentary indications of a huge kind of Theriodont reptile (*Titanosuchus ferox*, Owen), from Beaufort West, Gough Tract, Cape of Good Hope, by Prof. R. Owen, C.B., F.R.S. The author stated that among the fossils recently sent to the British Museum from the Cape of Good Hope by Mr. T. Bain, there were two boxes containing specimens of a most unpromising character, there being in them no entire bones, but only numerous more or less water-worn fragments. Among these was found a portion of a maxillary showing some traces of teeth; and sections having been made of this bone, the remains of several teeth were displayed, including a canine, the preserved portion of the socket of which was 4½ inches long. From the number and mode of implantation of the teeth, the author concluded that the animal to which they belonged resembled the Theriodont genera *Galesaurus* and *Galenops*. The anterior portion of the left ramus of the lower jaw, measuring 7½ inches in length, showed teeth presenting close analogies with those of Theriodonts, and this alliance was confirmed by the study of other fragments. Some of the characters presented by these remains seem to suggest affinities with the carnivorous mammalia, such as have been already indicated by the humeri of Theriodonts and Carnivores. The canine tooth of the new South-African reptile, which the author proposes to name *Titanosuchus ferox*, was six times as long as that of the allied form *Lycosaurus*; and we have in *Titanosuchus* evidence of a carnivorous reptile of more carnassial type than *Machairodus* and other felines. The author suggests that *Titanosuchus* found its prey in the contemporary *Pareiosauri*, Oudenodonts, and Tapinocephalans of the same locality.—Notes on the consolidated beach at Pernambuco, by J. C. Hawkshaw, M.A., F.G.S. The consolidated beach at Pernambuco, which has already attracted considerable notice, is a ridge of sandstone from 25 to 75 yards wide, and, as shown by borings made under the author's direction, from 10 to 13 feet thick. The landward or higher edge is nearly at the spring-tide high-water level, and it slopes seaward; the river (with a depth of 28 feet at low water 60 feet from the rock) flowing along the former face. The rise and fall of spring tides is 7 feet. Beneath the above rock is a stratum of sand with shells and stones about 8 feet thick, and then a second layer of sandstone rock. The consolidated beach is cemented by carbonate of lime, which the author considers to have been deposited by the action of water percolating through the rock, probably when the level of the land differed somewhat from what it is at present. He thinks it possible that this and other similar beaches on the Brazilian coast may mark periods of repose in the slow vertical movements which the coast has undergone.

Zoological Society, January 14.—Prof. Newton, F.R.S., vice-president, in the chair.—Dr. Traquair, F.R.S.E., exhibited a specimen of the Hackled Pigeon (*Alectorœnas nitidissima*) recognised, last September in the Museum of Science and Art in Edinburgh, by Prof. Newton, F.R.S., M.A., who made some remarks on the species showing (1) that it was peculiar to Mauritius, (2) that it is now wholly extinct, and (3) that only three specimens of it are known to have been preserved.—The Secretary read an extract from a letter received from Commander Hoskins, R.N., of H.M.S. *Wolverine*, on the subject of the range of the Mooruk, stating that no traces of the existence of this bird could be found in New Ireland.—An extract was read from a letter addressed to the secretary by the Rev. George Brown, giving additional particulars on the same subject.—The Secretary read an extract from a letter addressed to him by Mr. R. Trimen, F.Z.S., of Cape Town, on the subject of the true locality of the Black Spurwinged Goose (*Plectropterus niger*), which he had ascertained had been brought to Cape Town from Zanzibar.—A communication was read from Dr. Morrison Watson and Dr. Alfred H. Young, on the anatomy of the Spotted Hyæna (*Hyæna crocuta*).—A communication was read from Mr. A. D. Bartlett, giving an account of the habits and changes of plumage of Humboldt's Penguin, as observed in a specimen which had been recently living in the Society's Gardens.—A communication was read from Dr. O. Finsch, C.M.Z.S., containing an account of a collection of birds made by Mr. Huebner, on Duke of York Island and New Britain.—A communication was read from Mr. Edward J. Miers, F.Z.S., describing a collection of crustacea, made by Capt. H. C. St. John, R.N., in the Corean and Japanese Seas. The present paper related to the Podophthalmia of the collection, of which groups twenty-six species were described as apparently new to science.—A communication was read from Count T. Salvadori, C.M.Z.S., containing critical remarks on Mr. Elliot's paper on the Fruit-pigeons of the genus *Ptilopus*, lately published in the Society's *Proceedings*.—A communication was read from the late Marquis of Tweeddale, F.R.S., containing the twelfth of a series of contributions to the ornithology of the Philippines. The present paper gave an account of the collection made by Mr. A. H. Everett in the Island of Basilan.—Dr. A. Günther, F.R.S., gave an account of the mammals, reptiles, batrachians recently collected by Mr. Everett in the Philippine Islands, and called special attention to a new form of snakes of the family Calamariidæ, of which one example had been obtained. This snake, which was remarkable as possessing no external rudiments of eyes, was proposed to be called *Typhlogeophis brevis*.

