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A VIEW OF THE PROGRESS OF DISCOVERY

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No. VIII.

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Art. I.—*Biographical Notice of the Abbé Haüy.*[*]

René-Just Hauy, Honorary Canon of the metropolitan church of Paris, Member of the Legion of Honour, Professor of Mineralogy in the Royal Garden, and in the Faculty of Sciences of Paris, and Member of the Royal Academies of Paris, London, Petersburgh, Berlin, Edinburgh, Stockholm, &c.; was born on the 28th of February 1743, at Saint-Just, a little village in the department of the Oise. He was the elder brother of the late Mr Haüy, so well known as the inventor of a method of instruction for the blind. The father of these two children, who were destined to extend the bounds of science, and enlarge its applications, was a poor weaver, who, according to all appearances, would never have been able to give his sons any other profession than his own, if some generous persons had not come to his assistance. There was then at Saint-Just an Abbey in which the young Haüy attended with assiduity to the religious ceremonies that were practised, and showed much taste for the sacred music of the church. He drew the attention of the Prior, who sent for him, interrogated him, and, struck with the extraordinary intelligence of the child, had him instructed by some of the re-

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[*] This biographical sketch is composed of the eloquent eloge upon Haüy delivered by Baron Cuvier at the public sitting of the Academy of Sciences on the 2d June 1823, interspersed with copious additions respecting his writings and scientific labours.—Ed.

ligious incumbents of the Abbey. The progress of the scholar was so rapid that his masters engaged his mother to take him to Paris, where he might find the means of continuing his studies. The courageous mother followed this advice, notwithstanding that difficulties of all kinds presented themselves, and persevered through all the trials which she had to sustain in supporting herself and her son in a great city, where she found herself without resources. The first relief which she obtained, after a long period of expectation, was a place for her son as one of the infant choristers in a church in the Fauxbourg St Antoine. The young Haüy was able to improve upon the simple instruction which he received in that employment; he became a good musician. At length his protectors obtained for him a purse in the College of Navarre, and it is from his entrance into this college that we must date the commencement of his regular studies. His conduct secured the esteem and attachment of his professors; and when he ceased to be a scholar, though still very young, his masters judged him to be worthy of sharing with them in their labours. At the age of twenty-one he was regent of the fourth, and some time after, he passed as regent of the second to the college of Cardinal Lemoine. Nothing, until then, had directed his attention to the natural sciences, but he had attended the course of Brisson in the college at Navarre, and acquired some taste for experimental physics. Among his new *confreres* in the college of Lemoine was Lhomond, a man of profound knowledge, and yet more modest and pious than he was learned. This person had limited himself to the instruction of the sixth, and had composed works only for children; but they were remarkable for an uncommon clearness, and a simplicity of tone conformable to the character of the author.

The young Haüy soon became the friend of the respectable Lhomond, entrusted him with the secrets of his conscience, and felt for him the tenderness of a son. He took care of his business, comforted him in his sufferings, and accompanied him in his walks. Lhomond loved to herborize, but Haüy had yet no idea of botany. The industrious friendship of the young professor enabled him to fill up, in a very short time, this blank in his information, in order that he might be more agreeable and useful to his friend. At the first herborization, he could name the plants, and assign them their botanical characters; very soon he was on a level with his companion and from that time every thing was common between them, even to their amusements.

The College of Cardinal Lemoine is near the Garden of Plants; and it was natural that Haüy should often choose it for his promenade. Seeing one day a crowd of auditors pressing in to the attendance of a lecture of Daubenton, on mineralogy, he wished to hear this professor, and was charmed to find, in this part of natural history, subjects of theory more analogous to his taste for the physical sciences, than the pursuits of botany. The comparison of these two varieties of the productions of nature, excited in his mind a train of reflections which led the way to his discoveries in crystallography. How is it, said he, that the same stones and the same salts should show themselves in cubes, in prisms, in needles, without the change of a single atom in their composition, while the rose has always the same petals, the gland the same flexure, the cedar the same height and developement? He was occupied with these ideas, when examining one day some minerals at the house of his friend M. Defrance, he awkwardly, though luckily, let fall a beautiful group of prismatic crystals of calcareous spar. Some fragments broken from the group, presented the appearance of a new and regularly formed crystal, with smooth surfaces. Haüy discovered, with surprise, that this form was precisely that of rhomboidal crystals of Iceland spar. "*The mystery is explained*," cried he. In fact, his whole theory of crystallography, a monument as imperishable as the truths of geometry, is founded on this observation; but because this discovery was altogether geometrical, it was necessary that it should be explained and perfected through the medium of geometry. Haüy felt on this occasion also, that his studies had been imperfect. But he was not discouraged. He perceived what he stood in need of in order to continue his researches upon the structure of crystals; invented a method of measuring and describing them, and not till then did he venture to speak of his discoveries to his master, to whose lessons he had modestly and silently attended. It may readily be conceived that Daubenton was eager to accept and to make known such valuable labours. M. de Laplace, to whom he communicated them, hastened to encourage the author to bring them before the Academy of Sciences. But it was not easy to induce the modest Haüy to leave his happy obscurity to show himself at the house where the Academy held its sittings, and in the midst of this society of distinguished men. He yielded, however, to the solicitation, and went to the house as to an ecclesiastical ceremony, clothed with the costume prescribed by the canons. It was found necessary to have recourse to the authority of a doctor of the Sorbonne, to persuade him that he might, with a safe conscience, wear the same garb as the other ecclesiastics of that day. It is probable, however, that the Academy would have received him, whatever dress he might have chosen to appear in. On the 12th of February 1783, he was admitted as an adjunct in the class of Botany.

In the prosecution of the new views which Haüy had adopted respecting the structure of crystals, he was led to pay particular attention to the physical properties of minerals. The developement of electricity by heating the tourmaline, which had been discovered by Lemery, attracted his particular notice; and he was led to the discovery of the same property in the siliceous oxide of zinc, in boracite, in mesotype, prehnite, and sphene. So early as 1785, he published, in the *Memoirs of the Academy of Sciences*, his observations on the pyro-electricity of tourmaline, and in the same volume he announced his discovery of the pyro-electricity of the oxide of zinc, which is the more remarkable, as it belongs to the class of metallic substances. His attention having been thus particularly directed to the subject of electricity, he published, in the year 1787, his first separate work, in 1 vol. 8vo., entitled, *Exposition Raisonnée de la Theorie de l'Electricité et du Magnetisme, d'apres les Principes de M. Æpinus.* The work of M. Æpinus, in which this theory first appeared, was published at St Petersburg in 1760, under the title of *Tentamen Theoriæ Electricitatis et Magnetismi*, and was the first successful attempt to generalize the phenomena of these two interesting branches of science. Although the original work is written with great perspicuity, yet, from its want of method, Haüy had an opportunity of presenting the theory under a more systematic aspect, of explaining it by more precise and popular illustrations, and of adding the details and the theory of several interesting phenomena, such as the influence of points, the electrical spark, and the electricity developed in the cooling and evaporation of bodies according to the observations of Lavoisier, Laplace, and Saussure. By employing also the true law of magnetic and electrical action, as determined by Coulomb, he was enabled to give the theory a more precise form, and to rectify several of the calculations of Æpinus.

While Haüy was pursuing these peaceful labours, the Revolution burst upon the nation. The Bastile was destroyed, and the monarchy soon after shared the same fate; but all this did not disturb the naturalist from the train of his occupations, nor induce him to participate in the general movements. As he refused to take the oath to the ecclesiastical constitution prescribed at that period, he was deprived of all his perquisites, and found himself as poor as at the period when the place of an infant chorister was the object of his ambition. This poverty did not shield him from imminent dangers. Very ignorant of all that was passing around him, he saw one day his modest retreat invaded by men, who demanded of him whether he had any fire-arms. "I have no other than this," said he, drawing a spark from his electrical machine. They seized his papers, which contained nothing but mathematical calculations, overturned his collection, which was his only property; and, finally, shut him up with other priests in the Seminary of St Firmin, which had been converted into a prison. In thus exchanging one cell for another, he was not very uneasy in his new habitation. Calm under all circumstances, and seeing himself in company with many of his friends, he only thought of sending for his drawers, that he might put his crystals in order. Happily, he had friends without who knew better than he what was preparing for those who had incurred the popular displeasure. One of his pupils, afterwards his colleague, *Geoffroy de Saint Hilaire,* member of the Academy of Sciences, lodged then in the College of Cardinal Lemoine. As soon as he was informed of the fate of his master, he ran instantly to implore all those who he thought might have some influence, to endeavour to save him. An order was at length obtained for his deliverance. M. Geoffroy ran with it to St Firmin; but he was late. Haüy was so tranquil that nothing could induce him to go out on that day. The next day he was taken out almost by force,—and the day after was the 2d of September!

It is very remarkable, that, after the massacre from which Haüy had been so providentially rescued, he met with no further disturbance. One day only he was compelled to appear at the review of his battalion, but he was soon dismissed *on account of his bad figure.* This was nearly all that he knew, or at least all that he saw of the Revolution. At the time at which the convention was acting with the greatest violence, he was named one of the commissioners of weights and measures, and keeper of the cabinet of mines. When Lavoisier was arrested, when Borda and Delambre were deposed, Haüy alone could write in their favour, and he hesitated not to do it: he, an unregistered priest, performing every day his ecclesiastical functions! At such an epoch, his impunity was more surprising even than his courage.

At the death of Daubenton, the public voice designated Haüy as his successor. The votes of the Academy were, however, in favour of Dolomieu, probably on account of the extreme modesty of Haüy. But the former was at that time under arrest, contrary to the rights of nations, in the dungeons of the Neapolitan government; and the only evidence of his being alive was a few lines written upon the margin of a book with a splinter of wood, and the smoke of his lamp, which the ingenuity and humanity of an Englishman had bribed the jailor to transmit to his friend. These lines, as well as his works, pleaded powerfully in his favour, and the member who urged his election with the greatest zeal was Haüy himself. It might have been expected that such testimonials of esteem, rendered by such men, would have softened the rigour of Dolomieu's treatment; but how many persons are there in power, who, when blinded by a momentary passion, take no pains to inform themselves of the opinion of their fellow-creatures, until they discover it in the indignation of posterity! Dolomieu was released from his dungeon only by virtue of an article in a treaty of peace, and a premature death, occasioned by the treatment he had been subjected to, but too soon restored to Haüy the appointment he had so generously renounced. From this time, instruction in mineralogy acquired a new life. Collections were quadrupled, and arranged in an order conformable to the most recent discoveries. The mineralogists of Europe assembled to witness so many objects so well arranged, and to hear a professor so clear and elegant, and withal so complaisant. His native benevolence displayed itself on every occasion to those who wished to be informed. He admitted them to his chambers, opened to them his cabinets, and refused no explanations. The most humble students were received like the most learned and august personages; for he had pupils of all ranks.

During the unfortunate period when his country was torn by faction, Haüy was occupied in the more glorious pursuit of completing his mineralogical system, on which his reputation was destined to depend. He accordingly published, in 1801, under the patronage of the Council of Mines, his *Traité de Mineralogie* in 5 vols. Of this work we cannot speak with too much praise. It was the first great step to place mineralogy upon the immutable basis of scientific principles, and to wrest that noble science from the usurpation of ignorant charlatans. No man could pretend to follow our author through the varied and beautiful details of his system without some share of mathematical learning, without some knowledge of chemical science, and without a pretty general acquaintance with those branches of natural philosophy which come into such immediate contact with the physiology of mineral bodies. In Great Britain, therefore, the labours of Haüy were for a long time completely overlooked. Mineralogical lecturers could not be expected to expound what they did not themselves understand; and the traders in bulky compilations on mineralogy scarcely ventured to notice, and still less to adopt, the vast improvements with which Haüy had renovated and adorned their science.

Dr Thomas Thomson, now Regius Professor of Chemistry in the University of Glasgow, was, so far as we know, the first who seems to have studied and appreciated the labours of our author, and in his conversation, his lectures, and his writings, he was, no doubt, the means of making his countrymen acquainted with the crystallographic system.*

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* See the Article CRYSTALLOGRAPHY drawn up by Dr Thomson for the *Edinburgh Encyclopædia*, and his *System of Chemistry*, 5th Edition, vol. iii. p. 125. Mr Tilloch, so early as 1798, reprinted the sketch which Haüy had given of his theory in the *Annales de Chimie*, vol. xvii.

In speaking thus highly of the works of Haüy, we have no design of depreciating the previous labours of Romé de l'Isle, and we think it right to add the following estimate of his merits, drawn up by an eminent Crystallographer, as an addition to the life of Romé de l'Isle in the *Edinburgh Encyclopædia*, vol. xvii. Part ii. which is on the eve of publication.

The great merits of Romé de l'Isle in mineralogy are less generally acknowledged than they deserve; particularly by the French mineralogists. Modern mineralogists are often astonished at the accuracy of the descriptions given by this author, even of such substances as were afterwards confounded with each other by Haüy and those who copied him. In almost every page his power of observation is displayed in a remarkable degree, joined with good sense, correct reasoning, and vast mineralogical erudition. His figures of crystals, indeed, are frequently far from affording the pleasing effect of geometrical perfection, which captivates the eye in the figures adorning the great work of Haüy; yet they betray the hand of the master, who seized the peculiar character of the individual crystals which he represents, and which is often better preserved in these sketches than in better executed drawings.

The student will always find a great deal of instruction in perusing the second edition of his *Crystallographie*, the result of more than twenty years continued and well-directed exertions; but those who are already proficient in the science will find pleasure in discovering in his writings that they have often been anticipated in their descriptions. It may be said, with perfect propriety, that, however ingenious the views of Haüy may have been in regard to the property of cleavage, he could never have succeeded in establishing them as a general system, applicable to all crystallized minerals, had he not possessed the observations and drawings of Romé de l'Isle. This great man met with all the opposition commonly incidental to new ideas, or to a degree of accuracy which, in fact, is far beyond what had been customary before; but the predjudices had worn off, when Haüy's system appeared, which then earned the rewards both of its own merits and of Romé de l'Isle's. Haüy has always been candid enough to acknowledge every thing he owed to the latter; he supplied the link which made Romé de l'Isle's observations useful, by introducing general views in crystallography, founded upon geometrical processes, and by giving a particular name to every substance determined as a particular

After Haüy had published this great work, he devoted himself to the composition of a treatise on natural philosophy for the use of the French National Lyceum, a task which he executed with considerable success. This work appeared in 1803 under the title of *Traité Elementaire de Physique*, in 2 vols. 8vo., and was translated into English in 1807, by Dr Olinthus Gregory of Woolwich.

The impulse which Haüy had given to mineralogy was, in a few years, propagated over all Europe. Communications were made to him from every quarter, and many new mineral species were discovered. A new edition of his work, therefore, became necessary, and after twenty years labour he was enabled to complete it a short time before his death. In this edition, which appeared in 1822, the Crystallography was published separately in 2 vols. 8vo., while the *Treatise on Mineralogy* occupied four 8vo volumes, with a volume of plates. Besides these works, Haüy was the author of the *Tableau comparatif des Resultats de la Crystallographie et de l'Analyse Chimique*, which appeared at Paris in 1809, of the *Traité des Caractères Physiques des Pierres Precieuses, pour servir à leur determination lorsqu'elles été taillés*, Paris 1817, and of many valuable memoirs on the theory of crystallization, and on the forms and characters of individual minerals which were published in the *Memoircs de l'Institut*, *Rozier's*

species. Romé de l'Isle was particularly regardless of the two great points, which, according to Linnæus, like the thread of Ariadne, lead us through the maze of the variety of nature,—the systematic disposition and denomination of the species; although, in his paper *Des Caractères Extérieures des Minéraux*, he has given principles for the determination of the latter, independent of chemical analysis, which will stand every attack, and remain one of the most valuable disquisitions on the subject ever proposed to the public, and which ought to be studied by every one who wishes to inform himself on this important subject. Romé de l'Isle was the first to vindicate mineralogy to the province of natural history; against the pretensions of chemists, who, even at that time, when the chemical knowledge of minerals was so imperfect, undervalued every thing that was constant in minerals. This may account, in a great measure, together with the neglect of those parts which have been afterwards so highly improved by Haüy, why Romé de l'Isle's works have never had that degree of influence to which their excellence so justly entitled them."

Journal de Physique, the *Annales du Museum*, the *Journal des Mines*, and the *Annales des Mines*.

The University, at the time of its foundation, thought it an honour to place Haüy on the list of one of its faculties. He was not required to deliver lectures, for he was supplied with an adjunct well worthy of him in M. Brongniart, at present member of the Academy of Sciences, and his successor in the Museum of Natural History. But Haüy was unwilling to receive a title without fulfilling the duties which it implied. He accordingly invited the pupils of the Normal school to attend him at his rooms, and by amiable and diversified conversation, he initiated them into his secrets. His college life was thus agreeably renewed, he almost sported with the young people, and never sent them away without an ample collation. Thus passed his days. Religious duties, profound researches, and acts of benevolence, particularly in relation to young people, occupied his whole time. As tolerant as he was pious, the opinions of others never influenced his conduct towards them. As pious as he was faithful to his studies, the most sublime speculations could not divert him from any of the prescriptions of the ritual, and upon all worldly objects he placed just the value which they might be expected to hold in the eyes of a man penetrated with such sentiments. From the course of his pursuits, the most beautiful gems which nature produces came under his observation; and he published a treatise especially upon them, but without regarding them in any other light than as crystalline forms. A single degree, more or less, in the angle of a *schorl*, or a *spath*, would undoubtedly have interested him more than all the treasures of the two Indies: and if any room can be found for reproaching him with too strong an attachment to any thing, it was to his opinions on this subject. He devoted himself to this theory, and when objections were made to it, a degree of impatience was excited, which troubled his repose. It was the only occasion which could influence him to forget his inherent mildness and benevolence; and it must be acknowledged that this disposition was not without its effect. But at the same time that he was paying this tribute to the weakness of humanity, he was occupied with what he regarded as the true interests of science, and suffered himself to be vexed only by obstacles which, in his estimation, were opposed to the triumph of truth.

Such services deserved a reward, and he was at different times pressed to make known what would be most agreeable to himself. All his views were limited to the request that he might be put into a situation to collect his family around him, in order that they might take care of him during his age and infirmity. This desire was immediately satisfied by granting to the husband of his niece some little station in the department of finance. Who could believe that a recompense so well merited as this, would disappear on the first political change, and that the friends of Haüy should be able to obtain no other reply to their solicitations, than that "there was no connection between the public contributions and crystallography."

This trial was not the only one which this illustrious savant had to support. A short time afterwards, the state of the finances occasioned him to lose a pension which he could badly dispense with. His brother, who had been invited to Russia to spread a knowledge of the method of instructing the blind, returned from that country without a fulfilment of any of the promises that had been made him, and in a state of health so enfeebled as to render him a charge to his family. It was thus that, towards the end of his days, Haüy found himself reduced to the same necessitous condition that he had more than once experienced. His religious resignation would have become of indispensable importance to him, if his young relations had not concealed from him, with the greatest care, the embarrassment of his worldly affairs. The less he had it in his power to testify his gratitude to them, the more earnest were they to bestow upon him every delicate attention. The love of his pupils, and the respect of all Europe contributed also to console him. Intelligent men of all ranks who came to Paris, were anxious to express their regard for him and almost at the close of his life we have seen the heir of a great kingdom (the Prince Royal of Denmark) take various opportunities of conversing with him at his bed side, and evincing in the most feeling terms, the interest which he took in his welfare. But the best support which he experienced in this period of trial was, that in the midst of his glory and of his fortune, he had never abandoned his college habits, nor those of his native village. His hour of rising, of taking his meals, and of going to bed, had never been changed; he took every day nearly the same exercise, walked in the same places, and even in his walks, found some occasion for the exercise of his benevolence. When he saw a stranger in difficulty with respect to the way, he conducted him himself, or sent him a ticket of admission to the collections; numerous are the persons who have received these agreeable marks of attention, without doubting the hand from which they have sprung. His antique dress, his simple manners, his language, modest in the extreme, were not calculated to emblazon his reputation. When he spent a short time in his native village, none of his old neighbours would have suspected that he had become a considerable personage. One day, in a walk upon the boulevard, he met two soldiers who were about to settle a dispute by fighting; he immediately inquired into the cause of their quarrel, and succeeded in reconciling them; and that he might insure the continuance of their tranquillity, he went with them to a beer-house and sealed their reconciliation in the manner of a soldier.

Science and humanity were deprived of this worthy man on the 3d of June, 1822, at the age of 79. He left his family but one inheritance—his valuable and magnificent collection of crystals, which the donations of almost all Europe, during twenty years, had placed above all those which have hitherto been formed.*

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* This fine Collection is now in the possession of the Duke of Buckingham.

ART. II.—*A Popular Summary of the Experiments of Messrs Barlow, Christie, Babbage, and Herschel, on the Magnetism of Iron and other Metals, as exhibited by Rotation.*

THERE are few branches of modern science that are likely to excite a greater interest than that which relates to the influence of rotation on the phenomena of magnetism. We are proud to think that this remarkable discovery was first made in our own country, and that, with the exception of a few important experiments made in France, it has been prosecuted solely by the Fellows of the Royal Society of London. At no period of its history, perhaps, has this distinguished body exhibited such a display of pre-eminent and varied talent. In the higher mathematics, in the nicest manipulations of chemistry, and in the most recondite branches of physics, it can now boast of names which posterity will pronounce with reverence, and cherish with affection.

The Transactions of the Royal Society, for the year which is now about to close, cannot fail to excite such feelings in the minds of those who peruse them, and particularly that part which contains the valuable memoirs, of which we now propose to give a brief and popular summary.

It fortunately requires no mathematical knowledge, and no stretch of intellect, to comprehend the principal results of these investigations, and as the experiments address themselves in a peculiar manner to the eye, they are likely to be repeated and extended wherever a magnet and a turning lathe can be procured.

In the year 1818, when Mr Barlow first proposed the circular plate of iron for correcting the local attraction of vessels, he found that, as the plate was made to turn upon its centre, different parts of its circumference had different degrees of magnetic action on the compass, and, for this reason, he has, from the first, employed a double plate, so as to be enabled to combine the strong part of one plate with the weak part of the other, in order thereby to equalize the power in every part. * In repeating and extending these experi-

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* See *Essay on Magnetic Attraction*, 1st ed. p. 90.

ments, Mr Christie afterwards found, that not only had different points in the circumference of the same plate different attracting powers, but the same point had a different influence according as the plate was made to revolve to the right or left hand. Suppose, for example, any point in the circumference of the plate marked (a,) to be brought opposite to the compass, by turning the plate slowly round to the left hand, and that the entire action of the plate at that time deflected the needle from its true position 12° ; then, if the plate be again turned on its axis to the right hand, till the same point (a) occupies the same position as before, the deflection of the needle will not be the same, but be altered, perhaps to 13° or 14°. If it be made to revolve a second, or third, or, indeed, any number of times in the same direction, still the deflection will remain as before, (viz. 13° or 14°, according to our supposition ;) but if after this it be turned one revolution back again to the left, the deflection will become as at first 12°, and this quantity will not be altered by repeating the revolution in this direction. The quantity of deviation stated above is merely assumption, as the actual deviation differs in amount according to the distance of the plate from the needle, and its position with reference to the same. Mr Christie has, by means of a very ingenious machine, been enabled to place the plate in any position, and adopting the views of his friend Mr Barlow, by conceiving an ideal magnetic sphere to circumscribe the compass, he registers the latitude and longitude of the centre of the plate on this sphere with the corresponding deflection in each case, and then submits his experimental results to the test of theoretical investigation. We cannot follow the author in this part of his labours, but our readers will readily comprehend the following illustrations of the observed effects, (although we are not quite certain that it is the same view which the author himself has taken of the subject.)

Let us conceive a plate of iron placed in the magnetic meridian. This plate will be polarized by induction from the earth,—that is, the magnetic fluid in the plate will receive a certain polarized direction. If we could now conceive this plate to become hard steel, the magnetic fluid would become fixed, and, however the plate might be made to revolve, the particles of the fluid would revolve with the plate, and the entire action of the plate would be reversed by reversing its position. On the other hand, if we could find a plate of perfectly soft iron, then the magnetic particles of the fluid would maintain their direction independently of the rotation of the plate, and the effects observed by Mr Christie would not take place.

But iron cannot be obtained perfectly soft: There will be certain points in the best manufactured iron, which are harder, or which offer a stronger coercive power to the magnetic fluid than others; and, therefore, the magnetic particles will not revolve with the plate as in the first case, nor remain constant in position as in the second. The iron in the case in question being, however, nearly soft, the greater part of the fluid will maintain its original polarized direction, but other particles, meeting with the obstructions alluded to during the rotation, will be carried to the right or left hand with the plate, and produce all the observed phenomena; differing in effect, according as the position of the plate is more or less advantageously situated on the magnetic sphere, for the developement of its magnetism. This, at least, appears to be the most simple explanation of the phenomena, and it has the advantage of requiring the acknowledgment of no principle of magnetic energy that is not already admitted by most of the philosophers of the present day, and which has been found sufficient to explain all the phenomena. We ought to observe, that these experiments appear to have been made about three or four years back. They are very extensive and varied, but as an abstract of them has already appeared in this Journal, we shall not enter farther upon them in this place.

One of the most striking peculiarities in the preceding experiments is, that no increase of effect is produced by multiplying the number of rotations, so that there was nothing to conduct us to the inference that velocity had any essential influence. From some other considerations, however, which he states, Mr Barlow was led to conceive that magnetism which is produced by various processes with iron, might even be excited or disturbed by rapid rotation, and to pursue this inquiry, the following experiments were undertaken.

They were begun in December 1824, and completed last January, but the publication of them was delayed till June, in order that Mr Christie's paper might appear at the same time, the similarity of the inquiries rendering this measure desirable. During this interval, M. Arago discovered the magnetic effect of copper and other metals while in rotation; a subject which we shall have occasion to resume in our abstract of Messrs Babbage and Herschel's experiments.

Mr Barlow's first experiments were made on a thirteen inch shell, attached to one of the lathes in the Royal Arsenal, turned by the steam-engine, the mean speed of which was about 640 revolutions per minute. With this the effect of velocity was at once rendered obvious,—the deviation of the needle increasing with the speed,—and it remained constant in all cases when the velocity was constant; but the needle always returned correctly to its proper or original direction, the moment the motion of the ball ceased. This, therefore, is a phenomenon different from that observed by Mr Christie. In the latter, the effect is permanent, and independent of the number of revolutions; while, in the former, it is temporary, and is altogether dependent on the rapidity of rotation.

Mr Barlow afterwards suspended an eight inch shell after the manner of the cylinder of an electrical machine, and having the means of placing the axis of rotation in different azimuths, he examined, by neutralizing the needle, the direction of the new force thus impressed upon the shell, which he found in all cases equivalent to a polarization at right angles to the axis of rotation; and the explanation he has given is nearly the same as we have ventured upon in the preceding experiments, viz. that, if the iron were perfectly soft, the magnetic fluid would maintain its natural polarized position; but this not being the case, it is carried forward by the rapid rotation of the ball, thereby giving a certain degree of obliquity to the general axis of polarization, which oblique force, being resolved into two forces, one of them in the natural direction of the needle, the other perpendicular to it, and the former being neutralized as above stated, the new force at right angles to the axis exhibits itself to the observer, by the direction which it impresses on the needle, and which, in all cases, appears to be consistent with this view of the subject.

We have already stated, that, prior to the publication of the preceding experiments, M. Arago had discovered the curious fact, that if a copper plate be put in rapid rotation under a horizontal needle freely suspended, the rotation of the copper will first deflect the needle out of its true direction, and if the motion be made sufficiently rapid, and the needle and plate of sufficient dimensions, the former will increase in its deflection, till its passage to the opposite point, after which, it will continue to rotate, and ultimately with such velocity, as to be nearly undistinguishable by the eye.

This experiment was repeated in London by M. Gay Lussac in March or April, and soon after Messrs Herschel and Babbage undertook the experiments of which we now propose to give a sketch.

In order to obtain more measurable effects than could be arrived at by merely putting the needle in rotation, it was found necessary to reverse the experiment, by setting in rotation a strong horse-shoe magnet, and suspending over it thin plates of various metals; and by preserving always the same speed in the revolving axis, the effect produced was measured by the number of revolutions which the different plates made in a given time. The substances in which signs of magnetism were thus developed, were copper, zinc, silver, tin, lead, antimony, mercury, gold, bismuth, and carbon, in that peculiar metalloidal state in which it is precipitated from carburetted hydrogen in gas works. In the case of mercury, the total absence of iron was secured.

The relation in which the different metals stand towards each in their magnetic power, was estimated by having thick circular plates of the more usual of them cast all in the same mould, about a foot in diameter, and these being made to revolve at such a distance below a delicate compass as not to produce rotation, but merely a deviation in the needle, the respective powers were estimated by the deflection they produced, their order, as thus obtained, being as follows, viz. copper, zinc, tin, lead, antimony, and bismuth, which latter is very feeble in its action, compared with the first two. A second method was also employed, viz. by finding the times of rotation of a neutralized system of magnets suspended over them. The two methods gave always the same results, except in the cases of zinc and copper; the former according to three experiments, and the copper in the former, occupied respectively the first place.

Our authors next investigated the fact which M. Arago had stated, viz. that if the disc of copper, or other revolving metal, be cut from the circumference towards the centre like radii, but without taking away the metal, it will produce, upon the needle, a very diminished action. This was verified by Messrs Herschel and Babbage, and the farther curious fact ascertained, namely, that re-establishing the metallic contact with other metals, restores, either wholly or very nearly, the original powers, and that, too, even when the metal used for soldering has in itself a very feeble magnetic power. The law of increase of force, with a decrease of distance, was next examined, but it was not found to follow any constant ratio; it appeared to vary between the square and the cube.

The remaining part of the paper is employed in generalizing and explaining the facts detailed. The explanation given by Messrs Babbage and Herschel, is nearly the same as that given above relative to the rotation of iron. The different metals, for example, are conceived to contain a certain portion of latent magnetism, which is induced or called into action by the power of the magnets employed; but, in consequence of the coercive power of these metals, (although very small,) this developement is not instantaneous, nor is it lost instantaneously when the magnets are removed; the needle is therefore constantly urged forward by the magnetism which it has itself exerted, till it at length acquires the rotation above stated.

The preceding paper by Messrs Babbage and Herschel, is followed by a letter from Mr Christie, stating that he had repeated and verified all the foregoing results, and adding some

PLATE I.

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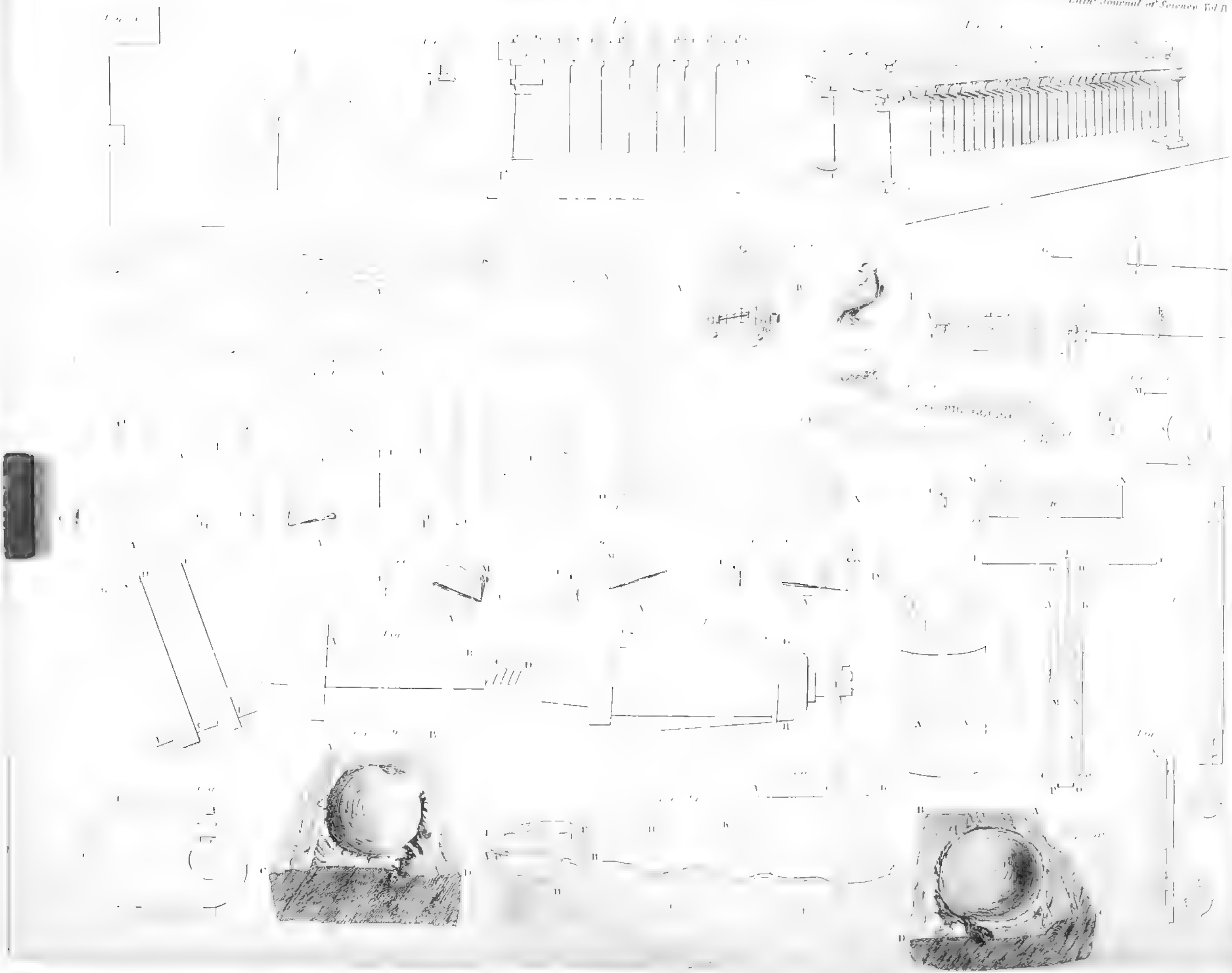


experiments relative to the law of the force. Mr Christie found, that, when a thick copper plate was made to revolve under a small magnet, the force tending to deflect the needle, varied inversely as the fourth power of the distance; but when the magnets were large, and the copper discs small, the power varied as stated in the preceding paper, according to some power of the distance between the square and the cube, and for plates of different weights, the force was very nearly in the ratio of the weights.