Mineralogical Society of Great Britain and Ireland, January 7.—General Meeting.—Mr. H. C. Sorby, F.R.S., president, in the chair.—The following papers were read or taken as read:—On pilolite, an unrecognised species, by Prof. M. F. Heddle, M.D.—On so-called green garnets from the Urals, by Prof. A. H. Church, M.A.—On the magnetism of rocks and minerals, by J. B. Hannay, F.C.S.—On the celestine and baryto-celestine of Clifton, by J. N. Collie, communicated by W. W. Stoddart, F.G.S.—On some silicates of copper, by Wm. Semmons, president of the Liverpool Geological Society.—Contributions towards a history of British meteorites, by T. M. Hall, F.G.S.—Notes on some crystals of iron, by Amos Beardsley, F.G.S.—Notes on massive and crystallised cronstedtite from Wheal Jane, by A. K. Barnett, F.G.S.—A large number of Members and Associates were elected by the Council previous to the meeting.

EDINBURGH

Royal Society, January 6.—Prof. Kelland, president, in the chair.—Mr. James Blyth gave notes on some experiments with the telephone. When the ends of two wires attached to the telephone were rubbed against one another and kept at a high temperature a grating sound was heard in the telephone, which diminished as the temperature was lowered. The sound, however, did not quite cease when the ends of both wires were cold. In this case the sound was louder and more distinct when the wires were attached to two files which were rubbed against each other. The experiment was modified by attaching one wire to the file and the other to a vice. Different substances—brass, carbon, zinc, iron, steel—were then screwed into the vice and rubbed by the file, but not much difference was observed between the effects produced. Another modification consisted in attaching the second wire to the axle of the fly-wheel of a lathe. In the last case the sound was very loud and distinct when the file attached to the other wire was held hard against the wheel as it revolved. A sound was also heard in the telephone when a hammer was made to strike a body—the hammer and the body being each connected to one of the telephonic wires. The sound was distinct but not so loud as with the rubbing. The sound was very loud when a large toothed wheel driven fast was used, and against which a strong spring struck, the one wire being attached to the wheel the other to the spring. Here there is a combination of striking and friction. Mr. Blyth suggested that these currents might be due to thermo-electric action or might be the electricity which Sir Wm. Thomson considers as the probable cause of friction.[1] The experiment was again varied by connecting one wire to the style of a phonograph and the other with the screw; there were two Bunsen cells in the circuit, which was completed by the style and cylinder. When the phonograph was spoken into, a person in a distant room could hear by means of the telephone. This seemed to show that the style presses unequally on the tinfoil and hence that although magnified copies of the curve on the tinfoil may be obtained by multiplying levers, these copies do not necessarily represent the motion of the style.—Prof. Tait gave a note on the measurement of beknottedness. The former measure was the smallest number of crossings whose signs must be changed to take off all the knotting. An objection to this was that these seemed to have no direct connection with the electro-magnetic measurement. The new method consists in drawing the knot in two parallel curvilinear lines easily distinguishable from each other by colour or formation, the one knot being thus wholly within the other. A knot is cut across through the symmetrical angle, and the ends joined again.—Prof. Tait gave a preliminary note describing some experiments

[1] Bakerian Lecture, 1856, *Phil. Trans.*, foot-note to second page.

he was making for the purpose of measuring what is known as the "Thomson Effect," viz., the convection of heat by electric currents from a cold to a hot part of a bar, or *vice versâ*. The method had occurred to him while testing the electric conductivity of bars heated for Forbes' conduction experiment.—A paper was read by Dr. Macfarlane and Mr. P. M. Playfair, on the disruptive discharge of electricity, in confirmation of former experiments of a similar nature. They found former anomalies with sparks of more than a certain length between two spheres, to be due to discharge by small sparks, and beyond that to escape into the air from the insulated wire. In the case of discharge between a plate and a point, there was a gradual increase in the difference of potential. Up to a certain limit the sparks were white; beyond that the sparks were violet, and there was very slight increase in the difference of potential required. On discharging through solid paraffin it was found that the first spark was by far the largest, and on examination the paraffin was found perforated in a zigzag manner, and the sides of the perforation were charred. The solid paraffin had twice as great electric strength as the same paraffin in the liquid state, and five times the electric strength of air. They found that the electric strength was a very definite method of distinguishing between different paraffins, but somewhat difficult of application.—Prof. Tait showed some pieces of sheet or tape india-rubber which Mr. Maclachlan of Mitcham had used to insulate wires, and which, after being stretched for some years, were found to be permanently strained; but they immediately regained their former dimensions on being dipped into hot water. The same phenomenon was true, he found, of india-rubber which, while warm, was stretched out nearly to rupture, and then kept stretched till cold. Prof. Clerk Maxwell had found a similar property true of gutta-percha pulled out when cold after being boiled. On heating it before a fire it took a peculiar form.