ART. III.—*Account of an Improvement on the Galvanic Battery.* By Mr JOHN HART, Civil Engineer, Glasgow. In a Letter to the Editor.

DEAR SIR,

ALLOW me, through the medium of your valuable *Journal*, to describe an improvement on the galvanic battery, which I have recently made, and the advantages of which have been ascertained by actual experience. Before I proceed, however, to give a description of it, it may be proper to notice the prominent defects of those which are in common use.

The pile of Volta is very troublesome to put in action, and as the moisture is liable to be pressed out of the discs of cloth by the weight of the plates, it frequently runs over the edges and destroys their insulation.

A capital improvement was made on this apparatus by the invention of the trough, by the ingenious Mr Cruikshanks of Woolwich. This trough, though extremely convenient and powerful, is subject to some disadvantages, the principal of which is, that the exciting liquid causes the wood to warp. The cement into which the plates are fixed, is thus cracked, and the liquid, insinuating itself into the fissures, soon destroys the insulation. For the purpose of keeping them in order, the cement must therefore be occasionally run over with a hot iron, which is a tedious and very troublesome process. In Mr Children's battery, (which was a combination of Volta's *couronne des tasses* and the trough of Cruikshanks,) porcelain troughs were substituted in place of wooden ones; but, independently of their being expensive, they occupy a great deal of room, and are easily broken, while the strong affinity of the glaze for moisture, soon renders the insulation imperfect, particularly if the acidulous exciting liquid be so strong as to cause effervescence. If this occurs, a shower of minute globules is thrown up from the liquid, which, falling on the edges of the cells, soon moisten them so completely as to destroy the insulation. To this fault, as well as the difficulty of drying the edges of the cells after they have been charged, both this and the preceding troughs are liable. Dr Wollaston's improvement on Mr Children's trough, added considerably to its deflagrating power. His improvement consisted in having a counterpart of copper to each side of the zinc; but still this did not remove the former objection. The great advantage of his modification of the apparatus, was strikingly exemplified in Mr Children's magnificent galvanic battery constructed on the above principle.

After seeing the improved battery of Dr Wollaston, and knowing from experience that the copper is only partially acted upon by the exciting liquid, it occurred to me, that, if *sides* and *bottoms* were added to the double copper plates, they would form cells of themselves for the acidulous liquid, and thus enable us to dispense with the use of troughs altogether.

An opportunity of proving this occurred to me last summer. In examining the apparatus of Anderson's Institution for the purpose of causing additions and repairs to be made, the galvanic part was found extremely defective; and, to supply the deficiency, I gave a sketch of the battery I thought most suitable, to Mr John Condie, a most ingenious mechanic, well known for his philosophical acquirements, and at present engaged in constructing new apparatus for the institution.

He constructed six batteries of twenty-five triads each upon the plan I gave him, and upon trial they were found superior to a new battery of Dr Wollaston's construction, made by that excellent artist, Mr Newman, of Lisle Street, London, with the same number of plates, but the plates of which contained double the surface. The comparative energy of these two forms of the apparatus was ascertained in the manner first proposed by M.M. Gay Lussac and Thenard, namely, by the amount of gas evolved from the decomposition of water collected in a graduated glass tube; a method which, according to these celebrated chemists, is a more correct mode of estimating the power of the battery, than the ignition of different lengths of metallic wire. In this way, two of Dr Wollaston's batteries, each containing ten triads in porcelain troughs, evolved a certain volume of gas in seventeen minutes, while a battery of the new construction, with the same number of triads, but presenting only one-half the surface of the other, yielded the same volume of gas in fourteen minutes.

Such a result can be attributed to nothing but the superior means of insulation possessed by this battery.

The cells are formed by cutting the copper in the form represented by Fig. 1. Plate I.; they are then folded up as seen in Fig. 2, and the seams grooved. A drop of tin is run into each lower corner to render the cells perfectly tight, and, at the same time, to increase the positive state of the copper. Fig 3 represents the zinc plate cast in the usual manner, and having a piece of screwed brass wire cast into the top of it in order to suspend it by.

Fig. 4 is a section of the battery, showing how the copper tail of the first cell is connected with the zinc plate of the second, and so on. This connection is rendered perfect by joining them with a drop of solder. The zinc plates are kept firm in their place in the cells by three small pieces of wood, in the same manner as in Dr Wollaston's battery; the whole are then fixed (by means of screw-nuts fitted on the brass wires) to a bar of baked wood, previously well varnished. Fig. 5 represents the battery in its complete state.

When the battery is small, two may be suspended on one frame. When used for shocks, they may be arranged with the positive and negative poles together, and joined with wire to complete the circuit; but when employed for deflagration, the batteries ought to be placed alongside of each other with all the positive poles at one end, and the negative at the other, and the poles of the same name joined: This arrangement will increase the surface, while the number is the same.

When the battery is to be used, it is to be lifted off the frame, and dipped into a wooden trough lined with lead, into which the acid has been poured, or it may be placed in the leaden trough, and the liquid poured into it, till the cells are full. It is then to be placed on the frame, and the rest charged in succession.

I am,
GLASGOW, *Aug.* 18, 1825. Dear Sir, yours truly,
JOHN HART.

To Dr BREWSTER.

ART. IV.—*An Account of the Frontier between the Southern part of Bengal and the Kingdom of Ava.* By FRANCIS HAMILTON, M.D. F.R.S. & F.A.S. Lond. and Edin. Communicated by the Author.—(*Concluded from* vol. iii. p. 212.)

THE village of the Moroosas, which I visited, was on a hill near the Mamuri, and the principal person, to whose house I was introduced, was named Kingdai, who had visited me at my tents. The village consisted of about twenty houses, forming one straight lane, the two rows of which were distant about ten feet. The buildings were exactly like those of the Joomea Muggs. The space below the platform is enclosed, and serves to secure the hogs and poultry, of which these people have abundance. I ascended by a notched stick serving for a ladder, and from this landed on a platform surrounded by mats, but open above. At one side of this were two apartments, the one belonging to the women, and also serving for a storehouse; the other used for a hall; both communicated by a door, which was open. We sat down on the floor of the hall, in which there was no furniture except a drum, and a shallow box filled with earth, which served for a hearth. Bamboos, split and laid open into a kind of plank, were used for making the walls and floor, and are very suitable in a hot climate. The house was clean.

Soon after my arrival we were joined by eight or ten stout young men, who were desirous of partaking in the conversation. They smoked long pipes like those in use among the Chinese. The mistress of the house attended to give the guests tobacco and fire; and, although modest in her carriage, had no aversion to be seen, being a young, comely, smart woman; nor did her husband seem at all to wish any concealment, although the old people and children did not appear.

Both sexes of the Moroosas are thick and squat, and our young landlady was too plump to have any pretensions to elegance of form; but she had, on the whole, reason to be satisfied with her appearance, having bright eyes, fine teeth, a smooth clean skin, and comely features, like those, however, of the Chinese, as is the case with all the tribe. The men wear their hair tied up in a knot, which projects over the forehead after the fashion of Ava. Some of them wear turbans like the Rakhain; others tie round their heads fillets of green beads. In their ears they have large circular rings of brass or zinc, and their necks and arms are often surrounded by rings of these metals, or by strings of beads. In hot weather they use no clothing but a narrow blue sash, which they pass round the haunches, and between the legs, and it is often secured by a girdle, consisting of several strings of beads. In cold weather, or in high dress, they throw round their shoulders a piece of cotton cloth, chequered red, blue, and white, something like the Highland tartan, and much used by the people of Ava.

The women tie their hair behind in a knot. Our young landlady had cylindrical hollow ear-rings, about four inches long, and one in diameter, which she wore after the fashion of Ava. Round her neck she had a string of coral beads, and on one of her arms a thick bracelet of a white metal Her only clothing was a piece of blue cloth, about a foot wide, and just so long as to meet at the ends round her haunches, where the upper edge was secured by a number of strings of white beads, bound round her like a sash. The two ends of this cloth, just meeting at one of her haunches, showed at every step almost the whole outside of her left thigh, and very little of the inside of either was concealed. The other women were dressed in a similar manner, but not quite so fine. In full dress the women also wear a chequered cloth round their shoulders.

These people seem to have abundance of provisions: hogs, goats, dogs, cats, fowls, fish, snakes, and lizards, form their animal food. Hogs and fowls they have in plenty; but they have much difficulty in preserving any goats from the tigers. Kingdai denied their eating cats and dogs, and said, that the Bengalese alleged their doing so, in order to render them ridiculous; but I was assured by the Joomeas, as well as by the Bengalese, that these animals are eaten; and several of the Moroosas, indeed, confirmed the report. Kingdai was therefore, probably, actuated by a false modesty; for that young cats and dogs are excellent eating there can be no doubt, as they are, I know, highly esteemed by the Chinese, the nation next to the French which has proceeded farthest in the refinement of eating. The Moroosas venture to attack tigers with short spears; but they do not eat such as they kill. In their jooms they cultivate rice, cotton, a kind of cucumber, an arum or kutchu, tobacco, and several other vegetables. They sell the cotton, and buy all the cloth which they use. They make a kind of fermented liquor, which they call arak, as is also done by all the neighbouring rude tribes in the following manner:—The root of a shrub, which the Moroosos name toa, and the Bengalese call moolee, is bruised, and from it is extracted a farinaceous substance, which, with the addition of a little rice-flour, is made into cakes like biscuits. These cakes are also called toa and moolee, and may be kept for a long time. When arak is to be prepared, some of the toa cake is mixed with entire rice, and wet with water. This wet mixture, by standing one day, ferments, and forms a mass, by the Moroosas called yoo. More water is then added to the yoo, and the fermentation is allowed to go on for three days. The liquor is then decanted, and boiled, when it is fit for use. The grains are given to hogs, and make them very fat.

On certain occasions, the old people of the Moroosas direct sacrifices to be offered to a male deity, named Sing-nam ; and the same is done by those who apprehend a bad crop, or are in danger from sickness. The ceremony is exactly similar to that performed by the Joomeas. The Moroosas know no other god, and are not yet far enough advanced to have framed for him an extensive circle of attributes. They burn the dead ; and usually keep the body three days before the ceremony is performed. During this time they feast, and make a great noise with drums. If the deceased has been a person of note, they open the belly, and put in some drugs, by which means they can preserve the body for nine days, and thus protract the time for feasting. So far as I could learn, they have no belief in a future state. In their oaths they invoke Sing-nam, being held in fear of the temporal punishments which he may inflict. Their marriages are not sanctioned by religious ceremonies. A lover, who wishes to marry, makes a present to the girl's parents of some knives, bills, swords, or other iron-work, or, if a very rich man, of a cow. If the offer is accepted, the mother delivers up the girl, who is conducted home with dancing and feasting, and without any other ceremony she is considered as married ; and one man, if he is able, takes several wives, but this seldom happens. They have slaves similar to those of the Joomeas.

The Moroosas defend themselves with wooden shields rudely varnished, and fight with short spears, armed at both ends, (the ἔγχος αμφίγυον of Homer.) Although all subject and tributary to the Joomeas, their villages have frequent wars, one with another. The chiefs of the villages (Ruasah) settle all their disputes, nor does Kaungla Pru seem to interfere farther than to exact his tribute. When a Moroosa dies, his property goes to his father, who supports his widow and children ; but, if the father is dead, the property is divided equally among the children, the widow also receiving a share. The property is of course all personal ; for every man can cultivate as much land as he pleases ; nor is any value placed on a hut that is renewed every year.

I had no opportunity of seeing any of the other tribe, included by the Bengalese under the name of Moroong, but called Mroun or Mroung in the dialects of the language of Ava. The chief person of this tribe has the title of Pomang Gri, or great captain, although subject to Kaungla Pru, who assumes no higher title. He is said to live six days journey east from Manikpur, leaving the Mamuri at Tuin chera, and proceeding two days by land over the hills. His residence is probably, therefore, near the Tyne Hill of Mr Walker, from which the Tuin chera, or rivulet, probably derives its name. I was informed by Aung-ghio-se, that they dress like the Tripuras, and speak the same language, and their men are readily distinguished from the Moroosas by wearing the hair tied in a knot on the nape of the neck. They seem to be some remains of the indigenous Tripuras, originally the inhabitants of the whole district of Chatigang, although, it must be observed, that I also heard of some villages in the territory of Kaungla Pru that were said to be occupied by Teura, or Tripuras; this, however, may have arisen from two names being given to the same people. Among the southern division of the Joomea Muggs, the rude tribe chiefly settled is that called Saksah by themselves, Sak by the people of Rakhain, and Sæk by those of Ava. These are the same with the people on the banks of the Karnaphuli already described.

I have already noticed, that a very considerable tribe, in its own language called Zho, extends from the Sunkar north along the sources of the rivers flowing towards Bengal, as far at least as Kachar and Manipur, and perhaps even to Asam, if they be the same with the Nagas of its inhabitants. (*Annals of Oriental Literature*, p. 263. See also this *Journal*, vol. ii. 53). South from the sources of the Sunkar none of this tribe retains independence, but there are a good many of their villages subject to Kaungla Pru, although governed by their own petty chiefs, (ruasah,) and allowed to retain their own customs. I had several interviews with these subjected Langæh, as they are called in the Rakhain dialect, whom I found rather inferior in appearance to the Moroosas; but as they were very imperfectly acquainted with the language of either Bengal or Ava, my intercourse with them was not very satisfactory. They are a lively, inquisitive, good-natured people, with harsh Chinese countenances, but seem abundantly acute. To cover their nakedness, both men and women who came to visit me, held round their waists a bit of cotton cloth; but this was secured by one of their hands, and was used out of compliment to me as a stranger, for at home both sexes go entirely naked. They are not, however, without ornaments of beads, tin, and silver. Of beads they use great numbers, and of considerable variety, green and white glass, coral, and amber. The latter they probably receive from Ava, where there are mines of this substance. They tie their hair in a knot on the nape of the neck.

The Langæh cultivate jooms in the same manner as their neighbours, and rear hogs, goats, and poultry. They have slaves, procured as usual by advancing money to those who are in debt. They have no writing, nor priests, but acknowledge two gods, a female named Po-vang, and a male named Sang-ro. The most intelligent chief of a village that I met did not pretend to know where these deities reside; but he said, that, on certain occasions, their old men and women directed the performance of sacrifices. These rites were also as usual vowed by those who dreaded a bad crop or disease. The sacrifice is performed by killing a fowl, a goat, or a pig, the blood being offered to the deity, and the flesh reserved for a feast. The Langæh takes an oath by holding up between his hands some cotton and rice, and wishing that Po-vang and Sang-ro may destroy him and his property if he does not speak truth. The Langæh bury their dead. I was not able to discover that they had any idea of a future state; but this may have been owing to a want of knowledge in their language.

The Langæh take only one wife. When a young man and woman like each other, the lover makes a present to the parents of the girl, and the marriage is celebrated with dancing and feasting, but is not accompanied by any religious ceremony. Gyals (*Bos frontalis, Lambert, Lin. Trans.* vii. 302. *Bœuf sauvage de l'Inde, St. Hillaire et Cuvier, Hist. Nat. des Mammiferes, Livr.* 41,) and all kind of provisions are collected for the marriage feast, which lasts for eight or nine days.

The arms of the Langæh consist of a shield and spear with a head at each end. With these they venture to attack the tiger. The bowls of their tobacco pipes are made of wood, and, like their shields, are blackened and varnished with the milky juice of a tree (*Holigarna longifolia*, *Roxb. Hort. Beng.* 22,) called by them vombul, by the Joomeas kei, and by the neighbouring Bengalese belua. I have little doubt that this is the same with the varnish tree, the juice of which is used by the people of Ava and Siam in their lackered ware. The juice of the holigarna is very acrid, and the Joomeas are so much afraid of it that they carefully avoid touching the plant. They brought a branch and some unripe fruit in a cleft stick, and would have persuaded me not to allow it to remain on my table, alleging that even its vapours would occasion a person's skin to break out into sores. This precaution is needless, for I saw the Langæh handle the plant freely. They avoided only to allow the milky juice to touch their skin. One of them, who had been climbing a tree to procure the juice, had on his hands, arms, legs, and body, large black marks containing some excoriated places. The juice is collected from twigs cut across in the joint of a bamboo, and will keep for a long time.

The following words of the Langæh language may serve to give some idea of its affinities: Sun, *nee*; moon, *hlaw*; stars, *arsee*; earth, *toil*; water, *tee*; fire, *moi*; stone, *loong*; wind, *hlee*; rain, *koa*; man, *moo*; woman, *noo-nau*; child, *ngau*; head, *loo*; mouth, *moor*; arm, *ban*; hand, *koot*; leg, *perai*; foot, *pepaw*; bird, *oaw*; fish, *ngaw*; good, *tchazæk*; bad, *meetchalo*; great, *ayæn*; little, *atom*; long, *sei*; short, *atoi*; one, *hakka*; two, *pannyecka*; three, *toomka*; four, *leeka*; five, *ngaka*; six, *roopka*; seven, *sereeka*; eight, *rietka*; nine, *koaka*; ten, *somka*; eat, *hæro*; drink, *tæinro*; sleep, *eenro*; walk, *paroltee*; sit, *chooro*; stand, *deengro*; kill, *hamro*; yes, *tootakanelro*; no, *bou*; here, *mekeen*; there, *mahou*; above, *chunchooa*; below, *koentoya*.

From this the language of the Langæh appears to have many words in common with that of Ava and Rakhain, in which dialects also the imperative in *ro* is common. The *ka* annexed to the numerals seems peculiar to the Langæh, but is perhaps analogous to the prefixed *to* used by the Moroosas.

The independent tribe of Langæh or Kungkis, that border on the Joomeas towards the N. E., is by them called Bonzhu, corrupted by the English into Bonjugy. Kaungla Pru told me that their chief intercourse was with Rakhain. They use bamboo ashes in place of salt, and manufacture a little cloth and earthenware. They have muskets, swords, and other arms, and their chief is called Ta-kang, which is one of the titles usually bestowed at Ava on the king's sons, and therefore analogous to our word prince. They are a numerous people, and much addicted to plunder. Their hills they fortify by cutting trees, and supporting them standing in such a manner, as that, when the hill is attacked, they can let the trees fall, and crush the invaders,—a device similar to that by which the Gauls are said to have destroyed the army of L. Posthumius consisting of 25,000 men, and containing two legions of Roman citizens. (*Livy*, lib. 3, cap. 24.) The Bonzhu have a number of slaves originally prisoners of war. I must also observe, that Kaungla Pru considered the term Bonzhu as different from Langæh, and that the former was a superior governing tribe to which the prince belonged, although a great part of his subjects belonged to the Langæh or Langga race. So far as I can judge, reasoning from very imperfect materials, these Bonzhu occupy the country on the left of the Karnaphuli, extending to the sources of the Sunkar, and from thence east along both sides of the river of Arakan, having in the centre of their territory a great hill called in our surveys the Blue Mountain, nearly in lat. 22½ N., and in long. 93 E. from Greenwich. Their territory may probably extend 60 or 70 British miles each way.

Having thus given an account of the people occupying this part of the frontier, I shall now give an account of the rivers by which it is watered.

The Sunkar, or Sunkha, as it is pronounced by the Bengalese, is called Rekree (great water) in the Rakhain dialect. In its lower part it is connected with the Karnaphuli by a channel named Korindea, into which the tide flows, and in the S. W. monsoon, when the passage by sea is dangerous, is of great importance, as boats can with safety pass through and enter into a plexus of small rivers, so as then to find a safe passage all the way to Ramoo. Above the Korindea some way, the Sunkar, above the fine plain called Hazari, passes through a valley called Hazaliya, which is well cultivated and occupied by Bengalese. At the eastern end of this valley commences the territory of Kaungla Pru, who has erected there, on the southern banks of the river, a market-place (haat) called by his name. A Muhammedan agent attends, and procures all foreign luxuries that his master requires, and he and the other subjects of the chief exchange their commodities with those of the Bengalese. This seems to be the place called Purangura in the Bengal Atlas, (No. 1,) or, at least, it is nearly in that situation. The highest hill visible from thence is by the Bengalese called Duchiliya Mura, and seems to be what Mr Walker calls Pyramid Hill. North from thence is a long ridge called Sita Mura, which reaches to the Karnaphuli, as I have formerly mentioned.

At Hazaliya the Sunkar is about 100 yards wide, and has hardly any motion but that of the tide, which does not go up much farther. The water, although dirty, is quite fresh. The Bengalese say, that the northern bank of the river is occupied by them to Duachery, some way above Kaungla Pru's market. At Duachery there is a guard of police officers. From thence a boat takes from morning to noon to reach Peinchera on the left, where a Joomea Ruasah, subject to Agunea, resides. It takes as much time to proceed from Peinchera to Gorau, a stream coming from the right. From thence, in one day, a boat can go to Noaputun Chera, beyond which the river is not navigable on account of stones. There are no inhabitants at Gorau or Noaputun, but they are frequented by the Bengalese, who cut bamboos and timber. The former are about eighteen cubits long, and are brought down in immense floats. About forty are tied firmly together by the root ends, which are turned towards the fore end of the float. Their hinder ends being opened, and the fore end of another similar bundle having been pushed up among the first, the two circular bindings are secured by a fore and aft lashing, and then one bundle after another is added till a chain of sufficient length has been formed. Parallel to the first a second chain is constructed in a similar manner; and the two chains are connected by cross lashings at each bundle. More chains are then added, till the float is perhaps twelve feet wide and 300 feet long. At Kaungla Pru's market three hundred of these bamboos are valued at only one rupee (little more than two shillings Sterling;) but three-fourths of a rupee, without any other allowance, are considered good monthly wages for a labouring man.

About a mile above the market-place, a very considerable branch, named Sualuk, enters the Sunkar from the south; and on this, at four or five miles from the market-place, is the residence of Kaungla Pru. A little way below the Sualuk another considerable branch, named Barwany, enters the Sunkar from the north, and on its bank is the residence of Agunnea, the chief of the northern division of the Joomeas, whose people trade with the Bengalese at Guleachera, a market-place on the Barwany, after that stream enters the low country occupied by Bengalese.

Between the Sunkar and the Mamuri (Moree, Rennell) the tide proceeds a little farther east than the road laid down by Rennell in the Bengal Atlas (No. I.;) but all the streams fall into either one or other of these rivers, both of nearly an equal size. The Bengalese population extends along its banks, through a fine valley named Chuckerya, to a place named Manikpur, where the rock descends to the river. It must be observed, that the places laid down on this route by Mr Rennell, such as Companyshaut, Sunouttu, Hurvung, Baratulla, Chuckerya, Dulloohazari and Edgong, are not villages but vallies; nor are there any villages or small towns between Islamabad and Ramoo. The Bengalese there live in detached houses; but at stated times, once or twice a week, assemble in open market-places to buy and sell what is wanted. At these market-places are usually some large trees, under the shade of which travellers halt. Such are most of the places laid down by Rennell in the Bengal Atlas, that are marked by a small circle (o). In parts of the country where many travellers pass, there may be a shop or two for supplying them with provisions, and some sheds, where hucksters, on market-days, expose their goods, but such is not the case in the southern parts of Chatigang.

The chief market-place in the valley of Chuckerya, on the Mamuri river, is called Dudusty Khans haat. The river there is a shallow clear stream, the tide reaching only a little farther up to Manikpur, a fine little valley occupied by Bengalese, but surrounded by the territory of Kaungla Pru, which consists there of numerous small hills, called, by the Bengalese, collectively, Sitaka Pahar. Among these wind various branches of the Mamuri river, along which canoes and floats of bamboos can be pushed by people walking in the channels, which are in general sandy. The villages, or rather townships, scattered there, are occupied by Joomeas, Moroongs and Teura, or Tripuras, each having a chief (ruasah) of their own tribe. At Dudusty Khan's market-place a considerable barter is carried on with these people, who bring cotton, bamboos, grass for thatch, and a few elephants' teeth, and take in exchange iron work, earthenware, sugar and salt; but several Muhammedan traders ascend the river and exchange these articles. The quantity of bamboos and thatch is enormous.

One of these traders gave me the following account of the route by which he proceeds. Above the rocks which bound Chuckerya on the east, is the valley named Manikpur, on the left of which are three Moroong chiefs, and on the right one. From Manikpur in one day a canoe goes up to Bilchery, where the inhabitants are Bengalese. On the second day the canoe reaches Kamaurabbu, where Joomeas live. On the third day it is taken to Tintoria, a village of the Mroun. On the fourth day the trader reaches the mouth of the Tuinchera, where also Mroun are the inhabitants. On the fifth day the trader reaches Dunzi Chera, where there are Joomea Muggs. On the sixth day he comes to Kalya Chera, a residence of the Mroun. The seventh day brings him to Peinchera, near which are people of the Joomea tribe. The chief man (ruasah) of this place I saw at Sualuk in attendance on Kaungla Pru. He came from his house in one day, and says, that it stands at the south end of the hill called Sitamura. On the eighth day the trader arrives at Kammi, a residence of the Mroun. On the ninth day he comes to more Joomeas. On the tenth day's journey he arrives at the residence of some Mugs, who came from the banks of the Sabouk, a river in

Arakan, and whose chief is distinguished by the title of Pomang (captain). From this tribe the channel of the river is full of stones, and its banks are uninhabited; but canoes can with some difficulty be pushed on two day's journey farther, to where the river descends from a great mountain called Muin Mura, beyond which the traders never go. A little above Bilchery a small river, named Baungngu, enters the Mamuri from the north, and by this there is a route to the Sualuk, which falls into the Sunkar. Through the south side of the Manikpur valley, a stream called Yaungsa enters the Mamuri from the south, and by this is a route to the Edgong valley; but these routes are only practicable for men on foot.

Aung-ghiose, a Joomea chief already mentioned, gave me another account of this river in writing, from which I have extracted as follows, adding an explanation.

Aung-ghiose Tammang's village is on the Yaungsa.

Above that is Besure, (Bilchery of the Bengalese,) a valley inhabited by Muhammedan Bengalese.

Above Besure, on the left, is the Baungngu.

Above that, on the left, is the Ramé.

Above that, on the left, is the Lamahya rivulet and a village of Jomea Mugs.

Above that, on the right, is Kamaurabbu and Wamses village.

Above that, on the left, is the Rauk rivulet, but no people.

Above that, on the right, is the Boré,

Above that, on the right, is Ngappio (plantain tree.)

Above that, on the left, is the Suing rivulet, near which is Tintoria.

Above that, on the right, is the Wunboun rivulet.

Above that, on the left, is the Tuin rivulet, and a village of the Mroun.

Above that, on the right, is Dungie, (Dunzi of the Bengalese,) where Joomeas reside.

Above that, on the right, is the Pusuang rivulet.

Above that, on the right, is Nganaurrow, which the Bengalese call Kalya Chera (black rivulet.)

Above that, on the left, is the Serraung rivulet.

Above that, on the right, is the Prein rivulet, (Pein Chera of the Bengalese,) where Tripuras inhabit.

Above that, on the left, is Ngayasa and Saraprus village.

Above that, on the right, is the Kuein rivulet.

Above that, on the right, is Kamaunglækgnorigniué. This extraordinary name belongs to an extraordinary tree, near which reside a tribe of Joomeas, called Sabouksah, because they originally came from the banks of the Sabouk, which is a branch of the Sunkar. The Bengalese trader called it a river of Arakan; but the two accounts may be reconciled by supposing, that the Sabouk is the branch by which the Sunkar anastomoses with the river of Arakan.

Above that, on the left, is Kangme (Kammi.)

Above that, on the left, is Kamaung rivulet.

Above that, on the right, is Buetee.

Above that, on the right, is Bede.

Above that, on the left, is Sanglangpah.

Above that, on the left, is Murepah.

Above that, on the right, is Bedeshé.

Above that, on the right, is the Dabur rivulet.

Above that, on the left, is Agalo.

Above that, on the right, is Marame.

Above that, on the left, is Teindu.

Above that, on the left, is Seindu and a Joomea village. (This is the place unnamed, where the trader halts on the ninth day.)

Above that, on the right, is the little Dabru rivulet.

Above that, on the right, is Daksuckine.

Above that, is the mountain Kreindan, (which the Bengalese trader calls Muin Mura.)

On the other side of Kreindan, is the rivulet Zeingdan, which falls into the Mayu river, (Manyeoo of Walker.)

The mountain Kreindang, or Muin Mura, cannot, in a direct line, be above twenty geographical miles from Bilchery, (Bilcherry of Walker,) and it seems surprising that, in so short a space, so many rivulets should fall into the Mamuri, and that there should be so many inhabitants, but both accounts agree, although taken from persons quite unconnected, and speaking different languages. We may, therefore, I am persuaded, safely think, that the mountainous region interposed between Ava and Bengal, is vastly more populous than is commonly imagined. Few countries, indeed, enjoy a better soil, or a more copious supply of water, which, with the heat of the climate, insures a most productive return to the cultivator. Hitherto, this great and fertile territory has been abandoned to its rude inhabitants, as a neutral ground, to fence between the encroachments of two great empires. If both are united, the present inhabitants must alter very much their manner of life. They probably will become more skilful in the arts, and obtain some tincture of science; but whether or not these advantages may compensate for the loss of independence, and for the encroachments of people more advanced in society, admits of considerable doubt. In case such an event should happen, it is to be hoped, that the victorious power may in time take proper steps to prevent the encroachments.

The last considerable stream in the territory of Kaungla Pru towards the south, is that, which passes Edgong, (Rennell) and Eadgur, (Walker) above the former. The river which runs through this valley, by the Moroosas who inhabit its banks, is called Rikango. It rises from the west side of a hill, which the Bengalese call Muni pahar, but which the Moroosas call Meindaung. Beyond this, my informants alleged, that they never had been; but they had heard, that beyond it reside the Kaungme, no doubt the Mroun, who live at Kammi or Kangme, on the Mamuri, which, therefore, comes from the south. Beyond that are the Zeindu, which, in the account of the Mamuri, is called Seindu, a Joomea village on that river. South from the Zeindu, according to the Moroosas of Edgong, are the Sak on the Mrooseit river, (Moroosay, Walker, Imrosyk, Robinson,) which is the principal branch of the Naaf. North from these Sak, are the Kulak Sak, a kindred tribe. Beyond these, on the Kula Deing river, (Kola Dyng, Walker,) live many Moroosas and Joomeas, dependent on Arakan, but many refugees from thence, unable to bear the tyranny of the Burmas, have retired to the Island of Mascally, (Fish-creek) on the coast of Chatigang.

The territory of Kaungla Pru, extending from the Sunkar to the Joareeah, (Rennell) is about thirty-seven British miles, in a direct line from north to south. The Joareeah is but a small stream, but is rendered of importance by the tide entering through it into a channel called Patili, that communicates with the Bakkally or Ramoo river, the entrance into which, is dangerous for boats in tempestuous weather; but the entrance into the Joareah, being sheltered by Maskally island, boats, during the south-west monsoon, have a fine passage from Ramoo to Chatigang.

The Bakkally, or Kamoo river, is the most considerable in the southern part of Chatigang. At Ramoo, it is deeper than the Mamuri at Chuckerya, nearly at the same distance from the sea. It is, however, neither so rapid nor so clear. The bottom is mud, and, although the water is fresh, the tide goes farther up a considerable way. By all the nations of the Burma race, this river is called Paingwa, and the upper parts of its banks, from the territory of the southern tribe of the Joomeas. Its chief informed me, that, north from the Mrooseit, or eastern branch of the Naaf, and separated from that by the hill called Saludaung, is one of his villages, which stands on the branch of the Pangwa, that goes off to the right in ascending. East from this village, are Sak, subject to Ari, as the Joomeas call Ava. Some of these Sak, however, are subject to this Joomea chief. Beyond the Sak subject to Ava, the country is occupied by Rakhain. The valley of Ramoo extends about two miles above the office of police, above which is a narrow valley about a mile long, but occupied by Bengalese. Above this, commences the territory of Umphry Palong, where the river is fordable in some places, but clear and rapid with a sandy channel. Here the Joomea chief has established a market-place, called Maiskum, where he and his dependents exchange commodities with the Bengalese. There some rocks come down to the river side, and consist of thin horizontal strata, alternately of sand and clay, slightly indurated.

ART. V.—*Proposal for Improving the Phantasmagoria.* By WILLIAM RITCHIE, A. M., Rector of Tain Academy. In a Letter to the Editor.

DEAR SIR,

YOU are well aware, that, in the common Phantasmagoria, the object becomes brighter and brighter as it diminishes, or as it seems to retire, till, at length, it verges into a luminous point. Now, this is so completely contrary to what takes place in nature, that the momentary belief of reality, so forcibly impressed on the mind, becomes gradually weaker, and at last totally vanishes. To supply this defect, I would, therefore, propose the following alteration, which will render the deception much more natural and striking.

Let a small portable gasometer be procured, capable of holding a sufficient quantity of condensed oil gas. Let a stop-cock, having a small groove, gradually deepening, be adapted to it, so that the quantity of gas escaping to the burner may be increased or diminished at pleasure. By diminishing the light according to a certain law, the brilliancy of the object will be gradually impaired as it retires, the lineaments of the figure will become shadowy and obscure, and the phantom itself will at length vanish into thin air. If you consider this notice worthy of a place in your Journal, by inserting it, you will oblige, Dear Sir, your most obedient and humble servant, WILLIAM RITCHIE.

TAIN ACADEMY, *Nov.* 15, 1825.

ART. VI.—*Notices of Insects of unusual occurrence which have occasionally appeared in great numbers on Trees, &c.* By Sir G. S. MACKENZIE, Bart., F. R. S. Lond. and Edin. In a Letter to the Editor.

MY DEAR SIR,

THE appearance, this season, of an unusual number of aphides, which have done great mischief to almost every tree, as well as to the more diminutive vegetables, having recalled to my memory some insects altogether new to the inhabitants of this country, which appeared many years ago, it has occurred to me, that some account of them, however slight, may be acceptable to you; as, by recording it, future observers may be enabled to note more precisely the habits of these singular creatures, as well as to describe them. Not being sufficiently versed in the technicalities of entomology, I must confine myself to a simple notice, and a very imperfect description. The facts, however, are curious, and may interest those who have paid particular attention to that branch of natural history.

The first insect which I have observed as of unusual occurrence, appeared eighteen or twenty years ago, and covered the panicles of the oat crop in this part of Scotland. It was of a globular shape, and of a deep brown, almost black colour. It seemed quite inert, and fixed to one spot on the grain. The size was about that of No. 3 shot. I could not find any person who had before observed the same insect, and it has not appeared since. The crop did not appear to have suffered any serious injury from it.

The next was a caterpillar, which I found infesting the pear-trees of only one garden in this county, that at Geanies House, situate on the eastern promontory of Ross. It appeared about the same time, I think, with the insect already noticed. It resembled very much a small black leech, and appeared as if wet with water. I think it was late in the autumn when it appeared. I have now to regret that I did not preserve some of these insects.

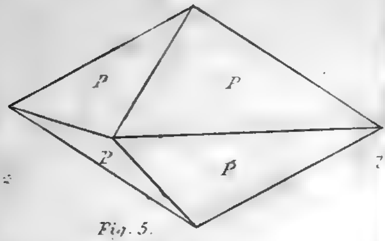
If I mistake not, it was in the year 1815, that a caterpillar, which I did not see, stript the birch trees of their leaves, over a great extent of country. I happened to be in Edinburgh at the time it was committing its ravages, and travelled northward after it had disappeared. I noticed the birch trees to the north of Dunkeld, and all along the Highland road, to be as naked about the end of July, as they had been in winter; and I dreaded to find my own extensive birch woods completely destroyed. I found, however, that the destroyer had kept within a certain limit to the westward; but I did not ascertain how far its ravages extended eastward. The insect was described to me as a small, green, caterpillar; and its numbers must have been immense, to have extended over a tract of country more than a hundred miles long. But no winged insects were observed, which might have been supposed to have laid their eggs on the leaves. I examined some very old men, two of them near eighty years of age, but they could not recollect any thing similar to the destruction of the foliage of the birch which they then witnessed.

Such examples as these might very well be cited as instances of equivocal generation, were it not that a little consideration leads us to believe that there is nothing equivocal in nature. Some have supposed that the ova of insects, like the seeds of many vegetables, may, in certain circumstances, be preserved during very long periods, until some accidental occurrence place them in a condition to produce a living creature. I do not think, however, that the analogy with seeds is good; and it appears to me, that it is not necessary to seek for distant analogies to explain such phenomena, since we may find a better analogy in the habits and transformations of insects themselves. It is not so much the sudden appearance of insects unknown to the generation which suffers by their depredations, that is to be wondered at, but their as sudden and total disappearance. It is this latter circumstance which I think explains the former. It is well known, that many tribes of insects exist in three states, that of the ovum, the pupa, and the imago, or perfect insect. It is also known, that while most insects remain but a short time in the first state, the time during which they are in the second varies very much. When ova are deposited, it is on or very near that substance or element which is to afford food to the larva; and, consequently, the time for being in the ovum is limited by the duration of the substance on which it is placed. The birch-trees already referred to had grown up in the memory of those persons whom I examined; and, indeed, none of them could exceed the age of forty years. But, during the whole period of their growth, nothing had happened similar to the devouring of their leaves. The ova must, therefore, have been deposited on the leaves the same season in which the caterpillars were produced. The disappearance happened when the caterpillars took the form of pupæ; and it is probable that the nature of this particular insect is such that it continues in that form perhaps longer than a century. To suppose that this is the case seems to me more natural, as it is more conformable to analogous facts, than to suppose that the ova continues so long. There were no circumstances, such as the stirring of the soil, which could have brought the ova into a condition to live; and the simultaneous appearance of the insects in different parts of the country, and their ravages being limited to a certain breadth, make it probable that the insects, after their usual long period, had issued from the earth, ascended the trees, deposited their eggs, and died. The pupæ into which the host of caterpillars passed are now probably in the earth under the trees, and from them a new host will at length arise, more numerous perhaps than the last. If it should happen that the trees shall have been removed before the pupæ shall have become perfect insects, no proper food will be found for their progeny, which will perish. It is probably this circumstance that saves much that we value from destruction; the proper food of insects being removed from the place where the pupæ are concealed. Of course, this does not limit the wanderings of migratory insects, but many even of these must perish, while in search of a proper place for their ova.

This season, there is an amazing number of aphides. There is scarcely a vegetable without its aphis. There has been a most luxuriant harvest for the bee tribe on the thorn hedges, which are loaded with the honey-dew, the produce of the aphis, which the bees greedily devour. The foliage of the birch has suffered severely from the attacks of an aphis. Even the strawberry has had its variety; but it was only on some plants which I forced on which I observed it. There is an aphis which we have every year on the spruce-fir, which forms a very beautiful nidus on the young shoots, resembling a small seed-cone, for which it has often been mistaken. The silver and the balm of Gilead firs have been killed in great numbers by the attacks of a woolly aphis, like that which infests the larch, and it attacks the bark in the manner of the apple aphis.

PLATE II . *Edinr Journal of Science Vol. IV p 41*

Fig. 1.



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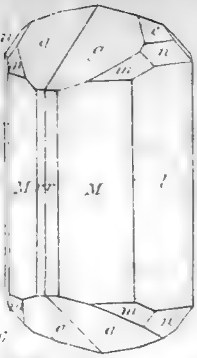

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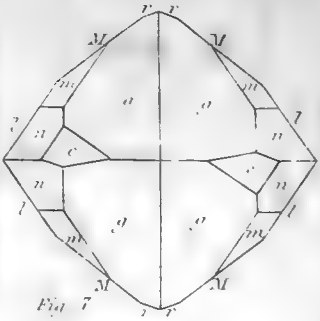

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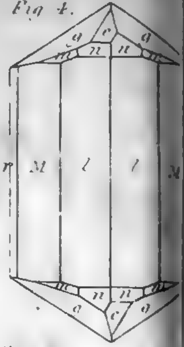

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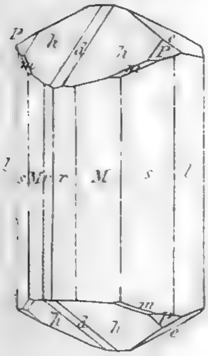

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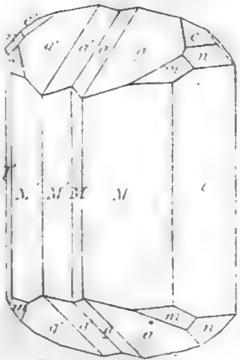

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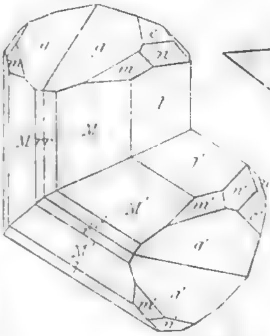

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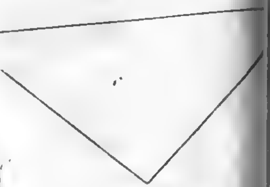
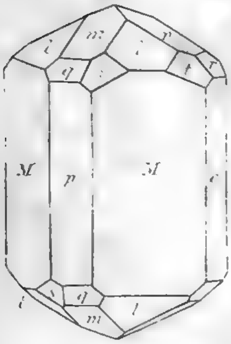


Fig 9



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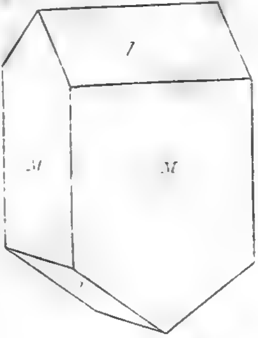
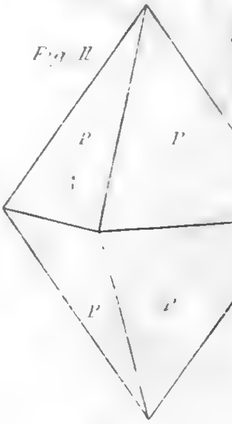


Fig 11



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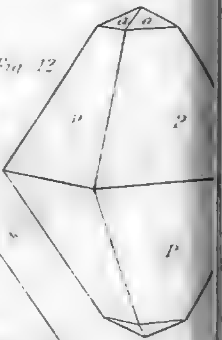

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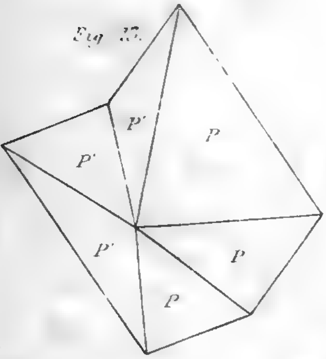


Fig 14

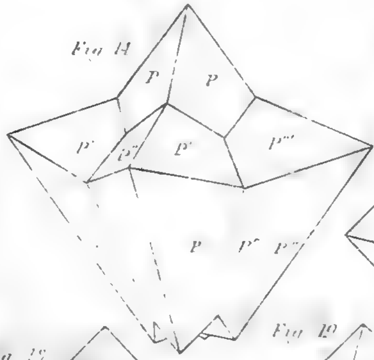


Fig 15

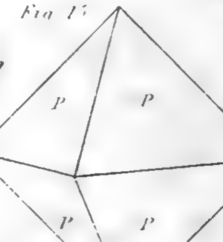


Fig 16

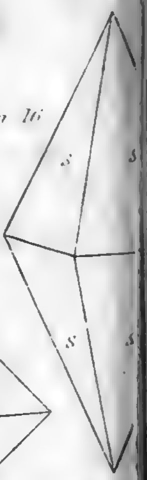


Fig 17

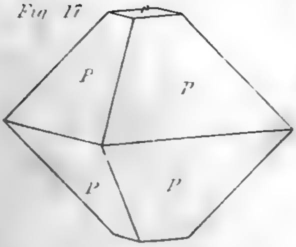


Fig 18

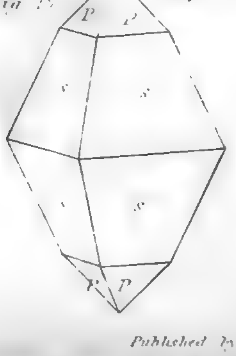


Fig 19

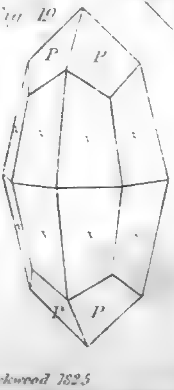
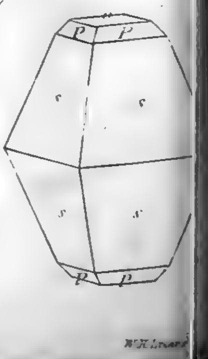


Fig. 20.



Published by Wm Blackwood 1825

W.H.Lizars

Larvæ, which are produced under the surface have been very numerous, and the onion and cauliflower tribe have suffered much. An insect, which I have not been able to detect, has almost totally destroyed my crop of apples and pears, by eating out the cores of the fruit when just set. Plums are all destroyed. I do not recollect a richer display of blossom than that which we had in spring, and our disappointment has been proportional to the hope excited. The *Curculio vastator*, which, by committing its depredations in the night, too often escapes the vigilance of the gardener, has not been so numerous as usual; nor have I seen so many moths and butterflies as usually occur. For some years past wasps have been scarce, but this season they are plentiful. I have observed that they are fond of the flower of the *Daucus hispidus*, which seems to stupify them, as they fall to the ground when the flower is shaken, or they may be picked off by means of pincers. Perhaps the flower of the common carrot may have the same effect. At any rate, I hope that the *Daucus hispidus* will be found a useful means of destroying this arch enemy of ripe fruit, by being planted in different parts of a garden,—a boy or girl being employed to go round and pick off the wasps that settle on the flowers. Ever yours truly,

G. S. MACKENZIE.

COUL, 3*d August* 1824.

ART. VII.—*On the Crystalline Forms and Properties of the Manganese Ores.* By WILLIAM HAIDINGER, Esq. F. R. S. E. Communicated by the Author. With a Plate.

I. *Prismatoidal Manganese Ore.*

FUNDAMENTAL form. Scalene four-sided pyramid. P = 130° 49′, 120° 54′, 80° 22′. Plate II. Fig. 1.

$$a : b : c := 1 : \sqrt{3.37} : \sqrt{2.4}.$$

Character of combinations, hemi-prismatic, with inclined faces.

Simple forms contained in the combinations which were observed among the crystals of the variety analyzed.

9.	$(\frac{4}{5}\bar{P}-2)^5$ (*g*)	=	172° 36′,	114° 37′,	66° 25′.
4.	$(\frac{5}{4}\breve{P}r-1)^3$ (*c*)	=	115° 17′,	143° 2′,	76° 56′.
5.	$(\breve{P}r)^3$ (*n*)	=	95° 4′,	132° 50′,	103° 24′.
2.	$P+1$ (*m*)	=	112° 35′,	97° 35′,	118° 45,′
3.	$P+\infty$ (*M*)	=	99° 40′.		
6.	$(\breve{P}r+\infty)^3$ (*l*)	=	51° 18′.		
8.	$(\bar{P}r+\infty)^3$ (*r*)	=	134° 14′.		
11.	$\bar{P}r$ (*d*)	=	114° 19′.		
7.	$(\bar{P}r-1)^3$ (*h*)	=	154° 13′,	116° 10′,	70° 2′.
12.	$\breve{P}r$ (*e*)	=	122° 50′.		
10.	$(\breve{P}r+\infty)^5$ (*s*)	=	76° 36′.		
1.	P (*P*)	=	130° 49′,	120° 54′,	80° 22′.

Combinations. 1. $(\frac{4}{5}\bar{P}-2)^5$. $\frac{(\frac{5}{4}\breve{P}r-1)^3}{2}$. $(\breve{P}r)^3$. $P+1$. $P+\infty$ · $(\breve{P}r+\infty)^3$. $(\bar{P}r+\infty)^3$. Fig 2.

The 3d figure represents the projection upon $P-\infty$, the 4th figure the elevation upon a plane parallel to the short diagonal of the prism $P+\infty$. The hemi-prismatic character of the species appears only in the disposition of the faces marked *c*. They form horizontal edges of combination with $(\breve{P}r)^3$. The edges between $(\frac{4}{5}\bar{P}-2)^5$ and $P+1$ are parallel to those between $P+1$ and $(\breve{P}r+\infty)^3$. These crystals are from two to three lines in thickness, and some of them nearly an inch long.

2. $\bar{P}r$. $(\bar{P}r-1)^3$. $\breve{P}r$. P. $P+1$. $P+\infty$ · $(\breve{P}r+\infty)^5$. $(\breve{P}r+\infty)^3$. $(\bar{P}r+\infty)^5$. Fig. 5.

Small, but very well pronounced crystals of this variety were disengaged from the same specimen which contains the variety 1. They were found in small drusy cavities, which were discovered when the whole was broken up for analysis. The faces of $\breve{P}r$, marked *e* in the figure, have not been described; they are rarely observed in the crystals of this species.

Cleavage, $\breve{P}r+\infty$ highly perfect and easily obtained; $P+\infty$ also perfect, but less easily obtained; traces of $\bar{P}r+\infty$, and of

$P-\infty$. Fracture uneven, surface, of the vertical prisms streaked parallel to their common edges of intersection; $\bar{P}r$ streaked parallel to the edges of combination with P; $P-\infty$ parallel to those with $\bar{P}r$. In general, the faces are smooth, and possess pretty high degrees of lustre.

Lustre, imperfect metallic. Colour, dark brownish-black, inclining to iron-black. Streak, reddish-brown. Opaque, in larger masses. When broken or cleaved in the direction of $\breve{P}r+\infty$, and exposed to the light of the sun, minute splinters are often observed, which, by transmitted light, appear of a bright brown colour, so that the mineral cannot be said to be absolutely opaque.

Brittle. Hardness = 4.0.—4.25. Sp. gr. = 4.328, of a number of fragments of crystals; = 4.312, in another experiment of a single crystal of considerable size.

Compound Varieties. Twin-crystals, formed in two different manners. In the first of them the axes of the two individuals are parallel, dependant on the hemi-prismatic character of the combinations of the species; in the second, they are inclined. 1. Face of composition, parallel to $\breve{P}r+\infty$, axis of revolution perpendicular to it. Fig. 6. If we did not give attention to the compound state of this variety, shown in the present instance by the groove along the place of junction, which is not always visible, we might be induced to believe that it possesses a hemi-prismatic character, referred to an axis inclined upon the base of the fundamental pyramid, which is not the case. One can generally trace the peculiar disposition of the crystalline faces upon each of the individuals. A repetition of this law produces thick prisms, terminated perpendicularly upon their axis by a rough face, which consists of the apices of numerous individuals, or rather of numerous particles of two individuals, alternating with each other. Such faces are not uncommon in the prismatoidal manganese ore. 2. Axis of revolution perpendicular, face of composition parallel to a plane of $\breve{P}r$. Fig. 7. The disposition of the faces marked *c*, upon which the hemi-prismatic character of the species depends, is such, that a mere revolution of 180° is not sufficient to bring the two individuals in the position required for joining in a regular twin; though the general disposition takes place also in the present instance, the portions of the two crystals, similarly situated, being 180° distant from each other, compared to the plane of composition.

Irregular composition is very common in this species; it is either granular, or columnar. The latter occurs much more frequently.

Observations.

Few species in mineralogy have been so incorrectly described as the ores of manganese, and, in particular, the most common one among them, the prismatoidal manganese-ore. It is not alone that the slight difference in the angles of two of the prisms, and the situation of the perfect cleavage, was not exactly referred to constant positions, but also colour, streak, hardness, specific gravity, and other important properties, were either incorrectly stated, or confounded with those of other species. The insufficiency of Haüy's descriptions was felt by many mineralogists, and several of them have endeavoured to substitute better ones in their place. The result, obtained by M. Von Leonhard,* is by no means more satisfactory than that of Haüy; Mr Phillips,† with his usual skill in crystallographic observations, has succeeded much better. The description of the forms given by Mohs ‡ agrees very nearly with the latter, at least much more so than any two other descriptions. There are some differences, however, in regard to the absolute measurement of the angles, and in the statement that, according to Mohs, the cleavage parallel to the short diagonal of the prism $P+\infty = 99°40'$ is more distinct, and more easily obtained than any other cleavage of the species; whereas, according to Phillips, the crystals "cleave readily, and with brilliant surfaces parallel to the lateral planes of a rhombic prism of 100° and 80°, and both its diagonals." Though, in many varieties, the cleavage parallel to the long diagonal of that prism may in fact be obtained, it is always less distinct than that parallel to the short diagonal, and often not at all observable. It

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* *Handbuch der Oryctognosie,* p. 371.

† *Elem. Introd. to Mineralogy,* p. 243.

‡ *Treatise on Mineralogy,* vol. ii. p. 419.

is important to attend to this difference in the perfection of cleavage; the more so, because the cleavage parallel to the short diagonal of $P+\infty = 99° 40'$, is at the same time parallel to the long diagonal of another prism, $(\breve{P}r+\infty)^5 = 76° 36'$ (the supplement of which is 103° 24′), which occurs very frequently in the same mineral, and might be, or has actually been, mistaken for it, in a more superficial examination of the crystalline forms of the species.

Descriptions of single varieties are particularly desirable, when the characters of the whole species are yet so imperfectly ascertained as in the present case. The variety to which the preceding description refers, was brought by Dr Turner from Ilefeld in the Hartz, and to him I have been indebted for the crystals described above. The most remarkable peculiarity in the series of crystallization of this species, is its hemi-prismatic character, the faces of those forms which assume it being inclined to each other. Those marked *c*, if sufficiently enlarged, would give rise to a form resembling a tetrahedron, like Fig. 8, the planes of which are equal and similar scalene triangles. Among the remaining species, whose forms belong to the prismatic system, only the sulphates of zinc, of magnesia, and of nickel, are known to possess an analogous formation. This was first placed beyond a doubt by Professor Mitscherlich, who observed the fact, that the faces *s* and *t*, Fig. 9, appear only contiguous to the alternating faces of *l*; although the alternating enlargement of these same faces, represented in Fig. 10, had been previously noticed in the sulphate of magnesia, by mineralogists, so far back as Romé de L'Isle and Linnæus. Large crystals of this salt generally show the hemi-prismatic character much more distinctly than small ones.

In the description given above, the streak of the crystals is stated to be reddish-brown, contrary to most indications in works on mineralogy. It is very often the case, however, that we meet with crystals, and still more frequently with compound varieties, consisting of the columnar individuals, which actually afford a black streak. The hardness of these varieties is much inferior to the hardness of the crystals that present a brown streak, being generally between 2.5 and 3.0, (a little below calcareous spar ;) and sometimes, in fibrous varieties, it is so inconsiderable as to soil the fingers, and write upon paper. On the contrary, their specific gravity is higher, and often approaches to 4.7. It is important to observe, that the exterior strata of large crystals sometimes afford a black streak, and show low degrees of hardness, while the interior parts still offer the characters indicated in the preceding description. It should seem, therefore, that the difference in several of these properties is owing to a change or decomposition of the substance itself, which does not affect the regular form.

II.—*Pyramidal Manganese Ore.*

Fundamental form. Isosceles four-sided pyramid. P = 105° 25′, 117° 54′. Fig. 11.

$$a = \sqrt{2.76}.$$

Simple forms. $\frac{4}{3}$ P—4 (*a*) = 139° 56′, 58° 46′ ; P—1 = 114° 51′, 99° 11′ ; P (P).

Char. of comb. pyramidal.

Combinations. 1. $\frac{4}{3}$ P—4. P. Fig. 12.

2. $\frac{4}{3}$ P—4. P—1. P.

Cleavage, P—∞ rather perfect ; P—1 and P less distinct, and interrupted. Fracture uneven. Surface, $\frac{4}{3}$P—4, very smooth and shining, P horizontally streaked and often dull.

Lustre imperfect metallic. Colour brownish-black. Streak dark-reddish, or chestnut-brown. Opaque.

Hardness = 5.0...5.5. Sp. gr. = 4.722, of a crystallized variety.

Compound Varieties.—Twin-crystals : axis of revolution perpendicular, face of composition parallel to a face of P—1, Fig. 13. The composition is often repeated parallel to all the faces of the pyramid, Fig. 14. Generally small particles only of the surrounding individuals are joined to the central one. Massive : composition granular, firmly connected.

Observations.

The preceding description is given by Professor Mohs.[*]

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[*] *Treatise on Mineralogy, Transl.* vol. ii. p. 416.

It would be superfluous to enlarge here on the propriety of considering this as a species of its own, since, besides Mr Mohs, it has likewise been established as such by Messrs Brooke and Phillips,* and by the Abbé Haüy.† Even in the works of the Wernerian school, the pyramidal forms had been long ago described, in reference to the identical specimen from which the above description was derived. Its locality is Ilmenau in Thuringia. Count Bournon ‡ mentions an ore of manganese crystallized in regular octahedrons, having their solid angles replaced by low four-sided pyramids; a form which might be explained upon the supposition, that the variety, Fig. 12, appears in the regular composition represented Fig. 14.; at least it would be interesting to have these varieties compared again with each other.

III.—*Uncleavable Manganese Ore.*

Regular forms and cleavage unknown. Fracture not observable.

Lustre imperfect metallic. Colour bluish-black and greyish-black, passing into dark steel-grey. Streak brownish-black, shining. Opaque.

Brittle. Hardness = 5.0 . . . 6.0. Sp. gr. = 4.145, a botryoidal variety.

Compound Varieties. Reniform, botryoidal, fruticose: composition columnar, impalpable; fracture flat, conchoidal, even; in a second composition it is curved lamellar, the faces of composition being smooth, rough or granulated. Massive: composition granular, impalpable, strongly connected; fracture flat, conchoidal, even.

Observations.

The specimen analyzed is from the neighbourhood of Schneeberg in Saxony, and agrees perfectly with the preceding description, extracted from the treatise of Mohs. It consists of alternating layers, having more or less lustre, dis-

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* *Phillips*, 3d Edit. p. 381.

† *Traité*, 2d Edit. t. iv. p. 264.

‡ *Catalogue*, p. 395.

posed in reniform coats. The specific gravity of those parts, which possess a rather stronger lustre, and a conchoidal fracture, is = 4.004, while the specific gravity of those without lustre, and an uneven fracture, was found to be = 4.079.

IV.—*Brachytypous Manganese Ore.*

Fundamental form. Isosceles four-sided pyramid. P = 109° 53′ 108° 39′. Fig. 15.

$$a = \sqrt{1.94}.$$

Simple forms. $P - \infty$ (*o*); P(*P*), Wunsiedel, Bayreuth; $P+2$ (*s*) = 96° 33′, 140° 30′, Fig. 16., Elgersburg, Thuringia; $(P+1)^3$ (*z*) = 144° 4′, 128° 17′, 154° 25′.

Char. of comb. pyramidal.

Combinations. 1. $P - \infty$. P. Fig. 17., Wunsiedel.

2. P. $P+2$. Fig. 18., Elgersburg.

3. P. $(P+1)^3$. Fig. 19., St Marcel, Piedmont.

4. $P - \infty$. P. $P+2$. Fig. 20., Wunsiedel.

Cleavage, very distinct in the direction of the faces of P; entire forms of cleavage may be obtained from larger individuals. Fracture uneven. Surface, $P - \infty$, possessing less lustre than P, but even, and sometimes faintly streaked parallel to the edges of combination with P; P often a little rounded; $P + \infty$ uneven, rough and horizontally streaked; $(P+1)^3$ smooth and even.

Lustre imperfect metallic. Colour dark brownish-black. Streak of the same colour.

Brittle. Hardness = 6.0 . . . 6.5. Sp. Gr. = 4.818, large cleavable individuals from Elgersburg.

Compound Varieties. Massive: composition granular, individuals strongly coherent.

Observations.

The first variety of the species of brachytypous Manganese-ore which I had the good fortune to examine, was brought by Dr Turner from Germany, the ticket bearing the locality of Elgersburg. Being struck with the facility with which this mineral yields to cleavage in the direction of the faces of a four-sided pyramid, and supposing it to belong to the species of the pyramidal manganese-ore of Mohs, I requested Dr Turner's permission to extract the form of cleavage from it, but was much surprised when I could not discover the single cleavage perpendicular to the axis, which is so very distinct in that mineral, and has been likewise indicated by Messrs Brooke and Phillips. Though the mineral cleaves very readily, yet its great hardness, being superior to that of feldspar, and a strong connection among the particles, render it extremely difficult to obtain the faces smooth and plain enough to reflect a good image even of a single very luminous point. I was, therefore, led to suppose, by several approximate measurements, that the regular octahedron should be considered as the fundamental form of the species. In some of the cavities of the same specimen there were, however, crystals in the form of acute four-sided pyramids, similar to Fig. 16, which did not agree with the symmetry of tessular forms. They were rough, and possessed of little lustre, so that they afforded only indistinct measurements of about 140° for the base of the pyramid. Certain varieties from Wunsiedel in Bayreuth, in the cabinet of Mr Allan, engaged in heavy-spar, and associated with prismatoidal manganese-ore in very delicate columnar composition, possess the form of Figs. 15, 17, and 20. The two first of these I also observed in a specimen in the collection of Mr Ferguson of Raith, having the following ticket by Mr Heuland: "Hydrous-oxide of manganese, in the form of an octahedron, with a square basis. Thuringia—is extinct." As Haüy's works contain the pyramidal manganese-ore of Mohs, under the denomination of *Manganese oxide hydraté*,* this specimen is probably intended for a variety of that species, which, however, is very inaccurately described by Haüy, who united under one head the physical properties of one species with the physical and the chemical properties of two or three others to form a general description, to which no object in nature corresponds. I had long ago observed crystals of the form Fig. 19, engaged in a specimen of the *epidote manganésifere* of Haüy, in the cabinet of Mr Allan, but which I believed likewise to be a variety

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* *Traité*, 2de Ed. t. iv. p. 264.

of the pyramidal manganese-ore. Upon measurement, however, for which the small but beautifully formed and bright crystals of this variety are better suited than any of the rest, these also turned out to belong to a species different from the pyramidal one formerly described. The angles which these crystals afforded are given above as the dimensions of the species. The results obtained from the remaining varieties are not sufficiently consistent to be considered different from these, and as, moreover, the colour of their streak and their hardness coincide, we may safely consider them as belonging to the same species. Some of the octahedral crystals, quoted by Count Bournon,* for which he proposes the denomination of *fer oxydulé manganésien*, must also very likely be referred to the brachytypous manganese-ore. He supposes their form to be derived from the regular octahedron, but does not quote any decisive proofs in favour of this opinion, which is rendered necessary when a species nearly resembling it is found to have, for its fundamental form, a four-sided pyramid so little different from the regular octahedron. Those varieties which have their solid angles replaced by four faces, may perhaps belong to the pyramidal manganese-ore, as is mentioned in the observations annexed to that species, which was likewise not distinguished as a species of its own at the period of publication of Count Bournon's catalogue.†

ART VIII.—*Account of the Eruption of the Volcano of Jorullo in Mexico.*‡ By BARON ALEXANDER DE HUMBOLDT. With a Section of the Mountain.

To the east of the Pic de Tancitaro, the *Volcan de Jorullo* (Xorullo, or Juruyo) was formed in the night of the 29th September 1759. M. Bonpland and myself reached its cra-

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* *Catalogue*, p. 395.

† Dr Turner is occupied with the Analysis of the Species described in this Paper, and will give the results in a subsequent Number.—ED.

‡ We have given the above abridged account of this remarkable volcano, in reference to a new theory of its formation by Mr Scrope, which forms the subject of the next Article. See Humboldt's *Essai Politique sur la Nouvelle Espagne*, his *Essai Geognostique*, p. 351, and his *Relation Historique*.—ED.

ter on the 19th September 1803. The great catastrophe in which this mountain rose from the earth, and by which a considerable extent of ground totally changed its appearance, is, perhaps, one of the most extraordinary physical revolutions in the annals of the history of our planet. Geology gives us no example of the formation, from the centre of a thousand small burning cones, of a mountain of scoria and ashes 517 metres (1695 feet) in height, comparing it only with the level of the old adjoining plains in the interior of a continent, 36 leagues distant from the coast, and more than 42 leagues from every other active volcano.

A vast plain extends from the hills of Aguasarco to near the villages of Teipa and Petatlan, both equally celebrated for their fine plantations of cotton. This plain, between the *Picachos del Mortero*, the *Cerros de las Cuevas, y de Cuiche*, is only from 750 to 800 metres (from 2460 to 2624 feet) above the level of the sea. In the middle of a tract of ground in which porphyry, with a base of greenstone predominates, basaltic cones appear, the summits of which are crowned with evergreen oaks of a laurel and olive foliage, intermingled with small palm trees with flabelliform leaves. This beautiful vegetation forms a singular contrast with the aridity of the plain, which was laid waste by volcanic fire.

Till the middle of the 18th century, fields cultivated with sugar-cane and indigo occupied the extent of ground between the two brooks called Cuitamba and San Pedro. They were bounded by basaltic mountains, of which the structure seems to indicate that all this country, at a very remote period, had been already several times convulsed by volcanoes. These fields, watered by artificial means, belonged to the plantation *(hacienda)* of San Pedro de Jorullo, one of the greatest and richest of the country. In the month of June 1759, a subterraneous noise was heard. Hollow noises of a most alarming nature *(bramidos,)* were accompanied by frequent earthquakes, which succeeded one another for from 50 to 60 days, to the great consternation of the inhabitants of the *hacienda*. From the beginning of September every thing seemed to announce the complete re-establishment of tranquillity, when, in the night between the 28th and 29th, the horrible subterraneous noise recommenced. The affrighted Indians fled to the mountains of Aguasarco. A tract of ground from three to four square miles in extent, which goes by the name of *Malpays*, rose up in the shape of a bladder. The bounds of this convulsion are still distinguishable in the fractured strata. The *Malpays* near its edges is only 39 feet above the old level of the plain called the *playas de Jorullo;* but the convexity of the ground thus thrown up increases progressively towards the centre to an elevation of 524 feet. See Plate I. Fig. 6.

Those who witnessed this great catastrophe from the top of Aguasarco assert that flames were seen to issue forth for an extent of more than half a square league, that fragments of burning rocks were thrown up to prodigious heights, and that, through a thick cloud of ashes, illumined by the volcanic fire, the softened surface of the earth was seen to swell up like an agitated sea. The rivers of Cuitamba and San Pedro precipitated themselves into the burning chasms. The decomposition of the water contributed to invigorate the flames, which were distinguishable at the city of Pascuaro, though situated on a very extensive table land 1400 metres (4592 feet) elevated above the plains of *las playas* de Jorullo. Eruptions of mud, and especially of strata of clay, enveloping balls of decomposed basaltes in concentrical layers, appear to indicate, that subterraneous water had no small share in producing this extraordinary revolution. Thousands of small cones, from two to three metres (from 6.5 feet to 9.8 feet) in height, called by the indigenes *ovens* (*hornitos*,) issued forth from the *Malpays*. Although within the last fifteen years, according to the testimony of the Indians, the heat of these volcanic ovens has suffered a great diminution, I have seen the thermometer rise to 95° (202° of Fahrenheit) on being plunged into fissures which exhale an aqueous vapour. Each small cone is a *fumarola*, from which a thick vapour ascends to the height of ten or fifteen metres. In many of them a subterraneous noise is heard, which appears to announce the proximity of a fluid in ebullition.

In the midst of the ovens six large masses, elevated from 4 to 500 metres (from 312 to 1640 feet) each above the old level of the plains, sprung up from a chasm, of which the direction is from the N.N.E. to the S.S.E. This is the phenomenon of the Montenovo of Naples, several times repeated in a range of volcanic hills. The most elevated of these enormous masses, which bears some resemblance to the *pays* de l'Auvergne, is the great Volcan de Jorullo. It is continually burning, and has thrown up from the north side an immense quantity of scorified and basaltic lavas, containing fragments of primitive rocks. These great eruptions of the central volcano continued till the month of 1760. In the following years they became gradually less frequent. The Indians, frightened at the horrible noises of the new volcano, abandoned, at first, all the villages situated within seven or eight leagues distance of the playas de Jorullo. They became gradually, however, accustomed to this terrific spectacle ; and, having returned to their cottages, they advanced towards the mountains Aguasarco and Santa Iñes, to admire the streams of fire discharged from an infinity of great and small volcanic apertures. The roofs of the houses of Queretaro were then covered with ashes at a distance of more than 48 leagues in a straight line from the scene of the explosion. Although the subterraneous fire now appears far from violent,* and the Malpays, and the great volcano, begin to be covered with vegetables, we, nevertheless, found the ambient air heated to such a degree by the action of the small ovens (*hornitos*,) that the thermometer, at a great distance from the surface, and in the shade, rose as high as 48° (109° of Fahrenheit.) This fact appears to prove, that there is no exaggeration in the accounts of several old Indians, who affirm that, for many years after the first eruption, the plains of Jorullo, even at a great distance from the scene of the explosion, were uninhabitable, from the excessive heat which prevailed in them.