VIENNA

Imperial Academy of Sciences, December 5, 1878.—On twins; a contribution to human physiology, by Dr. Göhlert.—On the diffusion of liquids, by Prof. Stefan.—Determination of the path of the third comet of 1877, by Herr Zellr.

December 12, 1878.—On the fish species in the two lakes of Lower Austria, the Erlaph and Lunzer Lakes, by Dr. Fitzinger.—New observations on sounding air columns, by Prof. v. Lang.

PARIS

Academy of Sciences, January 13.—M. Daubrée in the chair.—The following papers were read:—On the construction of bridge-arches realising the maximum of stability, by M. Villarceau.—Researches on ozone and on the electric effluve, by M. Berthelot. Oxygen (1 vol.) and hydrogen (2 vols.) do not combine under action of the effluve, though the tension be nearly that which gives, through air, sparks 7 to 8 ctm. long. O will combine with the metals, sulphurous acid, nitrogen, &c., under such conditions. CO (2 vols.) and O (1 vol.) combine under like tensions; but the reaction is incomplete; and even with excess of O it is so. The effluve, acting on a mixture of CO_2 and O partly decomposes the former, and the O contains ozone; acting on pure CO_2 in a space without mercury or oxidable bodies, the effects point apparently to the existence of percarbonic acid.—On the formation of ethers of hydracids in the gaseous state, by M. Berthelot.—Are there, among low organisms, species exclusively *aërobies* and others exclusively *anaërobies?* Should all these beings be ranged in two or three classes (Pasteur) or in one only? by M. Trecul. He argues for one class only, each species being capable of presenting at once one or several *aërobian* states, and one or several *anaërobian*.—Reply to M. Berthelot, by M. Pasteur.—Researches on the compressibility of gases, by M. Cailletet. He describes the manometer he uses; a tube of soft steel wound helically round a vertical cylinder, by turning which the tube is sent down a deep pit or wound up again. The lower end of this tube is connected with a laboratory-tube, in which is inclosed the piezometer containing the gas, and mercury is introduced into the apparatus. This tube is suspended by a fine graduated steel wire, the length of which unrolled measures the pressure. M. Cailletet tabulates his numerical results with nitrogen, which, it appears, contracts at first more than according to Mariotte's law; its compressibility then decreases (as in the case of air). It is about a pressure of 70 metres of mercury, that the gas presents this curious maximum.—The polymorphism of *Agaricus melleus*, Vahl., by M. Planchon.—Experiments relating to the action of waves on beaches and on artificial rock-work, by M. De Caligny. He reproduces in an artificial canal effects noticed at the rock-work of Cherburg, where large waves which, at low water, rolled the blocks towards the summit of the talus, had an undermining effect at high water.—M. Monot presented some specimens of results he has obtained in manufacture of various kinds of crystal.—The phylloxera in Panama, on the *Vitis caribæa*, D.C., by M. Collot.—On the employment of oil of asphalte against phylloxera, by M. Berton. Some one told him, when exploring the Dead Sea, that this oil had saved the vineyards of Judea from a worm (phylloxera?).—Letter to the President of the Commission on phylloxera, by M. Truchot.—MM. Felson and Chartre communicated a detailed catalogue of those erratic blocks most remarkable as regards the history of glacial phenomena.—The General-Inspector of Navigation presented data concerning flood and low-water of the Seine in 1878.—Observations of Saturn's satellites, at the Observatory of Toulouse, in 1877 and 1878, with the large Foucault telescope, by M. Baillaud.—New compound prism for direct-vision spectroscope of very great dispersive power, by M. Thollon. This sulphide of carbon prism is closed laterally by crown glass prisms, whose refringent angles are in opposite direction to that of the sulphide. The compound prism gives the enormous dispersion of 2'·0 angular distance of the D-lines, as compared with 45" for sulphide of carbon. Substituting the new prisms in his former spectroscope, he got a dispersion equivalent to that of 16 sulphide of carbon prisms of 60°, or 31 prisms of index 1·63. It gave 12' angular distance in the D-lines, and it presents quite new aspects of the spectrum. All the lines (newly) resolved were found to belong to different substances.—On M. Thollon's spectroscope, by M. Laurent.—On determination of the variations of level of a liquid surface, by M. Renou. A claim of priority.—Synthesis of uric derivatives of the series of allophane, by M. Grimaux.—Action of diastase, saliva, and pancreatic juice on starch and glycogen, by MM. Musculus and De Méring.—New observations on the development and metamorphoses of Taenias, by M. Megnin. Certain unarmed and armed Taenias are two adult forms of the same worm, their differences due exclusively to the conditions of their development.—Observations on Majorca and Minorca (continued), by M. Hermite.—New observations on the danger of use of powdered borax in meat-preserving, by M. Le Bon.

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