The traveller is still shown, near the Cerro de Santa Iñes, the rivers of Cuitamba and San Pedro, of which the limpid

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* We found, in the bottom of the crater, the air at 116°, 130°, and 139° of Fahrenheit. We passed over crevices which exhaled a sulphureous vapour, in which the thermometer rose to 185° Fahrenheit. The passage over these crevices and heaps of scoria, which cover considerable hollows, render the descent into the crater very dangerous.

waters formerly watered the sugar-cane plantation of Don André Pimentel. These streams disappeared in the night of the 29th September 1759; but, at a distance of 2000 metres (6561 feet) farther west, in the tract which was the theatre of the convulsion, two rivers are now seen bursting through the argillaceous vault of the *hornitos*, of the appearance of mineral waters, in which the thermometer rises to 52°,7 (126°,8 of Fahrenheit.) The Indians continue to give them the names of San Pedro and Cuitamba, because, in several parts of the Malpays, great masses of water are heard to run in the direction from east to west, from the mountains of Santa Ines towards *l'Hacienda de la Presentacion.* Near this habitation there is a brook, which disengages itself from the sulphureous hydrogen. It is more than nine yards in breadth, and is the most abundant hydro-sulphureous spring which I have ever seen.

The position of the new Volcana de Jorullo gives rise to a very curious geological observation. In New Spain there is a *parallel of great elevations*, or a narrow zone contained between 18°, 59′ and 19°, 12′ of latitude, in which all the summits of Anahuac which rise above the region of perpetual snow are situated. These summits are either volcanoes which still continue to burn, or mountains which, from their form, as well as the nature of their rocks, have, in all probability, formerly contained subterraneous fire. As we recede from the coast of the Atlantic, we find, in a direction from east to west, the Pic d'Orizaba, the two volcanoes of la Puebla, the Nevada de Toluca, the Pic de Tancitaro, and the Volcan de Colima. These great elevations, in place of forming the crest of the Cordillera of Anahuac, and following its direction, which is from the south-east to the north-west, are, on the contrary, placed on a line perpendicular to the axis of the great chain of mountains. It is undoubtedly worthy of observation, that, in 1759, the new volcano of Jorullo was formed in the prolongation of that line, on the same parallel with the ancient Mexican volcanoes!

A single glance bestowed on my plan of the environs of Jorullo will prove that the six large masses rose out of the earth, in a line which runs through the plain from the Cerro de las Cuevas to the Picacho del Mortero; and it is thus also that the bocche nove of Vesuvius are ranged along the prolongation of a chasm. Do not these analogies entitle us to suppose that there exists, in this part of Mexico, at a great depth in the interior of the earth, a chasm in a direction from east to west, for a length of 137 leagues, along which the volcanic fire, bursting through the interior crust of the porphyritical rocks, has made its appearance at different epochas from the gulf of Mexico to the South Sea? Does this chasm extend to the small group of islands called by M. Collnet the archipelago of Revillagigedo, around which, in the same parallel with the Mexican volcanoes, pumice-stone has been seen floating? Those naturalists who make a distinction between the facts which are offered us by descriptive geology and theoretical reveries on the primitive state of our planet, will forgive us these general observations on the general map of New Spain. Moreover, from the lake of Cuiseo, which is impregnated with muriate of soda, and which exhales sulphuretted hydrogen, as far as the city of Valladolid, for an extent of 48 square leagues, there are a great quantity of hot wells, which generally contain only muriatic acid, without any vestiges of terreous sulphates or metallic salts. Such are the mineral waters of the Chucandiro, Cuinche, San Sebastian, and San Juan Tararamco.

ART. IX.—*Observations on Humboldt's Theory of the Volcano of Jorullo.* By G. POULETT SCROPE, Esq. Secretary to the Geological Society.

THE theory of the volcano of Jorullo, given by Baron Humboldt in the preceding article, has been very ably examined by Mr Scrope in his *Considerations on Volcanoes,* a new and interesting work which has just appeared.

From a personal examination of almost all the extinct, as well as the active volcanoes of Europe, Mr Scrope was led to the opinion, that they display a remarkable uniformity of character, presenting few other variations than what depend on the degree of energy they have displayed. The phenomena of Jorullo, however, as explained by Humboldt, forms an exception to this uniform character, and hence, Mr Scrope was led to examine them with care, with the view of referring them to the ordinary principles of volcanic action.

In this examination, Mr Scrope has analyzed the opinions of M. de Humboldt with that respect and courtesy which are due to his distinguished talents, and he has never permitted the spirit of controversy to disturb the serenity of philosophical discussion. We should have wondered, indeed, how any man could have approached even to the errors of that great traveller with any other feelings but those of affection and respect, had we not perused a recent attempt to blacken and insult his high reputation. Every philosopher and naturalist in Europe view with indignation this warfare against a man who has contributed so much to the sciences which they cultivate; and every Englishman must feel that the character of our literature has been compromised by such unmeasured abuse and depreciation of foreign talent.

"Previous to 1759," says Mr Scrope, "it appears that the plain, from which Jorullo now rises, presented traces of former volcanization; its soil being composed of tufa; and the neighbouring mountains consisting of trachyte and basalt. In September of that year, a violent series of eruptions took place, of which M. de Humboldt distinguishes the results in the following order.

1*st*, The production of six volcanic cones, composed of scoriæ and fragmentary lava.

2*dly*, That of a promontory of basaltic lava proceeding from the summit of the largest of these cones (Jorullo,) which still emits wreaths of vapour from the interior of its crater.

3*dly*, The elevation in a convex form of the plain, (four square miles in superficial extent) upon which the cones were thrown up, and the centre of which is occupied by the largest (Jorullo,) at whose base the plain is higher by 550 feet than without the limits of this space. The plain, which M. de Humboldt calls "un errain bombè en forme de vessie," and the convexity of which he attributes to *inflation from below*, is represented as closely sprinkled with thousands of flattish conical hillocks, from six to nine feet high, formed of basaltic balls, separating into concentric leaves, imbedded in a *black clay*. These hillocks, as well as some large fissures which traverse the intermediate plain, act as so many *fumarole*, giving out thick clouds of aqueous vapour combined with sulphuric acid, and at a very high temperature.

The two first mentioned products of this eruption are of ordinary occurrence, and testify that, at least for the greater part, the volcanic action took effect here in the usual mode.

The phenomena of the third class are remarkable, and deserving of the greatest consideration, as appearing at first sight to differ materially from any hitherto observed, and as referred for this reason by M. de Humboldt to a mode of volcanic action invented by him for the occasion, and of which no other recorded eruption has ever afforded a parallel.

And here, with the utmost respect for the great talents of this first of scientific travellers, and giving all due weight to the impression which appears to have been made upon him on the spot, I own myself still unable to coincide in his opinion as to the mode of formation of this remarkable plain. And this for the two following reasons:

1*st*. In the first place, the appearances presented can be without the least difficulty explained by the ordinary mode of operation of volcanoes. In which case we are bound to dismiss one so extraordinary and unparalleled as that brought forward for the purpose by M. de Humboldt, and which, however brilliant or seducing to the imagination, it would be unwarrantable to persevere in.

2dly. *All* the supplementary arguments which M. de H. adduces, are completely invalid, and, instead of supporting his theory rather tell against it, as will be proved directly.

1. What are the positive facts with which we are acquainted relative to this eruption, divested of all theoretical assumptions?

In the month of September 1759, prodigious volcanic eruptions took place from six different openings, arranged on a single line of very little extent, upon the Mexican plateau. Their fragmentary projections produced six large volcanic cones; the central one being 1700 feet in height. A massive current of lava projects from the side of this last hill, having evidently flowed out of the crater at its summit. If any lava currents were produced by the apertures, marked by the other cones, they do not show themselves; but the plain from which these hills rise exhibits a great intumescence, or convexity of surface. Its superficial soil consists of horizontal layers of a black clay, in which augite crystals are thickly disseminated. The same clay, but enveloping concentric balls of *basalt*, composes the numerous little hollow conical protuberances, (or bubbles,) with which the surface of the plain is sprinkled.

Now, on comparing these appearances with those which result from ordinary volcanic eruptions, little other difference is perceivable than that the quantity of *lava* produced, or at least remaining visible, bears but a very small proportion to the violence of the eruptions, and the immense quantity of scoriæ thrown out. It seems extraordinary also, that but one out of six cones should have given rise to a lava current. Hence a suspicion arises that a greater quantity of lava was in fact emitted, but that it is concealed by the sprinkling of triturated scoriæ or volcanic sand, which these large cones must have thrown out during the latter period of their eruptions.

In this manner, the lava currents, produced by the eruption of Vesuvius in October 1822, lie at this moment covered to a depth of from two to ten feet by the finer fragmentary substances ejected by the volcano during the last days of its paroxysm. And what renders the analogy still more striking, these *ashes*, which, from the fineness of their comminution mixed into a retentive paste with the torrents of rain that immediately followed the eruption, present the appearance of strata of *a black clay*, precisely like those described by M. de Humboldt, as forming the surface of the plain of Malpais.

The convexity of this plain is therefore most naturally accounted for by supposing it to form the surface of a great bed of lava, resulting from the union of different currents, which, owing to the previous flatness of the surface on which they were poured forth, their simultaneous emission in great abundance from so many neighbouring orifices, and their very low degree of liquidity,* united into a sort of pool or lake of lava,

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* The very coarse grain of the lava of Jorullo (*Dolerite*, Humboldt,) warrants this assumption of its extremely imperfect liquidity.

which spread itself on all sides with great reluctance, and, therefore, would necessarily remain thickest and deepest where the lava was produced in greatest abundance, diminishing in bulk from thence towards the limits of the space it covered; *i. e.* would assume precisely the convexity of form peculiar to Malpais. The subsequent projections of loose and pulverulent matter from the six craters, and principally from Jorullo, will have increased that convexity, covering it with strata of volcanic ashes and augite crystals, which were reduced to the appearance of a black clay by mixture with rain water.

The fact that the only visible lava current proceeds from the *crater* of Jorullo, is a strong confirmation of this opinion; since it is at once obvious why this is seen, while those that may have been emitted *previous* to the formation of the other cones are concealed; and it becomes also probable that this *promontory* of lava is merely one extremity of the current of Jorullo, which, dipping under the strata of ashes, probably unites with the streams proceeding from the other apertures to form the substratum of the whole convex plain.

Thus there is no difficulty in accounting for the convexity of the plain of Malpais by the effects of the most ordinary volcanic phenomena; let us see whether this supposition will explain the other remarkable appearances it is said to exhibit.

And here a fact, recorded by M. de Humboldt himself, not only tends to confirm, but may be almost said to prove, the correctness of the view I have taken of the nature of the plain. He says that, in 1780, the temperature of the fissures which penetrate the surface of the plain and its hillocks, was so high, that a cigar might be lighted by plunging it to the depth of a few inches into them. Now I think it impossible to account for this without allowing the whole plain to have consisted of lava in a state of incandescence immediately beneath its outer crust; a circumstance to be expected, even so much as 20 years after its emission, in a bed of lava more than 500 feet in thickness, since Hamilton observed of one of the smaller currents of Vesuvius, that, three years after its production, a stick might be inflamed by thrusting it into one of the crevices of the rock.

It remains only to account for the formation of the small hillocks (hornitos) with which the surface of the plain is thickly studded. And here I must again have recourse to the results of the highly instructive eruption which took place from Vesuvius in October 1822.

All lava currents are well known both during their progress, and for a long time, often indeed many years afterwards, to disengage torrents of aqueous and sulphureous vapour. If these are produced on any point in considerable quantity, while the superficial lava is yet soft, their expansion raises up a portion of this into a small dome or bubble, which sometimes remains entire, at others it is broken through, leaving the tattered fragments of lava that separate to give passage to the vapour, in an upright position from their sudden congelation.* This process is, in fact, one of the causes of the numerous asperities that bristle the surface of most currents. When, however, a deep coating of ashes has subsequently fallen on this surface, its smaller roughness are effaced, and the larger protuberances alone show themselves in the form of small dome-shaped or sub-conical hillocks, which continue, through various crevices, to give a passage to the vapours by which they were at first thrown up. Many such hillocks, rising five or six feet above the average level of the surface, existed in the spring of 1823, on the Vesuvian lava currents above-mentioned, and sent forth copious columns of vapour, precisely of the same nature as that of the *Hornitos* of M. de Humboldt; while other fissures, intersecting the intervening surface of the small plain, formed by the lava on the Pedamentina, gave out similar vapours, presenting, on a small scale, the identical phenomena for which Malpais has been so long celebrated.†

Where the quantity of ashes, covering the lava bed, and mixed up into a paste with rain water, was great, as appears to have been the case on the Malpais, it is probable that numerous hillocks of this kind will have been formed by the in-

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* See Breislak's *Institutions Geologiques*, i. p. 251.

† That the eruptions of Jorullo threw up a prodigious quantity of volcanic ashes, is evident from the fact recorded by M. de Humboldt, that the roofs of the houses at *Queretaro*, 144 miles distant in a straight line, were thickly covered with them!

tumescence of this semi-liquid substance alone above the fumarole of the lava ;* and the mobility of parts, occasioned by this process, favouring the action of the concretionary forces, probably gave rise to the agglomeration of the clay into the foliated and concentric balls, of which the *hornitos* partly consist. At *Pont du Chateau*, in Auvergne, is an example of even a very coarse calcareo-volcanic conglomerate having assumed this precise variety of concretionary structure; and I suspect, from their being imbedded in the black clay, and consisting of a fine-grained rock very different from the *Doleritic basalt* of Jorullo, that the globular concretions of the hornitos are not a true basalt, but merely hardened nodular balls of volcanic ashes. They are, in fact, described by M. de Humboldt as *fragile and easily crumbled*, and totally different from the syenitic lava of the current of Jorullo.

It remains only to notice the supplementary facts produced by M. de Humboldt in support of the explanation he adopts of the appearances of Malpais, which I conceive tend much more strongly to confirm the opinion of its being merely the surface of a great bed of lava, which, up to the period of M. de Humboldt's visit, retained much of its internal heat.

These confirmatory facts are,

1. The noise made by the steps of a horse upon the plain.

2. The frequent formation of cracks or fissures across the plain, and the occasional occurrence of partial subsidences.

3. That two rivers, the Cuitimba and San Pedro, lose themselves below the eastern extremity of the plain, and reappear as hot springs (at 52° cent.) at its western limit.

1. With regard to the first mentioned circumstance, viz. the sound produced when the surface of the plain is struck by the hoofs of a horse, or, I presume, in any other mode of percussion, it is evidently the same phenomena of *reverberation*, to which the mimo-phoneutical term *rimbombo* is so well applied in Italy, and which, by a vulgar error, is often supposed to indicate a great cavity below the spot so resounding when struck. It is perfectly true that the roof of every large

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* " The *Hornitos* are *hollow*. When a mule steps upon them they break in."—*Humboldt*.

cavity does, under certain circumstances, offer the same phenomenon; but the converse of this is by no means true; and to produce this effect it is enough that the soil should be of loose, light, and porous materials, so as to contain numerous small cavities or interstices. Not only the bottom of the crater, but the external slopes of every volcanic cone, and every flat spot, however distant from any volcanic orifice, which has a moderate coating of fragmentary scoriæ or volcanic ashes, returns this sound on percussion. Not only the sides of Vesuvius, but the whole surface of the Campagna di Roma, and the Terra di Lavoro, must be suspended over a yawning gulf, if this phenomenon is a sufficient proof of such a position.

But even all *made ground* returns a more or less sonorous reverberation when struck sharply, and the causes which produce this effect are well known to natural philosophers. This sound would therefore be produced in the case of Malpais, as naturally by a superficial coating of volcanic ashes as by any vast cavity, did such indeed exist, underneath.

2. The frequent formation of cracks and fissures across the plain, far from proving the existence of such a subterranean gulf, is a circumstance which accompanies the cooling and consolidation of every bed of lava; and as these crevices are formed only in the lava (contracting as it congeals) it is to be expected that local subsidences must often take place in the coating of volcanic ashes or black clay, immediately above the clefts. The washing of this clay by rains into the fissures of the lava bed beneath, is another probable cause of such subsidences; much more probable, I should conceive, than the supposition of a natural arched cavity or bubble, four square miles in extent.

3. A further confirmation of the existence of a bed of lava, beneath the plain of Malpais, is obtained from the disappearance of two rivers beneath its surface; for this accident necessarily results in the instance of all lava currents which have occupied the bed of a river; in consequence of the numerous fissures with which they are penetrated, but particularly of the bed of loose and cellular scoriæ on which they invariably rest. This phenomenon occurs in repeated in-

stances in Auvergne. Wherever a bed of lava fills the bottom of a valley, the river or torrent which drains the valley, disappears below the upper extremity of the lava bed, and filtering through the interstices of the scoriæ which universally form its substratum, reappears in copious springs at the lower extremity or termination of the lava current. So long as the lava retains a very exalted temperature in its interior, the water percolating beneath it must be proportionately heated; and that this was the case with regard to the lava bed of Malpais, at the time of M. de Humboldt's visit, was proved by the numerous fumarole on its surface. Hence it was to be expected that the rivers Cuitimba and San Pedro, which find their way beneath it, should have had their temperature raised before they issued again into the air at the opposite extremity of the superinduced lava bed.

The noice heard on approaching the ear to any of the hillocks (hornitos) resembling that of a cascade, and which is, by M. de Humboldt, attributed to the rivers flowing through the hollow gulf below, is far more probably owing to the currents of elastic vapour rushing through the fissures by which they find a vent. A similar sound is produced by the rise of carbonic acid through the little cones of the mud volcanoes of *Maccaluba* in Sicily; and I have also observed a rushing sound of the same nature to be produced by every powerful *fumarola* of the lava currents of Vesuvius.

M. de Humboldt mentions himself, that the heat of the *Hornitos* decreases every year; and I have the authority of Mr. Bullock junior, who visited the spot a short time back, for the fact, that they have now ceased almost entirely to emit vapour, and that the hot springs are reduced to a very low temperature, evidently from the congelation of the subjacent bed of lava. This evidence is absolutely conclusive as to the correctness of the opinions advocated here on the nature of the plain of Malpais.

I have given thus much space to the endeavour to reconcile the phenomena presented by this plain to the ordinary and well known modes of volcanic agency, because the opinion expressed by M. de Humboldt of its surface having been raised by intumescence in the manner of an enormous *bladder* *or bubble*, (of four square miles in extent!) and covered by an effort of the same extraordinary and incomprehensible nature with thousand of small basaltic cones, each owing to a similar process, has been generally received by geologists as an ascertained fact, and made the basis of further and still more strange hypotheses for the purpose of explaining the origin of the dome-shaped mountains of frequent occurrence in Trachytic countries, and the still more common conical peaks of basalt.

If, from the reasons adduced above, it appears most probable that the convexity of the plain of Malpais is simply owing to its forming the surface of a massive subjacent bed of lava, emitted contemporaneously by the six volcanic cones which rise from its surface, it will be obviously impossible to draw any argument from the formation of the *Hornitos*, none of which exceed nine feet in height, as to that of mountains like the Puy de Dome, Chimboraco or Pichinca, the two latter of which are from 15 to 18,000 feet in height. The theory, therefore, built on the supposed example of Jorullo, must fall to the ground. *

It has been seen, in another part of this Essay, that the peculiarity of figure, assumed occasionally by masses of trachyte and basalt, is easily to be accounted for without having recourse to the agency of unknown and imaginary forces, or, indeed, any other than those with the operation of which we are thoroughly conversant, and which are fully equal to the purpose.

I trust to be forgiven the apparent presumption of thus calling in question opinions formed by an observer of such acknowledged sagacity and experience as M. de Humboldt, upon facts to which, except through his accounts, I am neces-

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* The other example adduced by Humboldt for the same purpose, viz the supposed intumescence of the plains that form themselves on the summit of volcanic cones in place of their craters, is equally inadmissible. It has been already shown, in the body of this work, that the craters are filled by a general law, from the accumulation of fragmentary ejections, and of lava swelling up from below. This will necessarily tend to produce a final convexity of surface; but it would be manifestly absurd to argue, from this form, the existence of a vaulted cavity below.

sarily a stranger; no other description of the volcanoes of Mexico having, I believe, been made public. I think, however, it must be allowed that the facts, of which we have the relation from M. de Humboldt himself, by no means bear out the theory he has proposed to account for them, but tend, on the contrary, one and all, to refer the volcanic eruptions of Jorullo and its vicinity to the same class of phenomena which have been uniformly observed in other localities.

In fact, in the process of argument from effects up to causes, no chain of reasoning can be stronger, no conclusion can be more imperative, than when, as in this instance, we are possessed of a considerable number of facts, all, without one exception, going to support a certain origin, and *that* not an imaginary species of phenomenon invented for the occasion, but the same which is observed in its continual operation on other spots to produce the same results, and the only one amongst all known natural processes that is capable of producing them.

I conceive, indeed, that no more effectual service can be rendered to science than the destruction of any one of those glaring theories, which, apparently based upon a few specious facts, and backed by the authority of some great name, are received by the world in general without examination, notwithstanding that they contradict the ordinary march of nature, and consequently throw the extremest perplexity into that of science.

The brilliant theory of the precipitation from one aqueous menstruum of all the crystalline rocks, now beginning to be reduced to its true value, is a striking example of the facility with which the most baseless hypothesis may be imposed on the scientific world as articles of faith, never to be called in question even in thought. Let us trust it will act as a warning for the future.

Art. X.—*Observations on the apparent Distances and Positions of* 389 *Double and Triple Stars.* By J. F. W. Herschel, Esq. Sec. R. S. Lond. and F. R. S. Edin. and James South, Esq. F. R. S. Lond. and Edin.—*Concluded from Vol. III. p.* 288.

N B Remarkable Stars are pointed out by a * affixed in Column 1.

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks
		h. m.	° ′	° ′		′ ″	
191	63 of the 145	14 55	54 33 N	73 10	*np*	40.845	
192	37 of the 145	14 56	6 12 N	76 30	*np*	10.749	
193	44 Bootis	14 58	48 21 N	40 53	*sp*	2.277	
194	H. C. 472	14 59	9 55 N	60 50	*sp*	4.777	
195	Libræ 97	15 4	17 45 S	50 58	*sf*	49.037	
196	V. 125	15 5	28 36 N	43 17	*sp*	32.553	
197	62 of the 145	15 5	19 56 N	80 51	*nf*	25.842	
198	H. C. 289	15 5	39 22 N	13 29	*np*	31.239	
199	δ Bootis	15 8	34 0 N	10 31	*nf*	1 45.333	Slightly changed in Pos.
200	H. C. 470	15 10	11 7 N	84 20	*sf*	13.268	
201	η Coronæ Bor.	15 16	30 57 N	64 3	*nf*	1.577	Scarcely changed.
202	H. C. 288	15 18	8 41 S	44 39	*sf*	51.760	
*203	I. 17, *sf* μ Bootis	15 18	37 59 N	63 42	*np*	1.652	Binary. Mean mot.—0°5783.
204	μ Bootis	15 18	38 1 N	81 51	*sf*	1 48.539	Unchanged.
*205	δ Serpentis	15 26	11 9 N	70 37	*sp*	3.053	Binary. Mean mot.—0°726.
206	Libræ 178	15 30	8 11 S	82 46	*sp*	11.862	
207	H. C. 469	15 33	10 33 S	38 5	*nf*	27.066	
208	ζ Coronæ Bor.	15 33	37 11 N	30 57	*np*	7.168	Changed + 5°. 6′. in Angle.
209	32 of the 145	15 40	36 59 N	53 43	*np*	31.517	
210	π′ Ursæ Min.	15 40	81 2 N	6 43	*nf*	31.102	
211	II. 85	15 47	1 39 S	55 17	*np*	6.882	Changed —9° 8′ in Position, and nearly 3″ in Distance.
212	III. 103	15 48	3 56 N	53 4	*np*	10.665	
213	H. C. 343	15 49	19 24 S	52 10	*np*	19.890	
214	V. 126	15 52	17 54 N	53 25	*sp*	34.923	
215	II. 21 prope ξ Scor.	15 54	10 56 S	10 57	*sf*	10.601	
	idem 1 and 3			78 39	*np*	4 41.533	
*216	ξ Scorpii	15 54	10 52 S	11 37	*nf*	6.769	Binary? Mean mot. — 0°.256.
217	β Scorpii	15 55	19 18 S	63 30	*nf*	13.650	Unchanged.
218	H. C. 159	15 58	13 49 N	58 44	*np*	31.935	
219	κ Herculis	16 0	17 32 N	80 25	*nf*	31.169	Dist. diminished 8″.711.
220	ν Scorpio	16 2	18 58 S	68 12	*np*	40.817	Unchanged.
*221	49 Serpentis	16 4	14 1 N	41 57	{ *np* *sf* }	4.215	Binary. Mean mot + 0°.510.
*222	σ Coronæ Bor.	16 8	34 20 N	18 27	*nf*	1.455 Ep. 1822.83	Binary. Mean mot.—2°.13, much accelerated, and distance diminished.
223	υ Coronæ Bor. 1 & 2	16 10	29 36 N	65 33	*nf*	1 28.694	
	——— 1 & 3			35 9	*nf*	2 64.20	

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″	
224	20 σ Scorpii	16 10	25 9 S	1 11	*np*	20.595	
225	V. 134	16 10	19 36 S	64 58	*np*	47.120	Unchanged in Distance.
226	V. 124	16 10	19 40 S	69 29	*nf*	13.280	Slightly changed.
227	γ Herculis	16 14	19 35 N	26 14	*sp*	38.325	
228	g. 5 Ophiuchi	16 15	23 1 S	87 30	*nf*	4.065	
229	H. C. 78	16 18	37 27 N	76 21	*np*	10.155	
230	III. 102	16 21	11 1 N	71 26	*nf*	14.833	
231	Herculis 71	16 21	18 47 N	19 12	*sf*	3.236	
232	II. 23	16 23	5 51 N	51 7	*np*	7.649	Probably changed in Pos.
233	H. C. 228	16 23	8 42 N	17 29	*nf*	59.544	
234	36 Herculis	16 32	4 33 N	39 37	*sp*	1 8.839	
235	V. 127 1 & 2	16 34	6 57 N	21 0	*np*	54.307	
	——— 1 & 3			74 10	*sp*	1 30.275	
236	17 Draconis	16 32	53 17 N	25 26	*sf*	4.512	Unchanged.
237	ζ Herculis	16 35	31 56 N	———		0.000	Single.
238	H. C. 369	16 35	24 0 N	21 27	*np*	6.755	
239	43 Herculis	16 37	8 55 N	39 9	*sp*	1 20.094	
240	Piazzi XVI. 236	16 46	19 15 S	42 44	*sp*	5.641	
241	H. C. 510	16 53	47 36 N	6 3	*np*	1 55.126	
*242	21 μ Draconis	17 3	54 43 N	61 39	*sp* *nf*	3.907	Binary. Mean mot. —0°5792.
243	36 Ophiuchi 1 & 2	17 4	26 18 S	42 41	*sp* *nf*	5.546	
	——— 1 & 3			19 5	*np*	3 0.735	
244	α Herculis	17 6	14 36 N	29 33	*sf*	5.286	Unchanged.
245	39 ο Ophiuchi	17 7	24 5 S	85 47	*np*	12.512	Unchanged in Pos.
*246	δ Herculis	17 8	25 3 N	82 10	*sf*	0 28.869	Altered + 9° 42′ in Pos., and — 5″.349 in Dist.
247	ν Serp. Ophiuchi	17 11	12 39 S	59 13	*nf*	50.213	
248	ϱ Herculis	17 17	37 19 N	37 53	*np*	4.463	Position changed 7° 32′ Dist. + 1″.494.
249	53 Ophiuchi	17 26	9 43 N	78 41	*sp*	41.662	Unchanged in Position.
250	ν Draconis	17 29	55 19 N	42 23	*np* *sf*	1 2.242	Unchanged in Position.
251	Ophiuchi 254 1 & 2	17 30	2 8 N	58 7	*np*	1 51.213	
	——— 1 & 3	—	———	68 37	*nf*	2 18.090	
	——— 2 & 3	—	———	27 23	*nf*	1 54.310	
252	61 Ophiuchi	17 36	2 41 N	3 33	*sf*	20.520	Unchanged.
253	H. C. 348	17 36	13 14 S	66 48	*sp*	15.869	
254	ψ Draconis	17 45	72 14 N	75 14	*nf*	31.777	
255	67 Ophiuchi	17 52	2 57 N	53 4	*sf*	55.228	
256	H. C. 168	17 52	30 5 N	8 53	*np*	20.181	
257	95 Herculis	17 54	21 36 N	8 8	*nf*	6.623	
*258	70 *p* Ophiuchi	17 56	2 33 N	64 48	*sf*	4.266 Ep. 1822.42	Binary. Mean Annual motion — 6°.811 not uniform.
259	H. C. 362	17 57	64 9 N	15 27	*np*	21.093	
260	III. 56	17 57	12 0 N	12 21	*sp*	6.748	Scarcely changed.
261	73 *q* Ophiuchi	18 1	3 57 N	12 23	*ns*	1.989	Distance increased.
262	100 Herculis	18 1	26 5 N	87 35	*nf* *sp*	14.281	
263	Anonyma	18 7	18 49 S	77 52	*nf*	54.302	
264	Struve 569	18 8	18 38 S	37 22	*nf*	16.419	
265	I. 86	18 12	25 28 N	82 48	*np*	4.587	
266	H. C. 298	18 12	15 10 S	51 37	*sp* *nf*	14.091	

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	′ ″	° ′		′ ″	
267	40 Ceph. or Drac.	18 13	71 58 N	34 56	*sp*	21.362	Unchanged.
*268	59 *d* Serpentis	18 18	0 5 N	48 5	*np*	4.151	BINARY? Orbit in a plane nearly passing through the eye.
				Epoch	—	Ep. 1822.95	
*269	39 Draconis 1 & 2	18 21	58 42 N	86 5	*nf*	3 599	BINARY? Mean motion —0°.205.
	——— 1 & 3			68 5	*nf*	1 30 201	
270	H. C. 300	18 30	52 13 N	4 34	*np*	26.226	
271	H. C. 291	18 30	41 7 N	70 15::	*np*	6.000	
*272	κ Lyræ	18 31	38 37 N	42 7	*sf*	42.108	Changed both in Angle and Dist. by proper motions.
						Ep. 1822.87	
273	IV. 94	18 36	34 32 N	5 51	*nf*	24.630	
274	H. C. 296	18 36	0 39 S	66 18	*np*	5.306	
275	5 Aquilæ	18 37	1 9 S	32 42	*sf*	14.468	
*276	4, ε Lyræ	18 38	39 27 N	64 7	*nf*	4.010	BINARY? Mean motion —0°.19 per ann.
277	Debilissima inter ε and 5 Lyræ	18 38	39 27 N	50 ±		53 ±	
278	5 Lyræ	18 38	39 27 N	69 56	*np* *sf*	3.801	BINARY. Mean motion —0°.325.
279	ζ Lyræ	18 38	37 25 N	59 51	*sf*	44.240	
280	H. C. 170	18 42	10 47 N	85 28	*sp*	4.794	
281	β Lyræ	18 43	33 10 N	60 1	*sf*	45.778	
282	H. C. 19?	18 48	33 46 N	80 15	*np*	46.035	
283	θ Serpentis	18 48	3 58 N	14 26	*sf*	21.679	
284	ο Draconis	18 49	59 10 N	79 11	*np*	29.949	
285	Piazzi XVIII. 274	18 54	0 58 S	58 49	*sf*	26 019	
286	15 Aquilæ	18 56	4 17 S	63 16	*sp*	35.619	
287	Anonyma	18 58	6 53 N	67 46	*np*	8.521	
288	H. C 19? Str. 609	19 2	34 18 N	10 27	*sp*	17.124	
289	Prec. η Lyræ	19 6	38 44 N	32 18	*nf*	40.391	
290	Cygni 6	19 7	49 31 N	44 6	*sp*	10.576	
291	η Lyræ	19 8	38 51 N	5 58	*nf*	29.336	
292	θ Lyræ	19 10	37 49 N	17 52	*nf*	1 41.665	
293	H. C. 90, STR. 616	19 11	5 16 N	87 46	*np*	31.420	
294	H. C. 111, STR. 619	19 18	9 54 S	35 49	*sf*	11.314	
295	III. 57	19 19	20 46 N	63 26	*np* *sf*	6.938	Changed + 4° 50′ in Position, unchanged in Dist.
296	II. 69	19 21	36 10 N	23 16	*nf* *sp*	7.430	Changed + 5° 56′ in Pos.
297	β Cygni	19 24	27 35 N	35 15	*nf*	34.383	Unchanged.
298	Aquilæ 151	19 34	8 43 S	56 34	*sf*	1 37.112	
299	16 Cygni	19 37	50 6 N	45 13	*np* *sf*	37.504	Probably unchanged.
300	STRUVE 634	19 38	33 14 N	56 15	*np*	......	
301	Anon. nova 1 & 2	19 38	33 14 N	15 56	*nf*	23.467	
	——— 1 & 3			57 35	*sf*		
302	STRUVE, 635	19 38	77 52 N	68 30	*nf*	11.936	
303	STRU. 336 1 & 2	19 38	35 39 N	36 52	*sf*	15.133	
	——— 1 & 3			18 5	*sp*	2 19.183	
304	δ Cygni	19 39	44 42 N	———	—	———	Single.
305	χ Cygni	19 40	33 20 N	16 42	*nf*	25.503	Probably unchanged.
*306	π Aquilæ	19 41	11 22 N	45 27	*sf*	1.957	BINARY. Mean motion + 0°.314.
*307	ζ Sagittæ	19 41	18 43 N	44 32	*np*	8.818	BINARY? Mean motion.

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″	
308	α Aquilæ	19 42	8 24 N	55 48	np	2 33.375	Common proper motion.
309	57 Aquilæ	19 45	8 42 S	81 8	sf	36.158	
310	Struve, 647	19 45	19 5 N	58 30	np sf	42.427	
311	ε Draconis	19 49	69 48 N	85 21	np	2.590	Probably unchanged.
312	ψ Cygni	19 51	51 58 N	88 0	sp	4.321	Unchanged in Position.
313	I. 96 1 and 2	19 56	35 32 N	86 52	sf	2.467	Hardly changed in Position.
	—— 1 and 3			59 29	np	41.335	
314	H.C. 16, Stru. 658	20 0	35 18 N	30 58	np	10.793	
	idem 1 and 3			61 48	nf	36.523	
315	Nova. H. and I.	20 0	35 17 N	33 26	sp	20.164	
316	Nova. H and I.	20 0	35 7 N	54 3	np	1 9.479	
317	II. 96	20 3	0 19 N	61 48	sp	4.100	Perhaps a slow change in Position.
318	H.C. 182. Str. 665	20 6	4 2 S	36 33	sp	14.491	
319	α Capricorni	20 8	13 3 S	21 26	up	6 12.999	
320	I. 95	20 14	54 48 N	69 39	np	3.980	
*321	κ Cephei	20 15	77 10 N	38 4	sf	8.138	Distance much increased 3″
322	ρ Capricorni VI. 29	20 19	18 24 S	60 45	sf	3 58.021	
323	ρ Capricorni II. 51	20 20	18 24 S	87 17	sf	4.026	
324	ο 12 Capricorni	20 20	19 10 S	30 17	sp	22.060	
325	H. C. 109; Str. 680	20 23	10 35 N	14 22	sp	15.484	
326	Anonyma (Nova)	20 32	38 5 N	88 43	np	9.478	
327	γ Delphini 1 & 2	20 38	15 29 N	3 43	np	12.317	
	———— 1 & 3			78 35	nf	2 20 857	
328	ε Equiulei	20 50	3 36 N	10 39	nf	12.374	
*329	61 Cygni	20 59	37 52 N	5 19	nf	15.425 Ep. 1822.29	Binary. Great proper motion = 5″ 38 in R. A. and 3″.30 in declin. Mean angular motion = + 0°730.
330	β Cephei	21 26	69 46 N	19 35	sp	13.163	
331	3 Pegasi	21 28	5 48 N	78 58	np	39.525	Perhaps a very slow change of Position.
332	μ Cygni 1 and 2	21 36	27 56 N	23 4	sf	5.744	
	idem 1 and 3			28 43	nf	3 37.401	
333	74 ? of the 145	21 46	18 55 N	20 15	sf	22.052	
334	57 of the 145	21 46	54 59 N	76 11	sp	20.308	
335	III. 74	21 49	5 6 N	33 29	nf	10.093	Diminished in Distance.
336	Nova Prope III. 74	21 49	5 6 N	44 0	sp	1 45.858	
337	ξ Cephei	21 58	63 45 N	23 15	np	5.817	
338	Pia. XXII. 11. 12.	22 3	58 25 N	45 13	np	22.094	
339	56 of the 145	22 4	21 53 S	30 42	sf	5.170	
340	120 of the 145	22 7	69 17 N	15 31	sp	14.839	
341	1 Lacertæ	22 8	36 51 N	78 43	sp	15.619	
342	33 Pegasi	22 15	19 56 N	75 45	np	56.045	
343	Struve 751	22 16	65 50 N	2 37	sf	3.723	
344	64 of the 145	22 17	44 27 N	0 5	nf	4.238	
345	53 Aquarii	22 17	17 39 S	3 7	np	10.032	
*346	ζ Aquarii	22 20	0 57 S	89 29	sp	4.989	Binary. Mean annual motion — 0°.4484.
347	δ Cephei	22 23	57 30 N	78 44	sp	41.612	
348	8 Lacertæ 1 and 2	22 28	38 42 N	85 39	sp	22.674	
	idem 1 and 3			55 15	sf	1 22.520	
349	Aquarii 213	22 34	9 11 S	51 19	np	3.398	
350	Aquarii 231 1 & 2	22 39	5 9 S	24 24	sp	4.319	
	idem 1 & 3			72 33	sf	57.381	

No.	Star's Name	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″	
351	16 Lacertæ	22 48	40 39 N	44 41	*nf*	1 4.541	
352	Piazzi XII. 306	22 59	31 51 N	58 19	*sf*	8.716	
353	H. C. 242; Str. 773	23 2	46 59 N	17 0	*sp*	14.709	
354	94 Aquarii	23 10	14 26 S	76 41	*np*	14.998	
355	Anonyma	23 22	57 32 N	0 0	*p*	1 13.953	
356	107 Aquarii	23 37	19 41 N	53 30	*sf*	5.056	
357	Androm. 281 1 & 2	23 43	36 54 N	0 17	{ *sp* *nf* }	5.011	
	idem 1 & 3			45 25	*sf*	3 45.941	
358		23 46	30 52 N	59 11	*np*	41.297	
359	σ Cassiopeiæ	23 50	54 45 N	57 41	*np*	2.924	Doubt. whether changed or not.
360	Andromedæ 37	23 51	32 43 N	81 38	*sp*	5.263	

Supplementary Stars; mostly imperfect measures.

361	Ceti, 27	0 2	4 4 S	18 45	*np*	9.00 0	Distance estimated.
362	Mira (*o*) Ceti	2 10	3 48 S	1 25	*nf*	—	Chan. both in pos. & dis.
363	7 Tauri	3 24	23 51 N	33 54	*nf*	21.005	Distance estimated.
364	μ Persei	4 2	47 57 N	38 18	*sp*	1 31.559	
365	III. 65	4 24	40 43 N	59 0	*nf*	12.468	
366	41 Aurigæ	5 58	48 44 N	83 16	*np*	8.809	
367	Telescopii 15	6 26	41 40 N	43 0	*sf*	28.064	
368	63 *p*, Geminorum	7 17	21 49 N	56 16	*np*		
369	*nf.* 40 Lyncis	9 10	35 9 N	57 15	*nf*	3 22.287	
370	21 Ur. Maj. 1 & 2	9 13	54 47 N	39 2	*np*	6.474	
	idem 1 & 3			74 36	*np*	4 45.000	
371	23 *h* Ursæ Maj.	9 17	63 51 N	0 33	*np*	27.332	
372	104 of the 145	11 7	15 22 S	36 ±	*np*	20 ±	
373	Camelop. 212	12 48	84 24 N	57 0	*np*	22.069	
374	*o* 84 Virginis	13 34	4 27 N	40 0	*sp*	3.918	Binary ? Mean annual motion — 0°.288.
375	18 Libræ	14 49	10 24 S	54 8	*nf*	26.614	
376	24 Libræ 1 and 2	15 2	19 6 S	21 39	*sf*	50.629	
	——— 1 and 3			21 39	*sf* ?	—	1, 2 and 3 are precisely in a line.
377	Struve 489	15 27	27 20 N	30 20	*sp*	5.941	
378	19 Ophiuchi	16 38	2 24 N	10 ±	*sf*	10....15	
379	40 of the 145	17 52	22 58 S	61 45	*sp*	10.952	
380	σ Capricorni	20 9	19 40 S	86 27	*sf*	53.704	

Art. XI.—*Notice of an Earthquake felt at Sea, in February* 1825. Communicated by a Correspondent.

There are few observations of greater importance, in reference to the theory of earthquakes, than the determination of the exact time when they are felt at sea. The place where they have their origin,—the velocity with which they are propagated,—and their probable depth beneath the surface, may be inferred from a series of accurate observation on the effects which they produce, and the time when they are felt at different points on the earth's surface.

The earthquake which was experienced at Lisbon, on the 2d February 1816, at five minutes past midnight, was felt at sea by the Portuguese vessel, the Marquis de Angeja, bound from Bengal to Lisbon, at the distance of 270 leagues from that city; and it was also experienced by another vessel, bound from Brazil to Portugal, at the distance of 120 leagues.

On the 4th of April 1812, the vessels on the coast of the Caraccas trembled, during the heavy shock of an earthquake, as if they had been on a reef of rocks.

In the earthquake which took place at Chili, on the 19th November 1822, the effect on the ships in the bay was such, as if the chain-cable had run out in an instant.

On the 10th February 1823, the East India Company's ship Winchelsea, in east long. 85° 33′, and north lat. 52°, experienced the effects of an earthquake. When the vessel was some hundred miles from land, and out of soundings, a tremulous motion was felt, as if it were passing over a coral rock, and this was accompanied with a loud rumbling noise, both of which continued for two or three minutes,

This effect bears a close resemblance to that which is described in the following extract of a letter from on board the Recovery of ——— in a voyage from Madeira to Honduras, in February 1825.

" In running through among the islands, we were in dread of every schooner-rigged vessel we saw, as these seas swarm with pirates. However, nothing worthy of note occurred till off the island of Ruatan. Between seven and eight o'clock at night, being quite dark, we were all alarmed by a rumbling noise, as if the vessel had been running over a reef of rocks. Every one rushed upon deck, and all cast a wishful look over the side of the vessel, expecting every moment to see her go down. The pumps were sounded, but no water was in the well. It was then concluded, that it must have been a large log of timber which the vessel had come in contact with; but, on arriving in Belize, we ascertained that it was the effect of a smart shock of an earthquake, which had been experienced there at the very time we felt the concussion."

ART. XII.—*Remarks on the Defoliation of Trees.* * By the Rev. JOHN FLEMING, D. D. F. R. S. E., &c. Communicated by the Author.

THE arrangements which prevail in the vegetable kingdom regarding the "DURATION of LEAVES" do not appear to have been studied with so much care as many other subjects connected with the economy of plants. Aristotle knew that some leaves were deciduous, others not. Cæsalpinus states, that many trees lose their leaves in autumn when their fruits are perfected, and their buds hardened, while such as retain the fruit long, keep also their leaves, even till a new crop is produced, and longer, as in the fir, the arbutus, and the bay. Linnæus distributes leaves, in reference to their duration, into *decidua, caduca, persistentia, perennia, sempervirentia.* Sir James Edward Smith simplifies this arrangement of Linnæus, and considers leaves as to their age as of two kinds. *Sempervirens*, evergreen, permanent through one, two, or more winters, so that the branches are never stripped, as the ivy, the fir, the cherry laurel, and the bay. *Deciduum*, deciduous, falling off at the approach of winter, as in most European trees and shrubs.

It is much to be regretted that the learned botanist last mentioned should have passed over this division of the character of plants without improving the classification of his master, or expressing himself more consistently with the phenomena of nature. A little attention to the subject will convince us, that *winter* is not the proximate cause of the falling of the leaf in many trees; that many leaves fall off long before the approach of winter, and that others, which have withstood its attacks, perish with the warmth of spring. The want of attention to these circumstances, so conspicuous among our systematical writers, and which I have witnessed among well informed practical botanists, may serve as an apology for the following remarks. Perhaps they possess no novelty to those who are acquainted with the labours of the more recent physiologists. To others, however, they may appear to have a little interest.

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* Read before the Royal Society of Edinburgh, December 5th 1825.

Trees, in reference to the duration of their leaves, appear capable of division into three classes. In the first class may be included those in which the leaves cease to exercise their functions whenever the bud has been perfected. In the second, the leaves continue to exercise their functions until new ones are produced in the following season. In the third class, the leaves continue to exercise their functions for several years.

In trees of the first class the leaf may, with propriety, be termed "*Folium deciduum.*" Its principal function appears to be connected with the ripening of the bud, and, when this object is accomplished, the leaf changes colour and dies. The falling of such leaves takes place, as, indeed, in all other cases, in the order in which they were evolved. Hence by midsummer we witness, in willows, for example, a considerable portion of the lower part of the shoot naked, its leaves having fallen, while towards the extremity its foliage is fresh and increasing in quantity.

In those trees in which two evolutions of buds take place in the course of the season, as in the beech, the leaves formed on the spring shoot change their colour and die sooner than those evolved at a later period on the summer shoot.

In those trees which seem to lose all their leaves suddenly, as the ash, the same order of defoliation actually prevails. The first evolved leaves of spring have perished, by degrees, in the course of the summer. Those with which the tree is clothed at the end of the season, are connected with the terminal buds, which, by becoming perfect about the same time, permit the leaves connected with them to fall off in rapid succession.

The leaves, in some cases, after they have ceased to exercise their functions, continue attached until the following spring, as the beech in hedges. When this plant, however, is not under the influence of the shears, the leaves fall off in the usual manner. The cause of this want of resemblance between individuals of the same species, may be found in an examination of the different circumstances in which they are placed. When the beech grows exposed to free air and sunshine, the buds attain their true size, the leaves execute regularly all their functions, and drop off when they cease to act their part in the economy of the plant. But when the beech is trained in a hedge, it is too much shaded, the buds seldom attain their true size, and the leaf is frequently destroyed by cold, previous to the end which it is destined to serve having been accomplished.

In some cases, leaves, which naturally would fall off in autumn, continue, when the plant is subjected to the shears, to outlive the winter,—as the privet. The leaves, under such circumstances, may be said, in the language of farmers, to be "kept back," and to be capable of resisting the cold, while useful to the economy of the plant. Many analogous examples occur among herbaceous plants.

In the trees with deciduous leaves, it is probable, that, during the period of their nakedness, the bark may be viewed as the aerating organ, destined to effect the escape of the superfluous carbon from the system. During this period, they may be viewed as resembling "*plantæ aphyllæ.*" The bark, indeed, of the young shoots of several trees and shrubs, as the common broom, is so very like, in colour and texture, to the leaves, as to render it, in all probability, fit to supply their place for a time.

In trees of the second class, the leaf may be termed "*folium annuum.*" It exercises its functions until a new set of leaves be produced, and is then cast off in the ordinary order of seniority. Many of our most ornamental evergreens are of this description, as the bay, laurel, ivy and holly. These are termed evergreens, because the plant is never left naked, and the leaves of this year exercise their functions, and preserve their colour, until the shoots of the following season have acquired their clothing. The leaves of the plants of this class, appear, therefore, to exercise a greater influence, in the economy of vegetation, than in those connected with the first. Here the plant requires the aid of leaves at all times, no other organs, in ordinary cases, appearing to be capable of exercising their functions, or acting as a substitute. Do these annual leaves exercise a greater variety of functions than the deciduous leaves? Or does the bark of a tree, with annual leaves, exercise fewer functions, than the same organ in trees with deciduous leaves?

When growing too much in the shade, or when subject to the influence of the shears, annual leaves may have the period of their life prolonged, so as to exercise their functions after the new shoots have evolved their leaves.

In trees of the third class, the leaf may be termed "*folium perenne.*" Its duration is not influenced, directly, by the perfection of the bud, nor the new supply of leaves during the following season. The leaves of two or more seasons, exercise, in trees of this class, their functions at the same time, and appear to be requisite for the prosperity of the stem. Our ordinary evergreen firs furnish very obvious examples of this persistent leafing. In trees of this description, the leaves seem to exercise functions even of a higher order, and continue to exercise these longer than in those of the two preceding groups. The tree here requires the leaves, not for a few months, or until new leaves be produced, but *leaves of different ages,*—two, three, or more years old.

In the trees of this class there is less regularity in the falling of the leaf, as to season, than in the two preceding ones. Few of the old leaves drop off, when the tree produces the shoots, and new leaves in spring. A greater number seem to perish about midsummer, and again on the approach of winter.

The succession in the fall of the leaves is, as in the other classes, in the order of their seniority on the same stem and branch. But sometimes only a portion (the first formed ones) of the leaves of one season drop off, the remaining portion continuing to exercise their functions during a longer period. On the same tree may even be observed leaves of three, four, five, six, or even seven years of age; and while a part of those three years old may be changing colour and dropping off, those seven years old may remain green and fresh. Those leaves which are placed in the shade live longest; yet even in this respect I have witnessed many anomalies.

These remarks apply to the duration of the leaves of the trees of this country. The influence of climate on the duration of leaves has often been stated as considerable, and capable of converting deciduous leaved trees into evergreens, or the reverse. In cold climates, vegetation is interrupted by winter. In warm climates, plants experience not such interruptions. It may therefore be asked, Will a warm climate alter the character of the leaves of certain trees, so far as to change a deciduous into an annual or perennial leaf? Or is there a source of deception arising from the *continued vegetation* exhibiting trees as evergreens, though in fact their leaves be deciduous? An affirmative answer to the latter question, will probably be found an expression of the truth.

MANSE OF FLISK,
4th November 1825.

ART. XIII.—*On the Habits and Food of the Stickleback.* From a Correspondent.

IN Volume III. of the *Journal of Science*, p. 74, Mr Ramage of Aberdeen has given an account of a stickleback, which was taken alive with a leech "fully as large as the stickleback itself" in its intestines. The leech, "in a few minutes," was protruded by the anal opening, and crawled on Mr Ramage's hand; but, "the stickleback died almost immediately after giving birth to this strange offspring, and the leech survived it only about twelve hours." The appearance and motion of the leech, it is added, "corresponded, in every respect, with those of the common leech, excepting that the colour was entirely white." The theory offered to account for this fact is, "that the leech was lodged in the small gut, and most probably had been swallowed by the stickleback for food when of a small size, and had grown to its present dimensions in the stickleback's belly, after having been swallowed." The leech and the stickleback were transmitted to the museum of the Royal Society of Edinburgh.

Upon this detail, it may be remarked, that the circumstance of a stickleback swallowing a leech is no uncommon one, for young leeches seem to be the favourite food of the three-spined stickleback, *Gasterosteus aculeatus, Lin.* My boys had several sticklebacks alive for some months during the last summer, and fed them at first with earth-worms, maggots, and occasionally the small house-fly, which, however, did not seem to be relished. Afterwards, at my suggestion, young leeches were brought from the ditch in which the sticklebacks were caught, as being more likely, with the larvæ of aquatic insects, to form part of their natural supply, than the food which was submitted to their choice. These were found to be preferred to all other aliment, and for a month at least they had scarcely any other food. The species of leeches procured were the *Hirudo sanguisuga*, the *H. vulgaris*, and the *H. complanata.* To ascertain what size of leech would be swallowed, a male stickleback, of about an inch and three quarters in length was selected and put in a large tumbler on a mantel-piece, where its mode of attacking and devouring its prey formed a source of amusement to the children for weeks.

On putting the leeches into the water, the stickleback darted round the tumbler with lively motions, till it found a leech detached, and in a proper situation for being seized. When the leech was very small, say about half an inch in length, it was often swallowed at once, before it reached the bottom of the vessel; but when a larger one, about an inch or an inch and a-half in length in its expanded state, was put in, and had fastened itself by its mouth to the glass, the efforts of the stickleback to seize and tear it from its hold were incessant, and never failed to succeed. It darted at the loose extremity, or, when both ends were fastened, at the curve in its middle, seized it in its mouth, rose to near the surface, and after a hearty shake (such as a dog would give a rat) let it drop. The leech, who evidently wished to avoid its enemy, upon its release again attached itself by its mouth to the glass; but again and again the attack was repeated, till the poor leech became exhausted, and ceased to attempt holding itself by its disc. The stickleback then seized it by the head in a proper position for swallowing, and after a few gulps the leech disappeared. The *H. complanata*, being of an ovate form, and having a hard skin, was not attacked, unless when very young, and scarcely two or three lines in length;* and leeches of the other species, when pretty well grown, or longer than himself when expanded, were killed in the manner above mentioned, but not swallowed.

In one of his attempts to seize a leech, the stickleback, having got it by the tail, the animal curled back, and fixed its disc upon his snout. The efforts of the stickleback to rid himself of this incumbrance were amusing. He let go his hold of the leech, which then hung over his mouth, and darting to the bottom and sides of the glass with all his strength, endeavoured to rub off this tantalizing morsel. This lasted for nearly a minute, when at last he got rid of the leech by rubbing his back upon the bottom of the vessel. The leech, perfectly aware of the company he was in, no sooner loosed his hold, than he attempted to wriggle away from his devourer; but before he had reached midway up the tumbler, the stickleback had turned, and finished the contest by swallowing him up.

This voracious little fish not only preys upon the young of the leech, but sometimes devours the fry of its own species. In two or three instances, when leeches had not been procured, a young stickleback, about half an inch long, was dropped into the glass, and instantly swallowed. On other occasions, when some of a larger size were put in along with him, he contented himself with killing them. Perhaps the spines of these larger fish, which are erected when in danger, and upon

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* It may be mentioned, as a curious instance of the wonderful arrangements of Nature in securing the continuance of species, that the young of the H. complanata, which I have generally found attached to aquatic plants, were, in one instance which fell under my notice, affixed to the under surface of the parent leech. This animal which, unlike most of its congeners, never swims, had fastened itself to the side of the glass, and three young ones, about a line in diameter, were thus exhibited to view in a most interesting light for an animal so low in the scale of existence. Thus protected, there was nothing to fear from the attacks of the stickleback or other enemies. They moved occasionally on the disc of the mother, and, it is conjectured, might remain in that situation, until they had attained such a size as to render further care on the part of the parent unnecessary. To convince myself that this protection was requisite, I detached one with the point of a knife, which was instantly devoured by the stickleback. The young H. complanata, from its transparency, forms a beautiful object for the microscope.

the death of the animal, were too strong for the texture of his throat. In the ponds and ditches where sticklebacks occur, the young fry will always be found to seek protection in the shallowest parts of the water from the attacks of their full-grown enemies. Our stickleback, at another time, when two minnows, much larger than himself, had been put in to keep him company, attacked them with fury. They fled from his bite in evident dismay; and one of them, finding no other means of escape, fairly leaped out of the vessel. Even a female of his own species was not better treated by this ungallant tyrant, who allowed no stranger to enter his domain with impunity.

The young of the leech being thus, it is conceived, a frequent food of the stickleback, it is not marvellous that such a little devourer should occasionally gorge himself by swallowing a leech of large dimensions for the capacity of his stomach. That this was the case of Mr Ramage's stickleback, seems evident from the situation in which it was found, near the surface of the water, and the facility with which it was caught. Leeches possess the power of contracting and expanding themselves to a great degree; and it is not in the least surprising, that, when relased from pressure by the death of the stickleback, and swelled by liquid, Mr Ramage's leech should appear to be larger than the animal that had swallowed it. That it could have lived in the stomach of the stickleback from the period when it was very young till it attained the size mentioned by Mr Ramage, is very improbable. From the circumstance of sticklebacks feeding on leeches with avidity, it may be inferred, that nature has provided them with the means of digesting this species of aliment; and the fact of their being fed for weeks on leeches alone, and the usual processes of digestion and excretion going on, raises this inference to absolute certainty. That an animal so tenacious of life as the leech, should, shortly after being swallowed, be found alive in the intestines of the stickleback, does not, therefore, appear wonderful; and that the stickleback should have died when "a few minutes" out of the water, and in the hands of a child, is still less so. The wonder would have been, had it continued to exist in an element so foreign to its nature, independent altogether of the danger of leech-birth in the hands of such assistants.

ART. XIV.—*On the Improvement of the Pipes of Organs.*[*]

By M. FELIX SAVART.

As the construction of organs has been hitherto abandoned to a blind routine, I cannot conclude these researches better than by pointing out some of their applications to the improvement of organ pipes, whether they are open at both ends, or open at one end and shut at the other.

It cannot be doubted, that much advantage is derived from employing only pipes of similar forms; for when we have once determined the proper dimensions of a tube for producing the best possible sound, it will be sufficient to construct the rest according to the law, that the number of vibrations in a column of air are reciprocally proportional to their linear dimensions, provided that every thing being proportional in these pipes, the intensity of the sound and the other qualities, such as the loudness, the clearness, and the timbre, are in the most suitable proportions. It is well known that ordinary organs are far from presenting this result, and that the grave sounds in them are too weak in relation to the sharp ones. In addition to this, the common pipes get out of tune with the greatest facility, from variations of temperature, and particularly from the derangement of the bottom, which is a moveable piston. Pipes of a similar form are free from this inconvenience; both because their dimensions may be determined with the greatest precision, and because the ratios between the numbers of vibrations which they produce cannot be influenced by variations of temperature, every thing going on, in each of them, in an analagous and proportional manner.

Since the direction of the port-vent and of the bevel have an effect on the sound yielded by a pipe, the true length of a column of air in vibration is not always the same as that of the

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[*] This paper is a translation and abstract of the practical part of M. Savart's *Nouvelles Recherches sur les Vibrations de l'Air,* in the *Ann. de Chim.* Aout 1825. Tom. xxix. p. 419.

side which carries the bevel. Nay, it may differ very much from this. If, for example, we take a prismatic square tube in which a piston moves, the length of the column will be the distance of the piston from the base of the tube, provided this distance is greater than the side of the base of the prism of air; but if it becomes less, the true length of the column of air is the small side of the base of the prism.

In general, when we cause air to sound in any vessel, the depth of the vessel ought to be taken as the length of the column of air, when its diameter is smaller than its depth, but when this diameter is greater than its own length, it becomes that of the column of air. If, for example, we place a small thin plate of wood or white-iron, or even the blade of a knife, on the orifice of a vessel with a narrow neck like a bottle, or a caraffe, and if we blow the air against the edge of the plate, either with a small port-vent, or with the mouth itself, we shall hear a sound which is in general very grave; but we must not suppose that the diameter of these vessels should be taken for the length of the column of air, this length being equal to the height of the vessel. With respect to the graveness of the sound, it depends on the length of the column of air, on its diameter, and on the small extent of the embouchure.

Cubical pipes emit sounds extremely pure, and of a particular timbre: They speak with a facility and a promptitude quite astonishing, and may be employed in the construction of organs. They will also have the advantage of occupying little room, at least for the highest octaves. The sound *u* is given by a cube oneof whose sides is from 53 to 54 lines, whilst the *bourdon*, which gives the same sound, is commonly from 10 to 11 inches long, and having one of its sides from 2 to 2½ inches. Hence it may be seen, that the sound of a cube of air, made to vibrate by one of its edges, is much more grave than if it were made to vibrate throughout the whole extent of one of its faces; for a column of air 54 lines long, shut up at one end, and made to vibrate with a full orifice, will give the sound *fa*, which is an octave and a quarter more acute than the sound *ut*, which is yielded by a cube of 54 lines made to vibrate partially. Whence it is easy to conclude, that we may pass from the sound of a cube of air to that of a very small pipe of the same length as the side of the cube, by a series of sounds graduated as we desire, and which will be given by pipes of the same length, but whose magnitude gradually decreases. I have verified this result with ten prismatic square pipes, three inches long, whose sizes were such that they described diatonically an octave and a half, commencing with the cube which gave the sound *sol*$^{b}_{3}$, and terminating with the sound *si*$^{b}_{4}$, which was emitted by the smallest pipe.

We may also save room in organs by taking advantage of the fact, that prismatic square tubes may be indefinitely diminished in thickness, by the approximation of their sides. It does not appear to me that the sound undergoes any sensible alteration by diminishing their thickness one-half, and even two-thirds.

There is some reason for thinking that we do not obtain the best possible result by placing the embouchure at one of the extremities of the pipe, as is usually done. Nay, there might even be some advantage in placing it in the middle of its length. I have constructed several pipes in this way, and they yielded a sound of a very fine quality, whether they were open or shut at both ends. I have observed also, that in placing the opening on the side, and at one end, as in flutes, the sound has a very agreeable timbre, which organ pipes seldom possess.

We may likewise construct flat pipes (made to vibrate by their *tranche*) of an infinity of powers, cylindrical, triangular, and elliptical; and I am convinced, by experiment, that we can obtain from them very fine sounds. The simple law of the number of vibrations for pipes of a similar form, allows us to determine, with facility, the dimensions which each pipe requires to give out any sound of the gamut.

Very short pipes, in which all the plates of air perpendicular to the embouchure are not actuated by the same kind of motion, do not appear to be susceptible of yielding agreeable sounds. Spheres of air, for example, yield sounds very dull, and approaching to a noise, without respect to the impression which they make upon the ear. The same thing takes place with cubes, having their embouchure in the middle of one of their faces. This quality of sound may depend upon this, that the number of harmonics co-existing with the principal sound are very inconsiderable. It is almost impossible, indeed, to obtain any of them in cubes. In spheres, I have found that, the first sound being called ut_1, the second was ut_4, the third sol_4 and the fourth ut_5; but, from this great interval between the first and the second harmonic, it is to be presumed, that I have not employed the proper means for obtaining all the series. I may besides remark, that the pipes which I employed had their embouchure only a small number of degrees of the circumference of one of their great circles, because I had it in view only to determine the law of the numbers of vibrations in spherical masses of air. It might have happened that the series of harmonics would have been different, and more easily obtained, had the embouchure been more extended; and perhaps, also, the sounds would have been stronger and more agreeable. The sound ut_3 is given by a sphere of air about 4½ inches in diameter.

In the case of curved tubes, it is important to remark, that the material of which the sides are formed has a notable influence on the qualities of the sound, and on the number of vibrations. The same is true of the thickness of the sides, and, consequently, we must pay attention to this circumstance; and in organ pipes of similar form, we must make the thickness proportional to the linear dimensions of the masses of air.

The laws of the number of vibrations for pipes of similar form, and for plates of air, conjointly with the law of Bernouilli * for pipes made to vibrate with a full orifice, a law which is sufficiently exact for columns of air of a small diameter, embrace very nearly all the cases which can occur in the construction of organ pipes, whether closed or open. Notwithstanding this, I shall point out a very simple method for determining immediately the dimensions of all pipes of similar form, which are susceptible of giving the same sound, and of which there are an infinity.

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* Namely, that the numbers of oscillations of columns of air, which sound in pipes open at both ends, or shut at one end and open at the other, are reciprocally proportional to the lengths of those columns, provided that they vibrate with a full orifice.

Suppose, for example, that we have a certain number of closed prismatic square pipes which give the same sound. Let us then take the ordinate length for the O Y, in Plate I. Fig. 7, and the sides of the base for the abscissa O X, and refer them to two rectangular axes. It is clear that we may, by this procedure, construct a curve which will give the dimensions of all the pipes intermediate to those which experience has determined. The curve represented in the figure is constructed in this way. The ordinate O Y is the length of a pipe infinitely small, which would give the sound *sol* $^{b}_{3}$; and the abscissa O X, of the same length as O Y, represents the side of a square plate of air infinitely small, made to vibrate in all the extent of this side, which would, consequently, give the same sound *sol* $^{b}_{3}$. All the other parts of the curve have been obtained by experiment.

It is unnecessary to remark, that this curve will be the same in all sounds, for which we should undertake to construct it; and it follows from this, that the number of vibrations are reciprocally proportional to the linear dimensions, in pipes of similar form.

I shall now conclude these observations with a few remarks on the German top, an instrument which is at present unexplained. This top is a hollow sphere, perforated with a hole, whose edges are sharp; and, when a rapid rotatory motion is given it, a very pure sound is produced. The cause of this will be obvious, if we remark, that, in blowing against the sharp edge of the orifice of the sphere, either with a small port-vent, or with the mouth, it will yield the same sound as when it is in rotation. In the first case, it is the current of air which is driven against the edges of the orifice; and, in the other case, it is the sharp edges of the orifices which strike the external air, which comes to the same thing; and the fluid contained in the sphere, though it be carried by the motion of rotation, is not allowed to vibrate, as if this motion did not exist.

We may, therefore, by means of the law of the number of vibrations being reciprocal to the linear dimensions for pipes of a similar form, determine, *a priori*, the sound of one of these instruments, in the case where its cavity is exactly spherical.

Art. XV.—CONTRIBUTIONS TO POPULAR SCIENCE.

No. V. On the Invisibility of certain Colours to certain Eyes.

A variety of cases have been recorded, where persons with sound eyes, capable of performing all their ordinary functions, were incapable of distinguishing certain colours, and what is still more remarkable, this imperfection runs in particular families. Mr Huddart mentions the case of one Harris, a shoemaker at Maryport in Cumberland, who could only distinguish black and white, and he had two brothers almost equally defective, one of whom always mistook orange for green. Harris observed this defect when he was four years old, and, chiefly from his inability to distinguish cherries on a tree like his companions. He had two other brothers and sisters, who, as well as their parents, had no such defect. Another case of a Mr Scott is recorded in the *Philosophical Transactions*, in which full reds and full greens appeared alike, while yellows and dark blues were very easily distinguished. Mr Scott's father, his maternal uncle, one of his sisters, and her two sons, had all the same imperfection. Our celebrated chemist, Mr Dalton, cannot distinguish blue from pink by daylight; and in the solar spectrum the red is scarcely visible, the rest of it appearing to consist of two colours, yellow and blue. Dr Butters, in a letter addressed to the editor of this work, has described the case of Mr R. Tucker, son of Dr Tucker of Ashburton, who mistakes orange for green, like one of the Harrises. Like Mr Dalton, he could not distinguish blue from pink; but he always knew yellow. The colours in the spectrum he describes as follows:

1. Red mistaken for . . . . brown,
2. Orange . . . . . green,
3. Yellow, generally known, but sometimes taken for orange,
4. Green mistaken for . . . . orange,
5. Blue . . . . . pink,
6. Indigo . . . . . purple,
7. Violet . . . . . purple.

Mr Harvey has described, in a paper read before the Royal Society of Edinburgh, and which will soon be published, the case of a person now alive, and aged 60, who could distinguish with certainty only white, yellow, and grey. He could, however, distinguish blues when they were light. Dr Nichols has recorded a case where a person who was in the navy purchased a blue uniform coat and waistcoat, with *red* breeches to match the *blue*, and he has mentioned one case in which the imperfection is derived through the father, and another in which it descended from the mother.

In the case of a young man in the prime of life, with whom the writer of this article is acquainted, only two colours were perceived in Dr Wollaston's spectrum of five colours, viz. red, green, blue, and violet. The colours which he saw were *blue* and *orange* or *yellow*, as he did not distinguish these two from one another. When all the colours of the spectrum were absorbed by a reddish glass, excepting *red* and *dark green*, he saw only one colour, viz. yellow or orange. When the middle of the red space was absorbed by a blue glass, he saw the black line with what he called the *yellow* on each side of it. We are acquainted with another gentleman who has a similar imperfection.

In all the preceding cases there is one general fact, that *red light, and colours in which it forms an ingredient, are not distinguishable by those who possess the peculiarity in question.* Mr Dalton thinks it probable that the red light is, in these cases, absorbed by the vitreous humour, which he supposes may have a blue colour; but as this is a mere conjecture, which is not confirmed by the most minute examination of the eye, we cannot hold it as an explanation of the phenomena. Dr Young thinks it much more simple to suppose the absence or paralysis of those fibres of the retina which are calculated to perceive red; while Dr Brewster conceives that the eye is, in these cases, insensible to the colours at the one end of the spectrum, just as the ear of certain persons has been proved, by Dr Wollaston, to be insensible to sounds at one extremity of the scale of musical notes, while it is perfectly sensible to all other sounds.

If we suppose, what we think will ultimately be demonstrated, that the choroid coat is essential to vision, we may ascribe the loss of red light in certain eyes to the retina itself having a blue tint. If this should be the case, the light which falls upon the choroid coat will be deprived of its red rays, by the absorptive power of the blue retina, and consequently the impression conveyed back to the retina, by the choroid coat, will not contain that of red light.

No VI. Description of the Thaumatrope.

The Thaumatrope, (or the *wonder-turner*, from θαυμα a *wonder*, and τρεπο to turn,) a very ingenious philosophical toy, invented, we believe, by Dr Paris, is founded on the well-known optical principle, that an impression upon the retina continues for about the eighth part of a second after the object which produced it is withdrawn. The luminous rings formed by the whirling of a burning stick in the dark are well known, and Homer has availed himself of the same principle in his description of the lengthened shadow of the flying javelin.

The Thaumatrope consists of a number of circular pieces of card, about two and a half inches in diameter, which may be twirled round with great velocity by the application of the fingers to pieces of silk string attached to two opposite points of their circumference. On each side of the card is painted a part of a picture, so that if we could see both sides at once, the two parts of the picture would form a whole picture. For example, in Plate I. Fig. 8., we have shown two sides of a card, on one of which is a cage, and on the other a bird. If we now take hold of each of the silk strings A and B, between the fore-finger and thumb of each hand, and put it into a twirling motion, the bird and the cage will appear to the eye at the same moment, in consequence of the impression of each continuing on the retina for a short space of time. The following are some of the other devices on the cards of the thaumatrope:

A rose-tree, with a garden pot on the reverse.

A horse, with a man on the reverse.

A leafless branch, which becomes verdant on the twirling of the card.

A female in one dress on one side, and another dress on the other.

The body of a Turk, with his head on the reverse.

The Watchman's box on one side, and himself on the other.

Harlequin and Columbine on different sides, appear together by the revolution of the card.

A comic head on one side, which, on turning round, becomes invested with a wig.

A man sleeping, and awakened by being turned round.

The principle of the thaumatrope may be extended to many other devices. Parts of a sentence may be written on one side, and the rest of the sentence on the other; and we may even put halves of the letters or words on one side, and the other halves on the other side. This method of breaking down letters or words or sentences may be varied *ad infinitum*, and will furnish us with a variety of rotatory cyphers.

Those who have used the thaumatrope, must have been dissatisfied with the general effect of the two combined pictures. There is a hobbling motion arising from the imperfection of the method adopted to produce the rotatory motion, which entirely destroys the effect; and it is manifest, that the rotatory motion should be produced by quite different means. If strings are adopted, they ought to be attached to the circular pieces of card, so that the axis of rotation should be in the plane of the card; but a solid axis of rotation is decidedly preferable, and will produce much more pleasing combinations.

No. VII. Singular Optical Illusion seen through a Telescope.

If we direct a telescope to the surface of a distant field on which there are no objects, such as trees, houses, &c. and if the field of the telescope embraces nothing but the surface of the field, the eye will speedily recognize that the field is horizontal or slightly inclined to the horizon, from the perspective of the furrows or drills upon its surface, or even from its aërial perspective, provided the difference in the distances of the nearer and the remoter end is considerable, and the air sufficiently hazy.

The field, however, may be so situated, and have such an inclination, that, when seen through the telescope, it appears like a perpendicular or *vertical wall of earth.* This phenomenon we have often seen in directing a telescope to a field above Melrose Abbey on the northern acclivity of the north-west Eildon Hill. This field is capable of being ploughed in the direction of its greatest declivity; but when it is viewed through a telescope, the slope is such that the furrows do not appear to converge, and the eye cannot readily perceive any difference between the breadth of the furrows at the remote end of the field, and their breadth at the near end. The observer, therefore, immediately concludes that the field must be nearly a vertical plain rising in front of him. This deception is a very remarkable one, and produces a singular effect on the mind when the field is covered with a crop, and when crows, &c. light upon it. I have not yet observed the effect produced when it is in the act of being ploughed. It is very probable that the impossibility of ploughing a vertical plain may remove the deception, upon the principles which we have explained in a subsequent article.

No. VIII. Variation of the Optical Deception of Le Cat.

M. Le Cat has described in his *Traité des Sens*, p. 298, a curious optical deception, in which an erect object placed near a hole in a card next the eye, will appear to be on the other side, and also inverted and magnified. Let CD, Plate I, Fig. 9 be a card perforated with a small hole, E a white wall or window, D the eye of the observer, and *d* the head of a pin held near the eye, and also near the hole in the card. Under these circumstances the pin *d* will be seen at F inverted and magnified. The reason of this is, as M. Le Cat has observed, that the eye in this case sees only the shadow of the pin on the retina, and since the light which is stopped by the upper part of the pin or its head comes from the lower part of the white wall or window F, and that which is stopped by the lower end of the pin comes from the upper part of the wall or window E, the shadow must necessarily appear inverted with respect to the object.

The following variation of Le Cat's experiment has been described by the writer of this article. Take a common pin and hold it in any position near the eye, so that the observer sees reflected from its head a faint circle of light, then hold a second pin opposite to it exactly as in Fig. 9, and an inverted image of the one pin will be seen in the head of the other. If the head of the first pin is round and well polished, the inverted and magnified image of the other will be more distinct. In this form of the experiment a diverging pencil of light from the window or a candle replaces the diverging pencil in Fig. 15, which proceeds from the perforation in the card CB, and of course produces the same effect. The little round knob, by the pressure upon which the case of a watch is often opened, will answer better than the finest pin head.

No. IX. Optical Illusion in examining a Dioramic Picture.

In examining a dioramic representation of the inside of Rochester cathedral, which produced the finest effect from the entire exclusion of all extraneous light, and of all objects, excepting those on the picture itself, the writer of this article was struck with an appearance of distortion in the perspective, which he ascribed to the canvas not hanging vertically. Upon mentioning this to the gentleman who exhibited the picture, he offered to walk in front of the picture, and strike its surface with the palm of his hand, to show that the canvas was freely suspended. Upon doing this a very remarkable deception took place. As his hand passed along, it gradually became larger and larger, till it reached the middle, when it became enormously large. It then diminished till it reached the other end of the canvas.

As the hand moved towards the middle of the picture, it touched parts of the picture more and more remote from the eye of the observer, and consequently the mind referred the hand and the object in contact with it to the same remote distance, and consequently gave it an apparent magnitude such as a body of its size would have had at the distance of the part of the picture which it covered.

We have seen an analogous illusion when viewing the mosaic pavement of St Paul's from the inside of the cupola. The lozenges had a certain apparent magnitude when seen alone, which, of course, was small. When a person, however, passed over the pavement, our knowledge of his size furnished us with a scale for measuring the real magnitude of the compartments in the pavement, and they accordingly increased in size, diminishing again when the person had passed from our view.

ART. XVI.—*On the Quartz District in the Neighbourhood of Inverness.* (*Concluded from* Vol. III. page 218.) By GEORGE ANDERSON, Esq. F. R. S. E., F. S. S. A. & Secretary to the Northern Institution for the Promotion of Science and Literature at Inverness. Communicated by the Author.

NOT to interfere with the description of the characters of the Quartz-Rock, which was given in the last number of this Journal, I have reserved for this place a sketch of its geographical distribution, together with a few other detached notices, which may now be brought forward without injuring the order of the previous details.

If we were to describe on a map the space which the quartz rock occupies, its lines of boundary would appear to almost meet at a point. This is the eastern extremity of the deposit; the quartz-rock lying between the granite and the stratified sandstone, and assuming a general form that may be justly called wedge-shaped. Towards the west and north the quartz rock is extended far and wide, and is variously blended with strata of gneiss. It cannot be said to observe the general bearing of our Scotch chains of mountains, and, indeed, its course seems to be transverse rather than parallel to the north-easterly direction of the great Caledonian Valley. The line of junction between the quartz and the granite, which is so precise and conspicuous in the rocks of Dun-Jardil, is lost to the eastward in the narrow space (covered mostly with peat and gravel) which intervenes between the hills of Balcharnoch and the granite knolls of Stratherwick. This space is in some places diversified by a series of dark Alpine lakes, which extend close to the bounds of the stratified sandstone, and help to vary this otherwise bleak table-land.

To the west of Dun-Jardil, the same line can be traced with more distinctness. It is chiefly to be found in a ridge which rises close behind the cottage of Boleskin, and the Inn of Foyers, and in a hollow or gully at the south of this ridge, stretching from what is called the head of the pass of Inverfarakaig, towards the cataract of Foyers.

Crossing the deep and winding chasm through which this celebrated river " pours down its mossy floods," the limits and junctions of the quartz rocks and granite may be observed among a series of nameless mountains towards Su-Cuming, the former keeping always the side next Loch Ness, while the latter stretches away over a rugged plain towards the mountains of Badenoch.

Near Whitbridge, the blue or grey quartz rock first comes to view, and, in union with gneiss, it characterizes the rest of the country to Fort Augustus. Here several varieties of rock occur, but proceeding still westwards, we again find the quartz prevailing along the banks of Loch Oich, and Loch Lochy.

On the south side of these lakes the quartz rock is associated with mica-slate, from which it seems to have acquired a new modification of colour, and a silvery lustre, owing to the increased commixture of scales of mica.

The high-peaked mountains, however, on the north side of the last mentioned lake, called the mountains of Glengary, are almost entirely composed of the red compact quartz rock, identical with that of Loch Ness.

The same rock is also visible between Loch Lochy and the sea, and I need scarcely remark, that a variety of quartz rock has often been described as extending far up Loch Eil.

To return again to Loch Ness,—its northern shores are lined with rocks, in which the red quartz is the most prevalent, but which is, in several places, especially near the entrances of the Glens Urquhart and Morison, beautifully and curiously intermixed with strata of gneiss. Nearer the lower end of the lake, the quartz, as already observed, seems to pass into a small-grained granite, and, along the whole line, all the different kinds of rock are intersected by numerous beds and veins of crystallized hornblende, and large-sized granite. *

In the upper part of Glen-Morison, I have met with a yellowish porphyritic granite, containing crystals of felspar upwards of half an inch square, and forming one of the most beautiful rocks in this country; while, near Inverness, I have noticed a chain of hills falling into Loch-Beauly, at a farm called Phopachy, composed of a fine distinct red *graphic* granite.

The quartz rock is not characterized by any suites of simple minerals; the only included substance which I have noticed being limestone, and that chiefly in small beds, near the house of Foyers.

In Glen-Urquhart limestone is rather abundant; but it is there contained in gneiss, and is rendered, in a great measure, unserviceable for agricultural purposes, by the quantity of asbestus, asbestous actynolite, and tremolite, which it contains.

Bronzite is said to occur in the same quarter, but I have not been so fortunate as to fall in with it. I have, however, noticed large detached specimens of this substance on the banks of Loch-Arkeg.

In Plate I. Figs. 10 and 11, is given a sketch of the north and south sides of Lochness.

Art. XVII.—*Description of the Bituminous Rock which occurs in Ross-shire, and the neighbourhood of Inverness, &c.* By George Anderson, Esq. F. R. S. E., &c. Communicated by the Author.

In the last Number of the *Edinburgh Journal of Science*, I remarked, that the predominant varieties of the sandstone,

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* Quartz rock occurs also in many other districts of this and the neighbouring counties, but it would be out of place to trace all its boundaries in the present paper.

into which the quartz rock, that formed the subject of my paper, passes, are the common old red sandstone, and a grey and very micaceous sandstone, soft and extremely fissile. The simple minerals found in the sandstone are pyrites, green earth, or earthy chlorite, heavy spar, occasionally arragonite, and foliated celestine, together with large well-defined crystals of prismatic calcareous spar.

But, as I have hinted, (*see page* 217 *of the last Number*) the most interesting association of the sandstone is with strata of a *bituminous* rock, hitherto but little noticed by geologists. By some it has been regarded and passed over as a subordinate variety of graywacke slate; and it has been occasionally called a transition clay-slate, or a secondary shale.

But its analysis, I understand, has not yet been given to the public; and its relations to rocks, so high in the series as the older sandstone, have not been thoroughly investigated. In the district now under consideration, the exact geological position of this rock may be described as being immediately above the old red sandstone. It appears on the acclivities of the conglomorate range of hills, between the quartz rock and stratified sandstone, and hence another very important distinction is afforded between these two rocks.

If again we trace this bituminous rock along the course of the River Beauly, we shall find that it possesses similar relations. In the valley of Strathpeffer, in Ross-shire, it is probable that the mineral waters, so highly impregnated with sulphuretted hydrogen in that neighbourhood, derive some of their properties from their passage through this interesting bituminous compound. I have lately also seen specimens of a similar bituminous rock, which was found associated with the sandstone formations of Orkney. The external characters of the rock may be now described.

It resembles the slate-clay, or bituminous shale of secondary districts, in the loose and thin slaty mode of its arrangement, and in its tending to decompose into an iron-shot, or ochry clay. When fresh, however, it is heavier than slate-clay, and the structure, which in the large is slaty, is in the cross fracture uneven and conchoidal, with a glimmering lustre, derived from numerous minute scales of mica. Its streak is white or grey, and when smartly struck, (especially before it has been long exposed to the air) it emits a strong disagreeable smell. It also appears to contain particles of iron pyrites.

In Ross-shire this is an abundant rock; but I have not found it about Inverness in beds of more than three or four feet in thickness.

These particular remarks are offered, from the consideration that the frequency of bitumen in the stony materials of the globe, is becoming more and more an object of interesting speculation. In the enumeration of the general substances containing this ingredient, as detailed by the Right Honourable George Knox, in his excellent paper on this subject, which has been published in the *Transactions of the Royal Society of London*, no substance is mentioned which exactly corresponds to the rock, the characters of which I have described. The nearest approach to it is the occurrence (mentioned by him) of bitumen in mica-slate, and fetid quartz.

ART. XVIII.—*Description of an inverting Sextant Telescope with Nautical Eye-Tube, for taking Altitudes at Sea when the Horizon is Invisible.* Invented by Mr MATTHEW ADAM, A. M. Rector of the Academy of Inverness.* Communicated by the Author.

THIS telescope, represented by AB, Plate I. (Fig. 12.) consists of three parts; viz. 1st, The eye-tube AE, to the lower side of which a spirit-level *kx* is attached by the the screws *o*, *p*, passing through the extremities C, and D, of the frame of the level tube; 2d, The object tube FB, which is attached to the sextant by the screw at *y*; and, 3d, The middle, or connecting tube EF, represented separately by GH, (Fig. 13.) of which the part EH enters the object tube at F, and the part EG is screwed into the eye tube at E by means of the screw EK, and thus brings the small glass G into its proper

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* This eye tube was executed under Mr Adam's inspection in July 1825, by Mr Robinson, Mathematical Instrument Maker, at 38, Devonshire Street, Portland Place, London. The dimensions of the telescope and level are reduced one-half in the annexed diagrams.—*See this Journal*, vol i. p. 179.

place at *b*, near the field of the telescope. The reduced diameter of the part GK permits the upper side *kl* of the level tube to enter 1-8th of an inch within the lower side of the eye tube, and thus brings the bubble, seen directly through the eye glass at A, as near as possible to the field of the telescope. In the centre of the field two cross hairs of silk intersect each other at right angles, the one horizontal and the other vertical; and the point of their intersection is adjusted exactly into the line of vision through the telescope by means of the screw nails *c*, *d*, acting on the diaphragm, the edge of which, seen at *e*, is filed quite thin on the farther side, for the purpose of more easily admitting the direct light of a lamp through the aperture *ab*, to illuminate the cross hairs at night. *hi*, *qr*, and *st*, are rectangular apertures in the frame of the level tube, and *tv* is a reflector placed below *st* to illuminate the spirits, and to show more distinctly the position of the bubble. The lines *f*, and *g*, are painted on the level tube at opposite extremities of the bubble, when it is in the middle; and, as the level is applied so that the line *f* is placed at the focal distance of the eye glass, the eye end of the bubble can be distinctly seen at *f*, and at 1-3d of an inch on either side of it. When, therefore, *kl*, the upper side of the level tube is adjusted parallel to AB, the line of vision through the telescope, if the eye end of the bubble be observed, and kept at *f*, the line of vision AB must then be truly horizontal, or parallel to the horizon. In order to take the altitudes at sea by a quadrant or sextant, furnished with this telescope and level, which may be made capable of distinguishing 10′, the observer should hold the sextant, as usual, in a vertical plane, passing through the celestial object whose altitude is required, the telescope being horizontal, and then bring the reflected image of the sun, moon, or star, into the field by the motion of the index on the limb of the instrument, which, after some experience, he will generally be able to do upon the first or second trial. When the celestial object is thus brought into the field, and the near end of the bubble seen at *f* in the level tube, the observer should clamp the index on the limb, and, by means of the tangent screw, while the near end of the bubble is kept at *f*, bring the lower limb of the observed object to touch the horizontal hair passing through the centre of the field; the required altitude of the lower limb of that object, affected only by refraction, will then be found, as usual, on the limb of the sextant.

To enable the observer to keep the eye end of the bubble at *f* till the required contact is observed, a light mahogany rod, about 2½ feet in length, attached to the sextant parallel to the telescope, is pressed against some fixed object on deck, which enables him gently to elevate or depress the telescope till the bubble is brought into the required position, and kept there as long as may be necessary. For this purpose, an iron staunchion, about six feet in length, should be made to screw, when required, into different parts of the deck near midship, with a sliding projection, about two or three inches in length, which may be fixed by a finger-screw at any required height, so as to afford a convenient prop, against which the sextant rod may be pressed by the observer, when taking observations. To show the cross hairs, and the position of the bubble, when taking night observations, a small lamp, made for this purpose, is applied to the right side of the eye tube by means of a brass rod, fixed to the lamp, which slides in a square socket, attached to the cylinder on the right of the holder of the telescope. The quantity of light thrown upon the bubble, and cross hairs, is easily increased or diminished by moving the lamp rod a little forward or backward in the socket. The same lamp, when detached, enables the observer to read off his observations.

The screw *om*, acting through the near end C of the level frame, gives it its vertical adjustment; and the two screws at *p*, acting horizontally against each other through the farther end D, give it its lateral adjustment. The accuracy of the vertical adjustment may be examined by comparing meridian altitudes of a celestial object, taken by means of the level, with those taken at, or nearly at, the same time, by means of an artificial horizon. At sea, the accuracy of this adjustment may be examined by moving the index backwards, off the limb, as many minutes as are equal to the dip of the horizon, and then observing whether the reflected horizon of the sea is brought up to the horizontal hair in the centre of the field, when the eye end of the bubble is at *f* in the level tube;

if not, its distance ± from it is equal to the error of the vertical adjustment, which may either be corrected by the screw, or allowed for, like an index error of the sextant.

To examine the lateral adjustment, screw the object tube FB firmly into the sextant holder of the telescope by means of the screw at *y*, or fix it steadily, by other means, in a horizontal position, which is easily determined by the vertical adjustment of the level. Move the united eye and middle tube a few degrees round in it to the right and left; and observe whether the bubble, formerly in the middle, now moves to either end of the level tube. If it does not, the lateral adjustment is already made. If it does, correct the observed motion by means of the adjusting screws at *p*. If this adjustment is not made, a slight deviation of the plane of the sextant from the vertical plane, which the observer cannot detect, when shut out from the horizon of the sea, may cause a considerable error in the observed altitude. To prevent this, let a plummet be suspended behind the plane of the sextant, which will readily detect any deviation of the instrument from the vertical plane.

If EH, the middle tube of the telescope, be moved forward or backward in the object tube FB, so as to place the object glass a little too near, or too far from the cross hairs in the centre of the field, the image of the observed object may thus be brought nearer to or farther from the eye than the intersection of these cross hairs, without causing any apparent indistinctness of the image. In this case, when the eye is slightly elevated or depressed, it will cause the contact of the image with the horizontal hair to appear either too close or too open, and may thereby cause an error of one or more minutes in the observation, according to the distance of the image on either side of the cross hairs.

To avoid this source of error, care must be taken to mark on the middle tube EH a line $\varepsilon\,\beta$, to which the middle tube should be moved, so that the image of a celestial object may be formed exactly at the cross hairs; for then, any elevation or depression of the eye will cause no sensible change of the apparent contact of the limb of the image with the horizontal hair. The proper distance of the object glass is a constant quantity for all celestial objects, but it varies with the distance of terrestial objects. As considerable care and application are necessary, in order to acquire correctness and facility in the practice of this method of observation, it will be proper, when practicable, that the observer should accustom himself to take observations by this method on shore, before he proceeds to sea.

MATTHEW ADAM.

INVERNESS ACADEMY, 19*th Nov*. 1825.

N. B.—The nautical eye tube, formerly tried at sea by Mr Adam, being more complex in its construction, was less easily used, and at the same time less susceptible of accuracy, than the one above described. Yet, upon reference to a list of 199 altitudes of the sun, moon, and stars, taken with it by Mr Adam on board H. M. sloop Clio, in the North Sea, in October 1823, it appears that the mean difference of these altitudes, taken by the eye tube, from those taken at the same time, in the ordinary way, by the officers of the Clio, was less than one minute and a half.

Several of the eye tubes, above described, are now about to be tried under the direction of the Board of Longitude, and four of them, with four new sextants, have been ordered by the committee of shipping of the Hon. the East India Company, for trial on board the first four of their ships proceeding to the East Indies.

Mr. A. has applied a similar telescope and level to the pocket sextant, for the purpose of taking the vertical angles required in surveying, and of thereby dispensing with the use of a theodolite for that purpose.

ART. XIX.—*On the Optical Illusion of the Conversion of Cameos into Intaglios, and of Intaglios into Cameos, with an Account of other Analogous Phenomena.*

THE remarkable phenomena to which we propose at present to direct the attention of our readers, while they possess all the interest which belongs to them as physical facts, have attached to them another kind of interest, not less deserving of attention. To those who are in the practice of exercising a presumptuous confidence in their own judgments, and who trust in the indications of their senses as infallible guides, we would recommend the particular study of this class of deceptions. They will here find their judgments deluded, where every thing is favourable to the discovery of the truth; and even when they are aware of the source of the deception, they will find themselves again brought under its dominion, and again released from it, by the operation of the most trivial circumstances which they are not able to discover, and the influence of which, if they do discover them, they are not able to appreciate. If all this takes place in matters of simple observation, where the senses of sight and of touch are allowed their undisturbed exercise, how much more liable must they be to error, where their passions, their prejudices, or their feelings, concur in promoting the delusion, or even in any remote degree prepare the mind for its reception.

The class of deceptions to which we allude, were, so far as we know, first noticed at one of the early meetings of the Royal Society of London, when a compound microscope, on a new construction, was exhibited. When the members were looking through it at a guinea, some of them saw the head upon the coin depressed, while others considered it to be raised, as it was in reality.

This deception was studied by Dr Philip Frederick Gmelin of Wurtemburg, who communicated the following observations upon it to the Royal Society of London in 1744.

" Being informed by a friend, says he, that if a common seal was applied to the focus of a compound microscope, or optical tube, which has two or three convex or plano-convex lenses, that part which is cut the deepest in it would appear very convex, and so on the contrary; and that sometimes, but very seldom it would appear in the same state as to the naked eye. I was desirous to make the observation myself, and found it constantly to happen as my friend told me. I thought the experiment worthy of being farther prosecuted; and, accordingly, on the 16th of last April, the morning not being very clear, but in a pretty light chamber, I viewed a watch hanging against a plain wall, through the optical tube; the whole of it appeared concave, and fixed into the wall. I also observed some flies that were running about the wall, and they appeared in like manner. I also viewed a small globe of a thermometer filled with red spirit, and this also seemed hollow, and fixed within the frame. I found the same to happen with the round parts of garments of all colours, and with the brazen protuberances of a small cabinet; all which appeared concave, and deeply sunk into the cloth and wood. I also viewed a small stag's head, cut in wood, and hanging horizontally on the wall; this also appeared concave, and fixed into the wall.

After this, I observed a ball of one of Fahrenheit's thermometers, full of quicksilver: but it did not change its natural convexity; nor did the empty glass ball of the inverted thermometer hanging against the wall, though the lower ball of the same, filled with red spirit, and that also of Fahrenheit's, filled with spirit, lost their convexity. Hence, I presently concluded, that white or shining uncoloured bodies, appear under the focus of this tube in the same manner as they appear to the naked eye; *at the same time, I must fairly acknowledge, that an assisting friend has sometimes made observations directly opposite to mine in the same circumstances; nay, in a darker day, I myself have found my observations quite contrary to those I had made the day before.* Hence, though the observations with the seal held constantly the same, I imagined there must be some particular circumstances hitherto undiscovered, in which these objects appeared thus perverted. I therefore endeavoured to discover some certain laws, according to which these perverted objects appeared when exposed to these foci, and some others according to which they constantly appeared as when they were exposed to the naked eye. After various experiments, I partly obtained my end.

As often as I viewed any object, rising upon a plane, of what colour soever, provided it was neither white nor shining, with the eye and optical tube directly opposite to it, the elevated parts appeared depressed, and the depressed parts elevated, as it happened in the seal, as often as I held the tube perpendicularly, and brought it in such a manner, that its whole surface almost covered the last glass of the tube; and in like manner it happened under the compound microscope. But as often as I viewed any of the other objects depending perpendicularly from a perpendicular plane, in such a manner that the tube was supported in a horizontal situation directly opposite to it, the same always happened, and the appearance was not altered, when the object hung obliquely or even horizontally. I was mightily delighted with the observation of a tobacco-pipe, which had a porcelain bowl of a snowy whiteness, and a tube of horn almost black, and hung obliquely from a beam; the bowl preserved its natural convexity, and the tube was deeply sunk, and seemed to be almost immersed in the wall. I also observed, that when I placed the watch horizontally upon a horizontal plane, and then looked on it perpendicularly, near the window, it no longer appeared so depressed, and surrounded with a shady ring; whence I began to *suspect, that all those fallacies were owing to shade*, just as painters can elevate or depress a figure, by making the ground lighter or deeper. Thus, when the raised object was so placed between the windows, that it must *be illuminated on all sides*, it did not change its convexity. But at last I discovered a method of making objects always appear with their natural convexity. If any object hung against a wall, or was contiguous to it in any situation whatsoever, I viewed sideways, in such a manner as not to oppose the tube directly against it, but below the eminence near the plain at some distance. By those means, the protuberance of the instrument and other objects always appeared to me of their true natural convexity. With regard to the seal, I held it in such a manner, that the whole circumference was perpendicular, or rather a little inclined. Then I applied the lower side of the tube exactly to the upper margin of the disc of the seal, so that the tube formed an obtuse angle with the seal; then, carefully preserving the same situation, I very gently raised the tube from the rim of the seal upon its face; and then I always saw the seal with its true natural face. But why all these things happen exactly after the same manner, I do not pretend to determine; nor why white, or uncoloured transparent bodies, rising in any manner above any plain, afford an exception from that rule of vision, and do not appear depressed when viewed after the method above mentioned."

In the year 1780, this subject occupied the attention of David Rittenhouse, president of the American Philosophical Society, who gave a correct explanation of the illusion, by referring it to the inversion of the shadow by the eye-tube. He employed in his observations an eye-piece, having two lenses placed at a distance greater than the sum of their focal distances; and by throwing a reflected light on the cavities observed, in a direction opposite to that of the light, which came from his window, he was able to see them raised into elevations, by looking through a tube without any lenses. Mr Rittenhouse also observed, that, by putting his finger into the cavity, the illusion ceased to take place.

Having thus given a brief detail of the experiments of Gmelin and Rittenhouse, we shall proceed to explain more minutely the principles on which this illusion depends.

It will afterwards be seen, that inverting telescopes and microscopes are not necessary to the production of this illusion; but it may be best seen by viewing with the eye-piece of an achromatic telescope the engraving upon a seal, when illuminated either by a candle or the window of an apartment. This eye-piece inverts the objects to which it is applied like the compound microscope, and the excavations or depressions of the seal are immediately raised up into elevations like a cameo, or a bas-relief. The cause of this illusion will be understood from Plate I. Fig. 14, where A represents a spherical cavity illuminated by a candle C. The shadow of the cavity will of course be on the left side S, and, therefore, if we view it through an inverting eye-piece or microscope, the cavity will be seen as at A, Fig. 15, with its shadow on the right hand S of the cavity. As the candle C remains where it was, the observer instantly concludes, that what was formerly a cavity, must now be a spherical elevation or segment of a sphere, as nothing but a raised body could have its shadow on the right hand S. If a second candle is now placed on the right hand side of A, so that it is between two candles, and is equally illuminated by both, the elevation will again sink into a cavity, as in Fig. 16.

If the object A, in place of being a cavity, is actually the raised segment of a solid sphere, the same phenomena will be observed, the inverting eye-piece converting it into a cavity. These two experiments may be made most successfully with a seal, and an impression taken from it.

It cannot therefore be doubted, that the optical illusion of the conversion of a cameo into an intaglio, and of an intaglio into a cameo, by an inverting eye-piece, is the result of an operation of our own minds, whereby we judge of the forms of bodies by the knowledge we have acquired of light and shadow. The greater our knowledge is, of this subject, the more readily does the illusion seize upon us; while, if we are but imperfectly acquainted with the effects of light and shadow, the more difficult is it to be deceived. If the hollow is not polished, but ground, and the surface round and of uniform colour and smoothness, almost every person, whether young or old, will be subject to the illusion; but if the object is the raised impression of a seal upon wax, we have often found that, when viewed with the eye-piece, it still seemed raised to the three youngest of six persons, while the three eldest were subject to the deception. By such trifling, and often unappreciable circumstances, is our judgment affected, that the same person at one moment sees the convexity raised, and at another time depressed, though viewed as nearly as possible under the same circumstances. This remarkable effect no doubt arises from the introduction of some casual reflected lights, which the slightest change of position will produce.

Having thus seen how our judgment concerning elevations and depressions is affected by our degree of knowledge of the effects of light and shade, and by unappreciable causes, we shall proceed to consider how our judgment is again deceived by the introduction of new circumstances.

Let the depression A, illuminated by one candle, as in Fig. 14, be converted into an elevation as in Fig. 15, by the application of an inverting eye-piece; then, if another candle C′, Fig. 16, is introduced so as to illuminate the depression

A in the same manner, and with nearly the same intensity as C does, the elevation will fall down into a depression. The cause of this is obvious: the application of the inverting eye-piece produces no effect whatever, for both the sides of the cavity are symmetrically illuminated. In moving round the second candle C′ from its position C′, so as to stand beside C, it is curious to observe the progress of the deception by which the depression is again changed into an elevation.

If, when the depression A, Fig. 17, is converted into an elevation, we introduce a small unpolished opaque body M, and place it either beside the hollow or in it, so that the body M, and its shadow *m*, may be distinctly seen by the microscope, we shall have the appearance shown in Fig. 18, the elevation having sunk into a depression. This correction of the deception arises from the introduction of a new illusion, namely, that which arises from the shadow *m;* for it is evident, that, as the body M appears to project its shadow in the direction M *m*, the luminous body must be supposed to be on the same side D; and the evidence that this is the case, is more powerful than our knowledge that the candle is actually at C, because it co-exists along with our perception of the depression A, whereas our knowledge of the situation of the candle is an act of recollection.

This correction of the delusion may be effected in another manner, which is perhaps more complete. If, in place of the unpolished body, we use a pin with a highly polished head, as shown at M, Fig. 19, and then apply the inverting eye-piece, we shall have the effect shown in Fig. 20, the cavity A appearing depressed. The image *s* of the candle C being seen by reflection in the polished head of the pin M, is seen by the application of the eye-piece at *s*, on the right hand side of M in Fig. 20, so that we immediately conceive, in opposition to our previous knowledge, that the candle must be at D; and hence the elevation falls into a depression the moment the pin head is pushed up into the field of view. The shadow M *m* has also its influence in the present case.

The next case in which this illusion is dispelled, is, when the sense of touch corrects the deduction formed through the medium of sight. Let the cavity A be raised into an elevation by the inverting eye-piece, as in Fig. 15. Then, if the cavity is sufficiently deep, and if we place the point of our finger in the cavity, the evidence which this gives us of its being a depression, is superior to the evidence of its being a cavity arising from the inversion of the shadow; the apparent elevation will of course sink into a depression; but the moment the finger is withdrawn, it will again rise into an elevation. If the cavity is a long groove, the part not touched by the finger will appear elevated, while the part touched by it will appear depressed!

Having thus considered some of the principal phenomena arising from the inversion of the object, we shall now proceed to explain some analogous facts which are owing to the semi-transparency of the body. If M N, Fig. 21, is a plate of mother-of-pearl, and A a cavity ground or turned in it; then if this cavity is illuminated by a candle C, or by a window at C, in place of there being a shadow at the side *s*, as there would have been had the body been opaque, there is a quantity of refracted light seen along the whole side *s*, next the candle. The consequence of this is, that the cavity appears as an elevation when seen only by the naked eye, as it is only an elevated surface that could have the side *s* illuminated. The fact which we have now stated, is, we think, a very important one, in so far as it may affect the labours of the sculptor. In some kinds of marble, the transparency is so great, that the depressions and elevations in the human face cannot be represented by it with any degree of accuracy; and, consequently, transparent marble ought never to be used for works of any importance.

Illusions arising from the same cause may be observed even when the surface of the object is perfectly plain and smooth. If M N, Fig. 22, is the surface of a mahogany table, M N *n m* a section of it, and *abc* a section of a knot in the wood, then it often happens, from the transparency of the thin edge at *a*, next the candle, that that side is illuminated while the opposite side at *c* is dark, the eye being placed in the plane of the section *abc*. The consequence of this is, that the spot *abc* appears to be a hollow in the table.

Hence arises the appearance in certain plates of agate, which has obtained for it the name of *hammered agate.* The surface on which these cavities appears, is a section of small spherical aggregations of siliceous matter like *abc* in Fig. 22, which present exactly the same phenomenon, arising from the same cause as the knots in mahogany and other woods.

The very same phenomenon is often seen in mother-of-pearl. Indeed, it is so common in this substance, that it is almost impossible to find a mother-of-pearl counter which seems to have its surfaces flat, although they are perfectly so when examined by the touch. Owing to the refraction of the light by the different growths of the shell lying in different planes, the flattest surface seems to be inequal and undulating.

One of the finest deceptions which we have ever met with, arising from the disposition of light and shadow, presented itself on viewing through a telescope the surface of a growing field of corn, illuminated by the sun when near the horizon. This field, on Sir Walter Scott's estate at Abbotsford, was about two miles distant, and was divided into furrows, which were directed to the eye of the observer, as shown in Fig. 23, where A B, C D, E F, represent the furrows. These furrows are of course depressed, and the growing corn rises gradually from two adjacent ones towards the middle *m n*, *o p*, so that the surfaces A *m* C, C *o* E were convex. The drills of corn on the highest summits *m n*, *o p*, caught the rays of the setting sun, which shone upon them very obliquely in the direction S *s*, and illuminated their summits laterally, while the furrows A B, C D, E F, were in shadow. The consequence of this disposition of the light and shade was, that the whole field seemed to be trenched, and the corn to be growing in the trenches as well as upon the elevated beds between them. The half furrow A B *n m* being shaded on its edge A B, and illuminated on its edge *m n*, became the elevated part of the trenched ground, while the other half *m n* C D appeared the sunk part, in consequence of the side *m n* being illuminated, and its other side C D in shade. At a certain period of the day, this deception did not take place, and it was dispelled the moment the sun had set. This very singular illusion we have seen on several days in July. The telescope had no effect whatever in producing it, as it showed objects erect.

An illusion of an analogous nature we once observed when looking at the Abbey Church of Paisley, where the clustered columns of a Gothic pillar all sunk into hollow flutings. The cause of this deception was not discovered, but it must have arisen from some mistaken notion respecting the direction in which the object was illuminated.

The last species of illusion of this nature, and perhaps the most remarkable of all of them, may be produced by a continued effort of the mind to deceive itself. If we take one of the intaglio moulds used for making the bas-reliefs of that able artist Mr Henning, and direct the eye to it steadily without noticing surrounding objects, we may coax ourselves into the belief that the intaglio is actually a bas-relief. It is difficult at first to produce the deception, but a little practice never fails to accomplish it.

We have succeeded in carrying this deception so far, as to be able, by the eye alone, to raise a complete hollow mask of the human face into a projecting head. In order to do this, we must exclude the vision of other objects; and also the margin or thickness of the cast. This experiment cannot fail to produce a very great degree of surprise in those who succeed in it; and it will no doubt be regarded by the sculptor who can use it as a great auxiliary in his art.

D. B.

ART. XX.—*Analysis of Picrosmine.* By GUSTAVUS MAGNUS, Esq. of Berlin. Communicated by the Author.

A DESCRIPTION of this mineral, which was first ascertained by Mr Haidinger to form a distinct species, is contained in the *Treatise on Mineralogy* by Professor Mohs,* and in a former Number of this *Journal.*† The description was

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* *Grundriss der Mineralogie,* Th. ii. English Translation, vol. iii. p. 137.

† See vol. ii. p. 376, April 1825.

taken from the same specimen, part of which I subjected to analysis.

When exposed alone to the heat of the blow-pipe, it is infusible, but it assumes a much higher degree of hardness. In the mattrass, its colour first becomes black, then white again, and it gives off water. With solution of cobalt, it gives a rose-red colour, indicative of magnesia. Salt of phosphorus and borax dissolve it; a skeleton of silica being visible in the former. If the mineral has been previously heated to redness, it is almost insoluble. Treated with soda or charcoal, it forms a half-vitrified mass, which is not transparent.

In order to ascertain the composition of picrosmine, 2.144 grammes, reduced to an impalpable powder, and carefully washed, were exposed in a platina crucible to the action of fuming dilute fluoric acid. The mineral was decomposed, and so much of caloric disengaged, that the fluid mass began to boil. While it cooled, it was now and then stirred with a small platina spoon, then some distilled sulphuric acid was added, and the whole carefully evaporated to dryness, and exposed to a slight red heat, in order to remove the fluosilicic and the superfluous sulphuric acids.

What remained was dissolved in water; a small insoluble residue was left, probably of silica, but it could not be ascertained, whether it still contained a portion of the undecomposed substance, because there was too little of it. It might have been supposed that it was sulphate of lime, but some other experiments, afterwards to be mentioned, leave no doubt that the mineral does not contain a trace of lime; and I am therefore inclined to consider it as produced by the decomposition, at a higher temperature, of some of the sulphates of alumina or iron.

Pure ammonia, added to the clear solution, produced a precipitate of alumina, oxide of iron, and a little manganese and magnesia. The filtered fluid, which still contained the greater part of the magnesia and of the manganese, yielded no precipitate with oxalate of ammonia, and therefore did not contain any lime. It was evaporated to dryness, and then ignited, to drive off the remaining sulphate of ammonia, and redissolved in a small quantity of water.

The precipitate, produced by ammonia, when dried and ignited, weighed 0.096 gr. or 4.477 per cent. It was dissolved in muriatic acid, and then digested with an excess of pure potash, in order to separate the soluble alumine from the insoluble oxides of iron and manganese, and the magnesia. The alkaline solution of alumina, was rendered acid by muriatic acid, and the alumina afterwards precipitated by carbonate of ammonia. It weighed 0.017 gr. or 0.792 per cent.

What had been precipitated by the potash, was dissolved in muriatic acid, exactly neutralized with pure ammonia, and the iron precipitated by means of succinate of ammonia. The succinate of iron, after being well washed, was decomposed on the filter with dilute caustic ammonia, in order to remove the greater part of the acid. The oxide of iron, dried and ignited, weighed 0.030 gr., equal to 1.399 per cent.

The liquid, from which the succinate of iron had been separated, as it did not contain any other substances but magnesia and manganese, was evaporated; the residue, completely dried and ignited, in order to drive off the volatile salts of ammonia, then dissolved in water, and added to the fluid obtained above, which likewise contained only magnesia and manganese. The whole was neutralized with ammonia, and hydrosulphuret of ammonia was added to it, to precipitate the manganese. Ignited, it weighed 0.010 gr., and as these may be considered as a combination of the peroxide with the protoxide of manganese, the proportion of sulphuret of manganese being very small, there can be no perceptible error in supposing them equal to 0.009 gr. of protoxide of manganese, or 0.420 per cent.

From the liquid still left all the hydro-sulphuret of ammonia was evaporated, and the sulphur separated by filtration. The remainder was dried and ignited, in order to get rid of the sal ammoniac; then redissolved in a small quantity of water, and a few drops of sulphuric acid added. The sulphate of magnesia, thus obtained, after being dried and exposed to a slight red heat, weighed 8.098 gr., corresponding to 0.715 gr., or 33.348 per cent. of magnesia.

In order to obtain any potash or soda which might have been united to the latter substance, it was dissolved in water, and acetate of baryta added, so long as any precipitate appeared. The sulphate of baryta was separated, and the remaining acetate of magnesia, along with the superabundant acetate of baryta, evaporated to dryness and ignited. The acetates having thus been transformed into carbonates, those of soda or potash should have been contained in the water with which they were digested; but this, having been again evaporated, did leave only a slight residue, which proved likewise to be magnesia, since it was soluble in muriatic acid, from which it was precipitated by ammonia. The mineral, therefore, does not contain either soda or potash.

The quantity of silica was ascertained by the usual process. A quantity of 0.982 gr. of the mineral, carefully prepared by grinding and washing, and mixed with three or four times its weight of carbonate of soda, was melted in a platina crucible, the mass dissolved in water, and muriatic acid added, as long as there yet appeared any effervescence. The fluid was evaporated, the residue well dried, and then redissolved in water, with a few drops of muriatic acid. The silica obtained weighed 0.539 gr., which corresponds to 54.886 per cent. of the mineral. The remaining liquid gave, with pure ammonia, a precipitate, which after ignition, weighed 0.047 or 4.786 per cent. Not a trace of lime could be detected by oxalate of ammonia. The quantity of water I ascertained, by exposing the mineral, in the state of powder, to the strongest heat that can be produced by means of the spirit-lamp, with double air current. Two experiments gave the following results:—

0.740 gr.	lost 0.0575 gr.	equal to 7.76 per cent.
0.453 gr.	lost 0.031 gr.	equal to 6.843 per cent.

the average of which, 7.301, gives pretty nearly the contents of volatile ingredients. They consist chiefly of water, with a slight alkaline action on litmus paper, owing probably to an inconsiderable portion of ammonia produced by the decomposition of that substance, which gives the black colour to the mineral when heated; a phenomenon which has been very generally observed in minerals containing magnesia. I possessed too small a quantity of the mineral to collect the water obtained by ignition, and to determine immediately its ratio to the other ingredients; nor could I, for the same reason, determine the loss which the mineral might sustain in a higher degree of incandescence.

The following table shows the results of the analysis :—

Silica, - - - -	54.886	containing oxygen 28.389
Magnesia, - - -	33.348	12.909
Alumina, - - -	0.792	0.367
Peroxide of iron, - -	1.399	0.429
Protoxide of Manganese,	0.420	0.092
Water, - - - -	7.301	6.490
	98.146	

The oxygen contained in all the bases together, is 13.797, nearly equal to half the quantity of oxygen in the silica; picrosmine, therefore, appears to be a bisilicate of magnesia. I must observe here, however, that I do not consider the specimen subjected to analysis as entirely pure, since it contained throughout its mass small brown dendritic specks, from which, perhaps, may originate the oxide of iron and the alumina in the analysis, for it is not likely that so small a quantity of a substance not isomorphous with the rest of the bases, should form an essential ingredient in the composition of the mineral. The brown colour of the intermixed substance induced me to consider the iron to be contained in the mineral as peroxide and not as protoxide. But I believe the manganese to be contained in it as a protoxide; because it is thus very frequently found along with magnesia, with which it is isomorphous, and with which it also agrees in many of its chemical properties. The mineralogical formula, in the method of Berzelius, in reference to the solid ingredients, will be $\left.\frac{M}{mn}\right\}S^2$, or if we neglect the small quantity of manganese, it will be MS^2.

If we consider all the volatile ingredients as water, their contents of ozygen, equal to 6.49 will form exactly one-half of 12.999, which is the quantity of oxygen in the bases, excluding the oxide of iron and the alumina as accidental ingredients. The formula of the whole is then transformed into $2MS^2 + Aq$.

Art. XXI.—*On the Means of Detecting Lithia in Minerals by the Blowpipe.*[*] By Edward Turner, M. D. F. R. S. E. &c. Lecturer on Chemistry, and Fellow of the Royal College of Physicians, Edinburgh. Communicated by the Author.

At the conclusion of a paper on Mica, published in the last number of the *Edinburgh Journal of Science,* I have made some observations on the colour communicated to the flame of a candle by the three alkalies, potash, soda, and lithia, by means of which they might be readily distinguished from each other. It seemed probable, from some facts there stated, that a body must be fluid, in order to communicate its characteristic colour to flame; and this idea became more plausible from the consideration, that the lithion-micas fuse readily, and then tinge the flame red, while some other minerals which do not produce that effect, though they contain lithia in considerable quantity, are very difficult of fusion. Hence it occurred to me, that the last description of minerals might also be made to redden flame, could we by any means increase their fusibility; and the following observation is in support of this notion. A minute particle of spodumene, previously reduced to fine powder, and made into a paste with water, was exposed to the flame of the blowpipe. For a time the mineral did not fuse, nor was a trace of redness visible; but, by urging the heat, fusion did at length occur, and at that instant the flame was tinged of a red colour, though in a slight degree. On mixing the same mineral with fluor-spar, its fusibility was considerably increased, and it gave a more distinct red hue to the flame.

But though the liquid form is favourable to the communication of colour to flame, it is not always an essential condition. Thus, the carbonate of copper tinges the flame of a candle green without fusing; and if the carbonate of strontia be strongly heated before the blowpipe, it phosphoresces remarkably, and yields a red colour to the flame, though the assay remains perfectly solid. Nor does a body cause its pe-

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[*] Read before the Royal Society of Edinburgh on the 5th December 1825.

culiar colour to appear from the mere circumstance of becoming fluid. Spodumene, for example, can be made to fuse by the addition of the carbonate of soda or potash, but no redness occurs. Fusion is rendered still more perfect by the action of boracic acid, or the phosphate of soda and ammonia, but without a trace of redness being visible.

These facts prove that a certain chemical condition of a body is necessary, in order that it should produce its effect on flame, and that this circumstance has a greater influence than form.

From the action of fluor-spar on spodumene, I was desirous of trying the effect of free fluoric acid on that mineral. It was accordingly mixed with some of the bifluate of potash, and a little of the mixture, made into a paste with a drop of water, was exposed by means of platinum wire to the flame of the blowpipe. It fused very easily, and emitted a brilliant red flame, far more distinct than that occasioned by the fluate of lime. To vary the experiment still further, a mixture was made, composed of fluate of lime and bi-sulphate of potash in atomic proportion; that is, one part of the former to about four and a half of the latter. When this flux was mixed with an equal quantity of powdered spodumene, the effect was, if any thing, still greater than in the previous instance. Both these fluxes appear to act by giving out fluoric acid at a high temperature, which destroys the composition of the mineral by combining with the silica and setting the lithia free. The latter flux is more effectual than the former, because it requires a stronger heat before yielding fluoric acid, and hence the disengagement takes place under the most favourable circumstances. It should therefore be preferred in practice.

In performing these experiments, it is important to keep in view the action of the flux itself on flame. Those that have been just recommended communicate a faint lilac colour, owing to the presence of potash, which cannot be mistaken for the action of lithia by any one who compares both effects together, as I shall immediately demonstrate to the society. But in case any doubt should arise, it is easy to avoid the difficulty by employing a flux that contains no potash. Such a one may be made by mixing one part of the fluate of lime with one and a half of the sulphate of ammonia. This mixture acts on spodumene in the same way as the preceding, and, doubtless, from the same cause. It communicates a pale-blueish green colour to the flame at the first moment, and before fusion occurs,—a property possessed by several of the salts of ammonia; but there is no appearance that can be mistaken for the red colour of lithia.

When petalite is heated alone before the blowpipe, it yields no trace of redness; but if subjected to the process just recommended, it affords abundant evidence of the presence of lithia. Indeed, from the great affinity of fluoric acid for silica, it is obvious that no siliceous mineral can withstand its action; and there can be almost as little doubt that the presence of lithia may be detected in any such compound by the process which is so successful with spodumene and petalite.

The advantage of possessing an easy and expeditious method of ascertaining the presence of lithia in mineral bodies, is twofold. In the first place, the mineralogist and chemist possesses a test for spodumene and petalite, from the want of which other minerals have sometimes been mistaken for them, and the error only discovered at the close of a tedious chemical process. Secondly, we obtain a method of ascertaining the presence or absence of lithia in other minerals. I have examined a considerable number of substances with this view, but have not hitherto been successful.

As several of the salts of strontia and lime possess the property of communicating a red colour to flame, it is natural to inquire, whether the presence of those earths in a mineral might not give rise to fallacy; and I have, accordingly, studied the subject with care. Though there is little danger of mistaking a native carbonate or sulphate of strontia for a siliceous mineral containing lithia, it may not be superfluous to mention the characters they exhibit before the blowpipe. When a particle of strontianite, powdered and made into a paste as usual, is exposed on platinum wire to the blowpipe flame, it communicates a yellowish colour to it. By continuing the blast for a little time, phosphorescence commences, and soon afterwards a red colour makes its appearance. This latter effect depends on the expulsion of carbonic acid; for no redness is visible till the phosphorescence sets in, and then the assay gives a strong brown stain to moistened turmeric paper. The property of strontianite in colouring flame is lessened by mixing it with the flux. When celestine is exposed in like manner, no redness appears at first; but if a strong heat be kept up for a minute or two, the salt is decomposed, phosphorescence commences, followed by a red hue, and the assay is found to be alkaline. This change is facilitated by mixing the celestine with the flux of bisulphate of potash and fluor-spar. Complete fusion then occurs, though without the least trace of a red colour; but, on continuing the blast, the assay gradually becomes solid, and then the strontia is speedily reduced to the caustic state. I have been thus particular in describing these appearances, because they afford us a useful test to distinguish the native salts of strontia from those of baryta; while they cannot be confounded with the effects produced by lithia.

The carbonate and sulphate of lime give rise to the same phenomena, though their effect is less distinct; and the colour, as in the case of strontia, does not appear till the lime is reduced to its caustic condition. I have examined a considerable number of siliceous minerals containing lime, in some of which, as datolite and apophyllite, that earth is present in a large proportion; but none of them, whether alone, or with flux, give a red colour to the flame of the blowpipe. It is probable, from this fact, that strontia, did it chance to occur in a siliceous mineral, would likewise be inert; or if it did redden the flame, it would be under circumstances which would distinguish it from the action of lithia. For the strontia would be converted into a sulphate by the flux, and could not produce its effect till that salt was decomposed.

It is very desirable that the presence of potash and soda in minerals could also be discovered by the blowpipe. The pale lilac produced by potash, though it enables a salt of that alkali to be readily distinguished from the salts of soda or lithia, is too faint for affording a test of its presence in minerals, unless it exists in considerable quantity. The property soda possesses of communicating a yellowish colour, and of making the flame larger at the same time, may be turned to some advantage; for several minerals that contain soda act on the blowpipe flame in the same manner as soda itself, from

PLATE III.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

then the assay gives a strong brown stain to moistened tur-
in colouring flame

they cannot be confound-
produced by lithia.

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PLATE III.

Fig. 1.

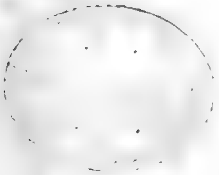

Fig. 3.

which we may be led to infer the presence of that alkali in them. This has been observed in sodalite, analcime, chabasie, albite, pitchstone, and several others. Unfortunately, however, a yellowish colour may be produced by other substances besides soda, so that it is a test which cannot altogether be relied on with certainty. Thus, a similar effect is occasioned, though in a less degree, by the fluate of lime, and, perhaps, by lime under other circumstances. However this may be, it is certain that many minerals that contain soda give a very distinct yellow colour to flame; it is a circumstance, therefore, which may be useful to the chemist and mineralogist, and as such I mention it.

I beg leave to observe, in conclusion, that experiments on the colour communicated to flame should be performed with a tallow candle, the colour of which is better fitted for the purpose than that of a spirit-lamp.

ART. XXII.—*On the Apparent Direction of Eyes in a Portrait.* By W. H. WOLLASTON, M. D. F. R. S. and V. P. With a Plate.

THIS very curious paper of Dr Wollaston's, of which we propose to give a brief abstract, appeared in the *Philosophical Transactions* for 1824. As it is one of those scientific papers which may be easily comprehended by general readers, we could have wished to transfer the whole of it to our pages; but it is partly illustrated with engravings on steel by Mr Perkins, which cannot be copied, and we are, therefore, obliged to confine ourselves to an abstract of the most popular and interesting part of it.

In examining the eyes of a person opposite to us, who looks horizontally within a range of about 20° on either side, we shall find that the white parts of his eyes increase and decrease according as they are turned to or from the nose. When the eyes of the person are looking straight at us, the two portions of white are nearly equal, so that, by the relative magnitudes of the white parts of each eye, we can estimate in what degree the eyes deviate in *direction from the face to which they belong.*

In judging, however, of *their direction in reference to ourselves,* we are not guided by the eyes alone, but by the concurrent position of the entire face. This will be understood from Plate III. Fig. 1. where the pair of eyes were originally drawn from the life by Sir Thomas Lawrence, actually looking at him. The face has been added according to the original design, so that the person represented in Fig. 1. appears decidedly looking at the spectator. If, however, a set of features oppositely turned, are applied to the same eyes, by laying down Fig. 2. the eyes will be found to look considerably to the right of the person viewing them. In "Fig. 1. the position of the face being at a certain angle to our left, the eyes which are turned at an equal angle from that position, seem pointed to ourselves. In Fig. 2. the deviation of the face from us being toward the same side as the turn of the eyes, gives additional obliquity to their apparent direction, and carries them far to the right of us, proving the influence of the stronger features, even in opposition to that of the minuter parts of the eyes themselves, which are not in correct drawing from this position."

The same principles apply to instances of moderate inclination of the face upwards or downwards; but the principle is most strikingly exemplified when the turn of a pair of eyes partakes of both inclinations, so as to be in a direction laterally upwards, as in Fig. 3. By giving the face a downward cast, as in Fig. 4. the change of effect is very remarkable. "The effect thus producible," says Dr W. "is by no means limited to the mere extent of deviation, as a total difference of character may be given to the same eyes by due representation of the other features. A lost look of devout abstraction, in an uplifted countenance, may be exchanged for an appearance of inquisitive archness, in the leer of a younger face turned downwards, and obliquely towards the opposite side. The under eyelid which, in the former position, conceals a portion of the ball of the eye, from an effect apparently of mere perspective, will, in the latter, seem raised with effort, and thus give the appearance of a smile to the same eyes, if supported by corresponding expression of the rest of the countenance." Dr Wollaston considers these examples as proving that the opposite direction of the eyes to or from the spectator, depends on the balance of two circumstances combined in the same representation, viz. 1. The general position of the face presented to the spectator ; and, 2. The turn of the eyes from that position.

In the same manner as the general position of the face carries the eyes along with it, so a change in the position of the eyes carries the face along with them. This fact, which is not mentioned by Dr Wollaston, is not less surprising than its counterpart, and may be well illustrated by causing a pair of moveable eyes to oscillate in the sockets of the eyes of a picture.

Dr Wollaston next proceeds to explain a fact which every person must have observed, that, if the eyes of a portrait look at the spectator when he stands in front of the picture, they follow and appear to look at him in every other direction. His explanation and illustration of this is every way satisfactory ; but not so popular as we think it may be made. The following illustration appears to us more easily comprehended. If a picture represents three soldiers, each firing a musket in parallel directions, and if the musket of the middle one is pointed accurately to one eye of the spectator, the other being supposed shut, then the muzzle of the musket will be exactly circular, and the spectator will see down the barrel, and no part of the right or left side of the barrel. In like manner, the spectator will see the left side of the barrel of the musket opposite his left hand, and the right side of the barrel of the musket opposite his right hand. If the spectator now changes his place, and takes ever such an oblique position, either laterally or vertically, he must see the same thing, because nothing else is painted on the canvas. The gun of the middle soldier must always point to the eye of the spectator, the gun of the other to the right of him, and the gun of the third to the left of him. They will, therefore, all three seem to move as he moves, and follow him in his motions. The same reasoning is applicable to perspective buildings.

Art. XXIII.—*On the Vegetable Productions of the Island of Madeira.* By Dr H. Kuhl.

The following account of the vegetation of the island of Madeira is given in the "*Botanische Zeitung*," as the substance of a letter received by Dr Nees Von Esenbeck, from Dr Kuhl, who undertook a scientific voyage to the East Indies, at the expence of the King of the Netherlands.

Dated on board the Nordloh, Sept. 27, 1820, 5° West
Longitude from Greenwich, 29° south latitude.

We had, for a long time previous to our arrival at Madeira, been indulging in the anticipation of traversing every part of the island, which, indeed, is but little known: but a residence of five days seemed too short to make us perfectly acquainted with it; and had it not been for the ready advice and active assistance of a gentleman of the highest respectability, Mr Veitch, the English consul, we should only have confined ourselves to the coast, and seen nothing of the interior, which can only be visited with the assistance of guides, and they again are not easily procured. The roads are nowhere better than footpaths, and, in many places, there are none at all, save the rocky beds or margins of the rivers, where you are obliged to leap from one stone to another, often among thorns and bushes. In this way we travelled for some distance by night, having devoted too much time during the day to botanizing, and then we could procure no shelter. We had travelled from four in the morning till ten at night, without resting above an hour, and then were obliged to lie down to sleep upon the bare rocks till the moon arose, and lighted us to the country house of the English consul, where we arrived richly laden with the spoils of the preceding day, at about six o'clock in the morning. I could easily give you an account of our excursion into the interior of the island, but, I believe, that some botanical information will be more acceptable to you. We examined every spot with the greatest attention, and scarcely suffered a single plant that was in flower to escape us. We collected, in the five days we spent in the country, altogether 224 species, and about 1000 specimens. Vegetation, however, is in general poor, and bore the character rather of that of Europe, than of the neighbouring Africa. As to the animals, they belong to European species, or are closely allied to them: Still, however, in what concerned the plants, the entire absence of Oaks, Firs, Birch, Willows, &c. must strike every stranger. All our European fruits are here cultivated; but such as are not planted in a soil that is properly manured, are far inferior to ours in point of flavour, at least such as we had the opportunity of eating. The grapes, indeed, must be excepted, which possess much richness, and are mostly red. The wine is a true claret, and the good old Madeira has the exact colour of Rhenish wine. The red, which is not a claret, is rare. All the native trees have coriaceous leaves, and one only bears an esculent fruit, which is an arborescent *Vaccinium;* the rest have been introduced by the Portuguese. One single species of *Fir,* it is said, was found on the island when it was discovered, but that was soon extirpated by the use that was made of it in building, for which purpose the *Chesnut* is now employed and cultivated. Of the thick stems of the arborescent *Heaths* (*Ericas,*) which crown the top of the Pico Ruivo, and whose wood is of a beautiful red colour, they make props for their vines, which are not, as with us, trained upright, but horizontally, just above the ground, forming a green covering,

As the climate of the different regions varies according to the relative heights of the mountains, so we meet with very different plants at different elevations; and the different belts or regions may thus be characterized.

1. Region of the Cacti,

Which, according to our calculations, reaches to an elevation of 630 feet above the level of the sea. Von Buch gives the same extent to this region at Teneriffe. In Madeira, however, the succulent *Euphorbiæ,* and other African plants, which abound in Teneriffe, are wanting. *Cactus Ficus Indica* grows alone upon the bare rocks, and *Vines, Canes, Figs, Arums* and *Musæ,* and other southern fruits, are cultivated in the fields. This district is rich in wild plants. We found of

Cryptogamia, one species, and that, indeed, *Adiantum capillus Veneris.*

Monocotyledons, seven; three *Panica, Cynodon, Setaria, Andropogon* and *Milium.*

Dicotyledons, sixty; amongst which, besides the genera which abound with us (such as *Rumex, Convolvulus,* &c.) were *Crotalaria, Physalis, Asclepias, Helminthia, Atractylis, Ageratum, Sida, Myrtus, Cassia,* &c.

The *Pomegranates, Figs,* and *Bananas,* which are planted about the houses, together with the bright green of the *Arums,* gave a singular charm to this district. Of these sixty-eight species, seventeen extended as far as the region of the Vine, and only two of them were met with again at a height of 5300 feet.

2. REGION OF THE VINE.

The cultivation of the Vine may indeed be said to commence at the sea shore; but the *Cactus* does not accompany it above 630 feet. The Vine ascends to an elevation equal to 2030 feet, but higher than that the fruit will not ripen. In this region the *Arum, Cane, Mulberry,* &c. *Potatoes, Corn,* and *Onions,* are cultivated, but not the *Bananas* and *Cacti.* The hedges consist of *Myrtle* and *Chesnut.* Agriculture is more successfully carried on here than elsewhere, on which account few wild plants are met with but such as we had already found in the lower region, and of those three that grew at a still higher elevation.

3. REGION OF THE CHESNUT.

This commences at a height of 2030 feet, and is eminently distinguished by the tall stout stems of the Chesnut, which tree ascends to about 2950 feet. Those that are found still higher are smaller, distorted, and bear no fruit. We stayed longest in this region, and our success in collecting plants was proportionally great. We found of

CRYPTOGAMIA, twenty-three species, of which twelve were Ferns, one *Darea* and *Woodwardia,* five Lichens, *Anthoceros, Marchantia, Boletus,* two *Jungermanniæ,* &c.

MONOCOTYLEDONS, twelve, of our common Genera; only one *Carex* and a beautiful *Cyperus.*

DICOTYLEDONS, sixty-six. *Rumex* five, *Clethra, Lobelia, Andryala, Chamamelum,* an arborescent *Euphorbia,* two shrubby species of *Teucrium, Cineraria, Disandra.* We found nine of these species in the next region.

4. REGION OF THE SPARTIUM.

This terminated at a height of 3920 feet, and is singularly poor in its vegetation. We found only one plant which we had not seen before, or which we did not meet with in the following region. The whole ridge is covered with the single *Spartium.*

5. Region of the Heath. (Erica.)

This extends to the summit of the Pico Ruivo, the highest point in the whole island; and, according to our reckoning, is 5300 feet above the level of the sea. It is very rich in interesting plants. In the middle of it are trees with coriaceous leaves, *Clethra*, an arborescent *Vaccinium*, and two trees called *Till* and *Vintratico*, but which, for want of flowers, we could not determine. Between the fourth and fifth region is a tract which is almost entirely covered with *Pteris aquilina*, and some other ferns, especially another *Pteris.* On many ridges they abound to the exclusion of all other plants, which was remarkably the case at a height of from 3920 to 4080 feet, whilst below them the *Spartium*, and above them the *Ericas*, maintain possession of the soil. But again, not far from the top of the Pico, is a tract where the *Ericas* are supplanted by the *Spartium*, only, however, for a short space; for the summit is covered by the thick stems of the Heaths. Besides fifteen species of plants common to the lower regions, we found of

Acotyledons, twelve species. *Peziza* and *Lichens.*

Monocotyledons, seven, among them, two *Scirpi.* Two of *Cynosurus, Aira*, and *Agrostis.*

Dicotyledons, thirty-seven. Among them, a *Sideritis*, a beautiful shrubby *Echium*, with a blue spike, *Crocodylium, Pyrethrum, Phyllis*, two *Semperviva, Sedum, Cotyledon*, &c. There is no Pine region.

It would, under existing circumstances, be too great a task to name all the genera which we have collected. We must reserve it for another opportunity; and I will here only enumerate the relative proportion of the species in some of the most striking families.

Filices,	1 in 15.	Cichoraceæ,	1 in 23.	Leguminosæ,	1 in 23.
Gramineæ	1 in 11.	Corymbiferæ,	1 in 19.	Caryophylleæ,	1 in 37.
Amentaceæ,	1 in 111.	Saxifrageæ,	1 in 224.	Malvaceæ,	1 in 74.
Euphorbiaceæ,	1 in 111.	Labiatæ,	1 in 19.	Rosaceæ,	1 in 25.
Umbelliferæ,	1 in 56.	Cruciferæ,	1 in 23.		

Whence it appears that the island is deficient in the northern families of the *Saxifrages*, *Amentaceæ*, *Caryophylleæ*, in the first of these especially. It is poor likewise in the predominant families of the tropics, the *Euphorbiaceæ*, *Malvaceæ* and *Corymbiferæ*, which latter are only in the proportion of 1 to 19, but at the Cape 1 to 5, and in other countries of the equator 1 to 6. But the *Cichoraceæ*, which belong to the temperate zone, are here numerous.

In our walks, we found upon the shore whole banks of *Fuci*: but it is at the Cape we hope to meet with treasures in this department.

Dr H. Kuhl.

Art. XXIV.—CONTRIBUTIONS TO METEOROLOGY.

1. *On the Negative Electricity of Showers.* By Mr John Foggo.

Sudden and copious precipitations of moisture from the atmosphere, whether in form of rain or hail, are generally attributed to the agency of electricity. Hail showers appear to be always accompanied by indications of electricity, amounting frequently to discharges of lightning with thunder. In every fall of rain, indeed, electrical indications more or less strong may be discovered; but, in those extensive rains which spread over vast tracts of country, the electrometer is seldom affected to a greater degree than may be easily considered as the spontaneous electricity of a moist atmosphere. But the showers, in which the influence of this element appears more decided, have characters different from general rains, and even from the heavy showers which occur in boisterous weather. They are more local, or circumscribed, of short duration, and the precipitation is most violent at the commencement; and when they have been preceded by dry and cold weather, their effects are discernible in the rapidity with which vegetation acquires a renewed freshness and vigour which cannot be imparted by artificial watering, or an ordinary shower of equal amount. They are also distinguished by the regularity with which the variations in the kind of electricity succeed each other. When negative electricity occurs in broken weather, its alternations with the positive are in general so rapid, that it is difficult to note them down, and the changes from positive to negative are frequently interrupted by periods in which it becomes *null.* If an electrometer be attached to a conducting rod, when an electrical shower or hail cloud is approaching, the phenomena are as follows: While the cloud is still at some distance, the air is generally strongly charged with + E.; when the foremost portion of the cloud is nearly over the conductor, the electrometer collapses, and then expands with — E.; this state lasts a short while, when + E. shows itself, and continues till the cloud has passed over, when — E. makes its appearance, and is again succeeded by the natural positive electricity of the atmosphere.

Mr Howard of London appears to have first distinctly stated, that the electricity at the circumference of a *nimbus* is negative, while that of the centre is positive. This experienced meteorologist observes, that it would be very interesting to ascertain whether the negative electricity is *ascending*, and the positive *descending*. About the end of the year 1823, I became anxious to make the experiment, conceiving that, if these ideas were found to be correct, they might be useful in explaining certain electrical phenomena, the history of which is at present very obscure. For that purpose, I prepared an apparatus, resembling that of Bennet, and connected with it a gold-leaf electrometer. No favourable opportunity occurred till the month of March 1824. On the 12th of that month, we had, at this place, a brisk wind from the N. W., with frequent showers all around. About 3, P. M., large dense clouds passed over the zenith, letting fall heavy showers of hail. The conductor was armed with a smoking match, and erected from a south window.

During the intervals of the showers, the electricity was always positive, and made the leaves diverge to their full extent. Indeed, the electrical tension of the air was so great, that a detached electrometer was fully charged by the slightest friction with a piece of dry silk applied to the brass cap, and even rubbing the outside of the glass with soft leather opened the leaves to more than 40°.

During the showers, or when the clouds were over head, though no precipitation took place, the E. was invariably positive, and of such intensity, that I could at any time draw sparks from the conducting-wire, by presenting my finger to it. I likewise ascertained, that, by taking hold of the wire, I could at pleasure intercept the fluid from reaching the instrument, so that the charge was, without doubt, received from the atmosphere or cloud. On the other hand, when the edge or circumference of the cloud was nearly over the conductor, the electricity became —, and appeared to be fully as strong as the positive charge. I found, however, that it could not be intercepted as before, by taking hold of the wire, nor by touching it with a pointed steel rod. The fluid was, therefore, not proceeding from the cloud as before, but was given off by the earth to the cloud. By presenting the steel point to the instrument itself, the divergence was so much increased as to endanger the gold-leaf, and sparks were heard to pass rapidly between the point and the electrometer, while sharp pricks were felt when the finger was approached to the brass cap.

In experiments on atmospherical electricity, I sometimes find it most convenient to employ an electrometer of the construction represented in Plate I. Fig. 31. It consists merely of a pith ball suspended by a fine silver-wire from a ring or loop, imbedded in sealing-wax, by which it is attached to the lid of the instrument. The lid is of turned wood, and through it are inserted the two glass tubes A. A. These tubes are about one-third of an inch in diameter, and are coated with sealing-wax on the internal surface. Brass knobs or caps are fixed on the lower ends of the tubes. Into one of the tubes, the end of a chain, proceeding from the conducting rod, is fixed so as to insure direct contact with the knob or cap, and a similar chain is placed within the other tube, to establish a communication with the earth and knob. The latter chain is about two yards long, and is covered with oiled silk, except at the ends; it is secured in its place by a pledget of silk.

When the conductor is elevated with this instrument attached to it, and the end of the covered chain rests on the earth, the pith ball is attracted by the knob connected with the conductor. It then carries the charge it has received to the other knob, and is thus made to vibrate between them so long as any electricity is brought down by the conductor. As the insulation of the pith ball is easily insured, this form is more delicate than electrometers with two pith balls, or even those of gold-leaf.

2. *Account of an Improved Hygrometer.*

It has occurred to several meteorologists, that Mr Daniell's hygrometer might be simplified, by applying the ether directly to the ball of a simple thermometer. Mr Jones of London employs a thermometer with a ball of black glass, and bent twice at right angles, in order (so far as we can judge from a very imperfect description of the instrument in Mr Brande's *Journal*) to bring the deposition surface more easily on a level with the eye of the observer. When one part of the ball is moistened with ether, the vapour of the atmosphere is condensed upen the other, and the temperature at which this takes place is noted. A similar method has been used during the last summer by a correspondent who has favoured us with a description. A thermometer, with a ball of black glass, has adapted to it, by gum arabic, a ring of silver, (as in Plate I. Fig. 32.) the upper part of the ball being covered with muslin. By this contrivance, the ether, when dropped on the muslin, is prevented from reaching the lower part of the ball on which the dew is deposited; and, unless some method of this kind be used, we do not see how it is possible to insure accuracy of observation. It has been suggested to us by several practical meteorologists, that, in this arrangement, there is a possibility of error from the circumstance of the deposition surface not being in immediate connection with the stem, or that part which indicates the temperature of the instrument. Should this suggestion be found correct, it will be necessary to employ a thermometer, bent as in Plate I. Fig. 33. If the ether be dropped on the upper part of the ball (a) the vapour is condensed upon the lower portion, which is the part that gives the temperature of deposition, and every chance of error is avoided.

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Art. XXV.—*Account of the Discoveries and Experiments of the Swedish Chemists during the year* 1825. Drawn up for this Journal by a Correspondent at Stockholm.

1. *Professor Berzelius's Discovery of Lithia in Mineral Waters.*

Professor Berzelius has been occupied with the examination of several mineral waters from Bohemia, viz. those of the Eger, or Franzensbad, and those of Marienbad. These waters were found to contain the same substances which this chemist detected in those of Carlsbad, the analysis of which has been for some time before the public, * but in the new analysis he has found also *lithia.* The quantity of the carbonate of the alkali is very small, particularly in the waters of Carlsbad, and in that of Eger; but the waters of the spring called Kreuzbrunn, at Marienbad, contain as much as a centigramme of the carbonate of lithia in every bottle.

The following is M. Berzelius's method of discovering this alkali in any solution. He precipitates the lime by means of oxalate of potash, and afterwards separates the magnesia by carbonate of soda, but the mixture must be evaporated to dryness, and the residue fused; for otherwise some of the magnesia would be easily redissolved in the form of a double carbonate of soda and magnesia. The mass, taken up by the water and filtered, will not give any farther precipitation even when pure phosphate of soda is added; but if it contains lithia, it will become turbid during the evaporation, which must be continued till the matter be perfectly dry. It is next redissolved in a very small quantity of cold water, which leaves undissolved a double phosphate of soda and lithia, equivalent to one-third of its weight of carbonate of lithia. The characters which distinguish this phosphate from the earthy phosphates with which it may be confounded, are as follows: It is very fusible before the blow-pipe. When melted with carbonate of soda, it enters with the soda into the charcoal. On a leaf of platina the melted mixture is limpid. The

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* See this *Journal,* vol. ii. p. 176, January 1825.

earthy phosphates remain on the charcoal while the soda penetrates it, and do not give a limpid mixture when they are melted on a leaf of platina. With twice its weight of carbonate of lime, it fuses at a red heat, without, however, attacking the platina, as lithia ordinarily does; but if some drops of water are added to it, and afterwards evaporated, the platina becomes yellow all round when the mass is heated anew.

2. *Professor Berzelius's Experiments on the Orange Gas produced from a mixture of Fluor-Spar and Chromate of Lead.*

As the English and French Journals have already given an account of Professor Berzelius's experiments on the different combinations of the fluoric acid which have facilitated the reduction of *Silicium*, *Zirconium*, and *Tantalum*, we shall not at present enter upon the subject.

A German chemist, M. Unverdorben, has published some experiments on the fluoric acid, the most curious of which was that in which, after mixing together fluor-spar and chromate of lead, he distilled them in a leaden retort, with fuming or anhydrous sulphuric acid. From this there resulted a gas, which could not be collected, because it destroyed the glass. This gas gave a very thick yellow or red smoke. It was readily absorbed in water, which was then found to contain a mixture of chromic and fluoric acids. When it came in contact with air, the gas deposited small red crystals, which were those of chromic acid.

Professor Berzelius repeated these experiments of M. Unverdorben, and he found that the experiment succeeded equally well with common concentrated sulphuric acid. He collected the gas in glass flasks covered with melted resin, and filled with mercury. The gas had a red colour. It gradually attacks the resin, deposits chromic acid in its mass, and penetrates even to the glass, which it decomposes without change of volume, the chrome being replaced by silicium. Ammoniacal gas introduced into it burns with explosion. Water dissolves it, and yields an orange-coloured fluid, which, evaporated to dryness in a platina dish, leaves as a residue pure chromic acid. The fluoric acid volatilizes entirely. This method is at present the only one which gives chromic acid perfectly pure.

If the gas is received in a platina vessel of some depth, whose sides have been slightly wetted, and into the bottom of which the gas has been made to descend, the water begins to absorb the gas, but, by and bye, crystals of a fine red colour are seen to form themselves round the opening of the metallic tube which conveys the gas, and, in a short time, the vessel is filled with a red snow, consisting of crystals of chromic acid. The fluoric acid dissipates itself in vapour, and absorbs entirely the water added at the beginning of the experiment. These crystals have this curious property, that, when they are heated to redness in a platina dish, they begin at first to melt, and afterwards, by a slight explosion, accompanied with a flash of light, they decompose themselves into oxygen gas, and the green protoxide of chrome. The chromic acid which has been dissolved in the water does not present this phenomenon. It fuses during its decomposition, but it does not give a flash of light. This difference does not arise from its containing water, for it is perfectly free from it when it is heated to a little above 100° centigrade.

M. Unverdorben had already observed, that crystals of chromic acid, introduced into ammoniacal gas, are decomposed with a flash of light. The ammonia is destroyed, and the acid leaves the protoxide as a residue. It is necessary to make these experiments quickly, as the crystallized acid is deliquescent.

In distilling chromate of lead with chloride of sodium, we obtain a gas similar to the preceding, and which contains chrome combined with chlorine, in such proportions, that the water, by its decomposition, gives rise to the formation of the hydrochloric and chromic acids. The gas is red, and may be collected over mercury, but it is very much charged with chlorine, when it it is prepared by means of the common concentrated sulphuric acid, whose water of combination destroys a certain quantity of the gas.

3. *Account of Professor Berzelius's Method of Detecting Arsenic in the Bodies of Persons Poisoned.*

Professor Berzelius has lately given some instructions for the discovery of arsenic in persons that have been poisoned with it. He considers the *reduction of arsenic to the metallic state as the only incontestible proof of the presence of this poison.* Arsenic may occur in two ways, viz. when it is found in substance (in the state of arsenious acid) in the dead body, and when it is not found in this state; though the intestines of the dead body may contain it in the state of a solution.

In the first of these cases, it is easy to determine the presence of arsenic. In order to do this, take a piece about three inches long of an ordinary barometer tube, and having drawn out one end of it C B, as shown in Plate I. Fig. 34. into a much narrower tube, close the end B. Let some of the arsenic found in the body be now put in at the open end A, so that it may fall down to the end B. Any quantity of this arsenic of sufficient volume to be taken from the body will suffice for this purpose. The arsenic being at the end B, a little charcoal is let fall upon it, after it has been freed from all moisture by bringing it to a red-heat with the blow-pipe. The charcoal is then heated in the tube at the flame of a spirit-lamp, the point B being held out of the flame. When the charcoal is very red, the point B containing the arsenic is drawn into the flame. The arsenic is then instantly volatilized, and passing into vapour by the red charcoal, it is reduced, and reappears on the other side of the flame in a metallic state. The flame is then brought slowly towards the metallic sublimate, which is thus concentrated into a smaller space in the small tube, and then presents a small metallic ring shining like polished steel. * We have now only to verify, by its smell, that the metallic sublimate is arsenic. For this purpose, cut the small tube with a file a little above the sublimate, and, having heated the place where it lies, put the nose above it at a small distance, and the particular odour of the metal will be immediately perceived.

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* Had the experiment been made in the wide part of the tube, the result would scarcely have been visible with a small quantity of arsenic.

In the case where the solid arsenic cannot be found, we must collect as much as possible of the contents of the stomach and the intestines, or even cut the stomach in pieces, and mix it with its contents. The whole is then to be digested with a solution of hydrate of potash. Hydrochloric acid is then added in excess. The whole is filtered, and, if the liquid is too much diluted, it is concentrated by evaporation. A current of sulphuretted hydrogen is then passed through it, which precipitates the arsenic in the form of the yellow sulphuret. If the quantity of arsenic is very small, the liquid will become yellow without giving a precipitate. It must then be evaporated, and, in proportion as the hydrochloric acid becomes more concentrated, the sulphuret of arsenic will begin to be deposited. It is then filtered. If the sulphuret remaining on the filter is in too small a quantity to be taken from the paper, add some drops of caustic ammonia, which will dissolve it. Then put the liquid which passes the filter into a watch-glass, and evaporate it. The ammonia will be volatilized, and will leave as a residue the sulphuret of arsenic. If it shall still be difficult to collect the sulphuret, we must put into the watch-glass a litttle pulverized nitrate of potash, and, with the finger, mix the sulphuret with the nitrate of potash, which detaches it from the glass. At the bottom of a small phial, or a piece of glass tube, shut at one end, melt a little nitrate of potash at the flame of a spirit-lamp, and introduce into it, when melted, a little of the mixture which contains the sulphuret of arsenic. It is oxidized with effervescence, but without fire, or detonation, and without loss of arsenic. The melted salt is then to be dissolved in water, and lime added in excess, and the liquid boiled. The arseniate of lime will then be deposited, and may be collected. When dried, it is mixed with charcoal, and then brought to a red heat by the blow-pipe, and a small quantity of this mixture is allowed to fall to the end B of the above tube. It is now gradually heated to expel all humidity which tends to throw it into the wide tube A C, and when it is very dry, heat at the flame of the blow-pipe, the part of the tube which contains the mixture. The arsenic will be disengaged, and be sublimed, at a distance from the heated part. An addition of vitrified boracic acid greatly promotes the decomposition which then takes place at a less elevated temperature; but this acid frequently contains water, and produces a bubbling of the melted matter which raises it in the tube, and causes the vapours to issue by perforating the softened part of the glass.

M. Berzelius maintains, that the *sixth part of a grain of sulphuret of arsenic is sufficient to make three different trials;* but he adds, that, when we have discovered only very small traces of arsenic, we must take care not to introduce any by means of re-agents, among which, both the sulphuric and the hydrochloric acid may contain it. The first almost always contains some arsenic when it is not manufactured from volcanic sulphur, and the second, in consequence of sulphuric acid being used in the preparation of the hydrochloric acid, yields the arsenic which it contains in separating it from soda. We must, therefore, be certain of the purity of these re-agents.

When death has been caused by the arsenic, and not by the arsenious acid, the process must be modified, because the sulphuretted hydrogen gas decomposes the arsenic acid too slowly. In this case, we must add hydrosulphuret of ammonia, which reduces the arsenic acid to the state of sulphuret, which is afterwards precipitated by the hydrochloric acid. *

4. *Professor Berzelius's Researches on Molybdæna.*

In studying the properties of molybdæna, M. Berzelius has found that this metal, of which we knew only the purple oxide, produced by drying the blue oxide, and molybdic acid, has two salifiable oxides, whose saline combinations were till

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* It is obvious that Berzelius has not seen Dr Christison's paper on the "Detection of minute quantities of arsenic in mixed fluids." These gentlemen agree in precipitating arsenious acid by sulphuretted hydrogen, so as to obtain the yellow sulphuret; but their subsequent methods differ: Berzelius adopts a process which requires all the dexterity of as expert a chemist as himself for conducting it with success. Dr Christison, on the contrary, scrapes the sulphuret from the filtre with a knife, which may be done though a very minute portion of it is present, and obtains metallic arsenic at once by heating it with black flux. We refer for particulars to his paper in the *Edinburgh Medical and Surgical Journal.*

now unknown. The deutoxide may be procured by digesting a mixture of molybdic acid, metallic molybdæna, and sulphuric or hydrochloric acid, till the colour of the liquid becomes a deep red. Instead of metallic molybdæna, we may substitute metallic copper. The red liquid gives, with ammonia, a rust-yellow precipitate, which is the hydrate of the deutoxide of molybdæna. This hydrate is very soluble in water. When it is washed, the water, after having removed the saline substances, which caused its precipitation, begins to dissolve the hydrate, and becomes yellow. It at last dissolves it entirely, and the saturated solution is red. It reddens turnsol. The hydrate dissolves in acids, and gives salts, whose solutions are red, but which, when evaporated to dryness, are almost black.

The protoxide is produced when we macerate the solution of a salt, with a base of the deutoxide, with mercury, and add, from time to time, a liquid amalgam of potassium. The colour of the liquid becomes deeper, and ends by growing black. Before the introduction of the amalgam, we must add to it hydrochloric acid, in order to prevent a part of the deutoxide from being precipitated before its entire reduction to the protoxide. The black solution is then precipitated by ammonia, and the black precipitate is the hydrate of the protoxide, which must be well washed, and then dried *in vacuo.* The hydrate appears then under the form of a jet black powder. When heated *in vacuo,* it gives out slowly its water, and afterwards, at a temperature which approaches to that of brown-red, it takes fire, and burns with scintillation. The barometer of the air-pump is not affected by this phenomenon, which, in other respects, is of the same nature as that which is observed in the hydrate of the peroxide of iron, and the protoxide of chrome, and of zircon. The anhydrous protoxide is insoluble in acids. When heated in air, it takes fire, and burns feebly, producing the brown oxide of molybdæna. The salts of this oxide are black, and their dilute solutions have a compound colour of green, black, and brown, though sometimes they assume a fine purple colour. The fluate of the protoxide, for example, is a very fine purple, and the double fluates with potash, soda, and ammonia, are of a rose red colour.

In order to form the protoxide of molybdæna, we may make use of zinc in place of the amalgam of potassium, but the protoxide then retains the oxide of zinc in a very obstinate manner.

What is called molybdous acid, that is to say, the blue oxide of molybdæna, is not a particular acid. It cannot be combined with alkalis, which, on the contrary, decompose it, by precipitating the hydrate of the yellow oxide, and combining with the molybdic acid. It may be produced most readily in dissolving the bimolybdate of ammonia, and adding to it a solution of a salt with a base of the deutoxide. It produces a precipitate of a fine deep blue, which is very soluble in water, and is only deposited because the water contains salts. We may wash it with a solution of sal ammoniac, afterwards removing the salt by a little cold water. It gives with warm water a blue solution, highly saturated, which may be easily preserved at the ordinary temperature of the atmosphere. In the dry form it resembles indigo, and retains its solubility in water.

Professor Berzelius has found, that the deutoxide of molybdæna is composed of one atom of molybdæna, and two atoms of oxygen. The molybdic acid contains three atoms. The blue oxide is a bi-molybdate of the deutoxide of molybdæna, that is $\ddot{Mo} + 4\,\dddot{Mo}$. There is still another combination between the oxide and the acid which is produced when the blue liquid is digested with metallic molybdæna. It is green, equally soluble in water, and precipitable in sal ammoniac. M. Berzelius supposes its composition to be $\ddot{Mo} + 2\,\dddot{Mo}$. Tungstic acid likewise combines with the deutoxide of molybdæna, and the combination is very soluble in water, and of a superb purple colour. It is also precipitated by sal ammoniac.

The molybdic acid performs the part of a base towards the stronger acids. M. Berzelius has examined them in this point of view, and has described some of the salts which it forms.

M. Berzelius has discovered a new sulphuret of molybdæna, proportional to the molybdic acid. It is of a ruby colour, transparent and crystallized. It combines with the metallic protosulphurets, and forms with them particular salts, of which a great number are soluble in water.

Molybdæna combines with chlorine in three proportions. The first is red, and a little volatile. The second is black, very fusible, very volatile, and crystallizes in a black mass, of a brilliant colour, like iodine, which it resembles even in the colour of its gas, which, however, is more red than violet. The third is colourless, and crystallizes in scales. These three chlorides correspond to the muriates of the protoxide, of the deutoxide, and of the peroxide, that is to say, of the acid. Iodine does not combine in the dry way with molybdæna, but the hydriodic acid dissolves the protoxide and the deutoxide. The molybdic acid decomposes it, and separates the iodine from it

The best method of obtaining molybdæna, in some quantity, is to heat the molybdic acid in a porcelain tube. When this tube is heated to redness, there is introduced into it a current of hydrogen gas, which is continued as long as it produces water.

5. *M. Setterberg's Experiments on the Sulphurets of Cobalt.*

M. Setterberg has found that the deutoxide of cobalt decomposes sulphuretted hydrogen gas when cold. The sulphuret thus produced contains three atoms of sulphur. Hydrochloric acid dissolves some of the cobalt in it, and leaves another sulphuret of cobalt in the form of a black powder, which contains *four* atoms of sulphur for *one* atom of metal.

6. *M. Mosander on the Precipitation of Magnesia by Carbonate of Soda.*

During the analysis of a new species of noble serpentine, M. Mosander made an observation which merits the attention of chemists who are occupied with the analysis of minerals. He remarked, that when the carbonate of soda is used to precipitate magnesia, the precipitate contains a double carbonate of soda and magnesia; that the alkali cannot be removed from it by edulcoration with water, and that the washings always contain magnesia. It is necessary, therefore, to evaporate the alkaline liquid to dryness, and melt the salt to render the magnesia caustic. As carbonate of potash is commonly used for this operation, there is no risk of being exposed to this inconvenience ; but it is evident, that, whenever the liquid contains a salt with a base of soda, even though potash is used to precipitate the magnesia, the double carbonate of soda and magnesia ought to be precipitated.

7. *M. Mosander's Analysis of the Oxides of Iron, formed by continued Heat.*

It is well known that M. Berthier analyzed the cinder which is formed on pieces of iron intended for being laminated to form iron-plate, and that he considered it as a new degree of oxidation of iron, which contained $1\frac{1}{6}$ as much oxygen as the protoxide. M. Berzelius kept a piece of iron, intended for iron-plate, forty-eight hours in a furnace. The oxidated crust was two lines thick, and exhibited, what M. Berthier has also observed, two distinct layers. M. Mosander undertook the analysis and examination of it. It was at first evident, that M. Berthier had analyzed together two distinct substances. The interior layer is more black than the other, has a grained fracture of little lustre, and is very slightly magnetic. The exterior layer has a brilliant metallic lustre, a bright and shining fracture, and a grey metallic colour, and, what is very remarkable, has a powerful action on the magnetic needle.

M. Mosander found that the layers consisted of

	Inner Layer.	Atoms.	Outer Layer.
Peroxide of Iron,	27	1	36
Protoxide of Iron,	73	3	64

The formula for the first is $\overset{\cdots}{Fe}+3\overset{\cdot\cdot}{Fe}$. The analysis of the outer layer is the same as M. Berthier had obtained for the two layers mixed together. This approached to $\overset{\cdots}{Fe}+2\overset{\cdot\cdot}{Fe}$.

But, as on this occasion, the oxidated layer was supplied with oxygen from the outer layer, and with iron from the interior layer, it may be supposed that there was an insensible gradation from the most oxidated to the least oxidated side.

M. Mosander was thus led to analyze different zones of the two layers ; and he found that at the exterior layer this was actually the arrangement. The external surface consisted of the red oxide, quite pure; below this was the ordinary magnetic oxide (*oxidum ferrosoferricum* of Berzelius,) and farther in the quantity of protoxide gradually increased to the commencement of the interior layer, which he found homogeneous throughout. It appears, then, to be determined by these experiments, that we have two combinations of the peroxide of iron with the protoxide, that is, the magnetic oxide $\ddot{Fe} + \dddot{Fe}$, and the less magnetic one which forms the inner layer of the oxidated crusts produced upon metallic iron by heat, $\dddot{Fe}+3\ddot{Fe}$.

STOCKHOLM, *November* 10*th* 1825.

ART. XXVI.—*On some Remarkable Concretions which are found in the Sandstone of Kerridge in Cheshire.*[*] By SAMUEL HIBBERT, M. D. F. R. S. E. and M. G. S. Secretary to the Society of Scottish Antiquaries. Communicated by the Author.

THE stony concretions that form the subject of this short paper are found under circumstances that it will be previously requisite to describe. They are obtained from a sandstone of the coal formation composing a small ridge of hills named Kerridge, situated about three miles from Macclesfield, in Cheshire. Not far distant is the more recent deposit of the newer red sandstone, or red marle formation. Near the junction of the sandstone, of the coal formation, and of that of the red marle, there is a considerable disturbance of the strata. The celebrated hill of Cheshire, Alderly Edge, which rises abruptly from a level country, has its strata of the newer red sandstone, inclined at about an angle of 20°, while the adjoining strata of the same formation are nearly horizontal; and in like manner, the strata of Kerridge belonging to the sandstone of the coal deposit, exhibit numerous faults and dislocations, being likewise intersected by small rents, or fissures, such as I have observed to take place in the vicinity of whin dikes; but, in this instance, the disturbing cause has not made its appearance. The seams of coal in the immediate vi-

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[*] Read at the Royal Society of Edinburgh, 5th December 1825.

cinity, from partaking of the dislocation, are said to have defied the operations of the miner. In fact, there are no rocks of this kind which I have examined, where the Huttonian could discover more presumptive proof in favour of that theory, which attributes the elevation and dislocation of strata to an expansive power acting from beneath; and this view would find additional support in the very remarkable induration which prevails through all the strata of Kerridge,—a circumstance which the same theorist would refer to the intense influence of subterranean heat, which operated on these secondary strata at the period of their consolidation. This uncommon induration has long rendered the sandstone of Kerridge one of the most valuable quarries of Cheshire, for, being very fissile, it readily splits into laminæ of various degrees of thickness, yet so very firm in its consistence, as to render it in great demand for the purpose of roofing slate. But hard as is the general structure of this sandstone, it is not unusual for the workmen, while quarrying it, to meet with considerable patches of the rock, the dimensions of which are often several yards, acquiring an almost superlative degree of induration. In this state it is converted to the purposes to which trap-rocks of unquestionable igneous origin are applied, being used for paving and repairing the roads of the country. When a patch of this unyielding rock occurs, it is very significantly named by the labourers *burnt stone.* This mode of accounting for the phenomenon, induces us to suspect, that some Huttonian had given to the rock so Plutonic a name, otherwise the originality of the theory taught by the illustrious founder of this school becomes questionable, having been anticipated by the popular view of the same kind entertained by the illiterate quarry-men of Kerridge. But who, in this age of theorizing, can boast a system that will long remain unchallenged? The peasants of Cheshire have, from time immemorial, speculated upon the highly inclined strata of Alderly Edge, almost in the same manner as Hutton himself would do were the same phenomena to present themselves to his notice. They have elevated these rocks by an expansive force, alleging that an immense vacant space exists beneath them, which they say may be distinctly recognized by the hollow sound that is emitted whenever a traveller rides over the hill,—the sound being responsive to the tramp of his horse's feet. It would, however, have been well if an hypothesis like this had even here stopped short; but as geology and romance are often united, the theorists of Cheshire, on the principle of nature abhorring a vacuum, have filled this vacant space in the hill of Alderley with valorous knights in armour and the fair objects of their chivalry. Nor have the natural phenomena exhibited at Kerridge been less the subject of bold speculation. The hill is considered as *spell-bound*, the indications of which are not only the *burnt stone*, but certain remarkable concretions found imbedded in the rock, which were first introduced to my notice under the name of *witch-knots*. Assuredly the origin of these concretions is as puzzling as most appearances which the geologist encounters. It may be questioned, therefore, whether it is not more prudent to allow the theory which the popular voice of superstition assigns to their causation to remain undisturbed, than to hazard, on this occasion, any conjecture of my own, which may perhaps be not a whit the less chimerical.

The stony concretions, named *witch-knots*, which are found in the Hill of Kerridge, occur in some abundance, being detected when force is applied to the block of stone in which they lie concealed, for the purpose of splitting it up into thin slabs. When a stone has been thus split in the direction of the plane of its fissility into two parts, one slab shows a round hollow in the form of a basin, while the other slab exhibits the segment of a solid sphere of sandstone projecting from its surface, and exactly fitting the basin-shaped hollow of the other slab into which it was received when the two fragments were united *in situ*. (See Plate I., Figs. 29. and 30.) If we could be assured that the fragment in which the basin-shaped hollow is found was *in situ* always the lowest, the parallel and horizontal lines, which, on a reference to Fig. 30, of the Plate, will be found to encircle the projecting segment of the spheroid body, would be easily enough accounted for; they would indicate a succession of layers of sandstone, which had filled up the corresponding hollow of the other slab. But I could not learn that this relative situation *in situ* of the two fragments had been completely ascertained; or, granting even that this had been done, there would still remain a question touching the origin of the basin in which these parallel layers of sandstone were deposited. A theory has been hazarded by one of my friends, that the hollow might have been induced by the corroding action of running water, which was afterwards filled up by successive deposits of sand, that became indurated during the process of consolidation which the rock underwent. This view, however, admits of little to be said in its support.

The dimensions of the specimen, a drawing of which accompanies this account, are as follows:* From A to B 13 inches; from C to D, 17 inches; from A to C, 13½ inches; from B to D, 14½ inches. The diameter of the basin, and of the corresponding section of the spherical body, is 10 inches.

All these concretions differ in no respect, as to the nature of the rock of which they are composed, from that of the solid slab in which they are found imbedded. They are of various sizes, some being double the magnitude of the specimen which is figured in the Plate. Nor is the form of the basin, and consequently of the concretion which fills it, always the same. One specimen had a form something between oval and triangular, the recipient basin corresponding to it.

In the same sandstone where these concretions are found, I detected the fossil remains of gigantic reeds, such as are usually found in coal-fields.

This is all the description which I have to give of these concretions, and of the circumstances under which they are found; my object being rather to introduce them to the notice of the naturalist, than to offer any hypothesis on their origin, regarding which, I actually feel great lack of invention. Without any further observations, therefore, I shall leave the witch-knots of Kerridge to be unravelled by some more successful geological conjuror than I would confess myself to be.

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* I am indebted for the specimen to Philip Antrobus, Esq. of Bollington, who was so obliging as to point out to me the site of these concretions.

ART. XXVII.—*Notice regarding the Discovery of Live Cockles in a Peat Moss at a great distance from the Sea.* By JOHN STARK, Esq. M. W. S. Communicated by the Author.

AT the meeting of the Wernerian Society on the 19th of November, Henry Witham, Esq. read a very interesting paper "On the Discovery of Live Cockles in Peat-moss, at a great distance from the Sea, and much above its present level." These shells were discovered in the month of October last in Yorkshire, about forty miles from the sea-coast, in the course of a mineralogical excursion by Mr Witham through that county. He was led to the spot by a tradition which prevailed in the country of this anomalous occurrence, and found the cockles alive in the sandy bottom of a drain which had been formed through the moss. This peat-moss is situate about a mile and a half, or two miles, (we understood him to say) from Greta Bridge, and about two miles from the river Tees. That cockles had existed in that spot for a period of unknown antiquity is ascertained from the name of the farm in which this peat-moss occurs, and which it has borne for centuries—*Cocklesbury.* Specimens of the cockles were laid on the table by Mr Witham, and of the sand in which they burrowed; and live specimens would have been exhibited, but from the circumstance of the ditch being frozen over when a friend visited the place for the purpose of procuring them. The cockles are found in considerable quantity. Mr W. gathered a number, and even had the curiosity to eat some of them. They differed but little in taste from the common cockle, unless it were that they seemed not quite so salt.

The specimens of the shells exhibited by Mr Witham, and of which the writer of this notice, by the kindness of that gentleman, is in possession of one, agree in every respect with those found on most of our sandy shores—the *Cardium edule* of Linnæus. They are of the ordinary size, and nothing in their external appearance would lead any one to suspect they were from a locality so very different. With the exception of one instance, which has been pointed out to us by a scientific friend, nothing similar, as far as has come to our knowledge, has been remarked before; though the publication of Mr Witham's discovery, by directing attention to the subject, may lead to the knowledge of collateral facts. The instance alluded to is found in the Description of Zetland by John Brand, published in 1701; and as the statement is interesting, and the book in which it occurs of considerable rarity, we give the passage in the words of the author:

"A gentleman in the parish of Dunrossness told one of the ministers in this country, that about five years since a plough in this parish did cast up *fresh Cockles*, tho' the place where the plough was going was three-quarters of a mile from the sea; which cockles the gentleman saw made ready and eaten. How these shell fishes came there, and should be fed at such a distance from their ordinary element, I cannot know, if they have not been cast upon land by a violent storm, much of the ground of this parish, especially what they labour, lying very low, and the sea hath been observed in such storms both to cast out stones and fishes; or if these Cockles have been found in some deep furrow, from which to the sea there hath been a conveyance by some small stream, upon which the sea hath flowed in stream tides, especially when there is also some storm blowing. If only shells were found, such as of oysters and the like, the marvel would not be great, seeing such are found upon the tops of high mountains, at a greater distance from the sea, which, in all probability, have been there since the universal deluge; but that any shell-fish should be found at some distance from the sea, and fit for use, is somewhat wonderful and astonishing."*

When Dr Hibbert was recently in Shetland, he was led by this curious passage to make inquiry on the spot regarding these cockles, but could procure no information on the subject; and the surface of the soil being covered to some depth by drifted sand, precluded further investigation.

Professor Wallace, it may be mentioned, found oyster shells in Bagshot Heath, too recent in appearance to be characterized as fossil, of which the origin is not known; and modern experiment has proved that shell-fish may be transferred from salt to fresh water with impunity, though it is difficult to believe that the ingenuity of our ancestors exerted itself in providing such articles of luxury in such a way. The

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* *A Brief Description of Orkney, Zetland, Pightland-Firth, and Caithness, &c.* By John Brand. pp. 115, 116. Edinburgh, 1701.

fact observed and related by Mr Witham, therefore, of live cockles being found at a distance so considerable from the sea, and at such a height above its level, can only be accounted for by the retrocession of the ocean—or by supposing some great convulsion to have submerged the land, and left these evidences of its effects. In any view the discovery is interesting, and similar occurrences will probably lead to a modification of the prevailing theories. If the shells in question had not been found alive, it might have been conjectured that they had been deposited there at a very distant period, by one of those catastrophes which are supposed to have changed the bed of the ocean, or floated its astonished inhabitants over the land, and an unknown and mysterious antiquity thus assigned to shells which might have been alive shortly before. That similar circumstances have, on more occasions than one, misled observers we have little doubt. We have seen specimens of shells from the banks of Lochlomond, which seem, from their appearance, to be in this predicament; and instead of supposing that these were the remains of animals which had been left there when Lochlomond joined the eastern and western seas, we should conjecture that they had recently lived and died in the very lake on the banks of which they were found.

In the paper, by Mr J. Adamson, which gave an account of the shells thus found, and which is printed in the *Wernerian Transactions*, Vol. iv. p. 334, that gentleman says, that " the shells begin to appear about half way between the highest and lowest, or the winter and summer surfaces of the water, which varies in this respect about six feet. After removing a slight covering of coarse gravel, we find a thin bed of clay, of different shades of brown, passing into yellow colours, as we descend. In the *upper*, or brown clay, are found shells of the following species: Those marked with an asterisk are doubtful. Buccinum reticulatum*, Nerita glaucina, Tellina tenuis*, Cardium edule, Venus striatula, Venus Islandica, Nucula rostrata, young, Pecten obsoletus, Anomia ephippium, young, Balanus communis, Balanus rugosus, Echinus esculentus.

" A skilful conchologist would discover many others, from the numerous traces of them in the clay. Those shells appear to have been deposited generally in an entire state, and many are found with both valves in their natural position. The Balanus is still slightly attached to the Venus or Pecten; and the spines of the Echinus are found clustered in the clay inclosing its fragments; so that they must have been either covered by water to a considerable depth, or thrown on a beach not much exposed to waves. Few of them, however, can be extracted entire, as several of the species are always in a state of gritty chalk; but many complete and beautiful specimens of the Pecten can easily be procured. Few of their fragments appear on the exposed part of the beach, but, during summer, many may be seen a few feet under water."

We lately received several specimens of the *Buccinum lapillus*, from Shetland, which were found alive on the margin of a lake in the island of Yell, about a mile and a half from the sea. The lake has an outlet by a small rivulet. The shells are somewhat thinner in their texture than their congeners on the rocks of the neighbouring coast, and are all of the banded variety of that shell, or crossed with dark-coloured lines. That these shells had been carried to that locality by water-fowl is not unlikely; and the outer lip of the shells being somewhat broken, may have occurred in the attempt to extract the animal as food. But the fact of the animals being alive when the specimens were picked up, goes to prove that shell-fish may be brought to live in fresh water; and the experiments undertaken by Mr Arnold of Guernsey at the suggestion of Dr MacCulloch, and the discovery of live cockles at a distance from the sea by Mr Witham, leave little room to doubt that many species of fish may be transported to, and live and propagate in, inland fresh water ponds and rivulets.

As the result of Dr MacCulloch's experiments may not be generally known, we give a list of the species of fish naturally belonging to the sea, which have been found to live in fresh water. Those marked with an asterisk have been finally naturalized:

Conger
Torsk
Sprat
Shad
Alose
Greater Lamprey
Lesser Lamprey
Stickleback
Cottus Quadricornis
Mullet
* Plaice
Flounder
Red Do.
White Whale
Cod
* Basse
Loach
Red Do.
* Smelt
* Atherine

* Rock Fish
* Cuckoo Fish
Old Wife
* Sole
* Turbot
Sand Eel
Rockling
Whiting Pout
Mackerel
Herring
* Horse Mackerel
* Pollack
Prawns
Shrimps
Crabs
* Oysters
* Mussels.*

The pond in which the fish are kept is about four acres in extent, and close by the sea, from which it is separated by an embankment; but it must not be concealed, that, "receiving an insufficient supply of fresh water in summer, it varies, so that while it is perfectly fresh in winter, it is nearly salt in very dry weather, and brackish in various degrees at intermediate periods." The result of Dr MacCulloch's experiment, therefore, though flattering as to the ultimate success of the plan, is not so decisive as if it had been made in a pond at a distance from the sea, and whose waters were invariably fresh. Perhaps a series of ponds in which the water was less and less salt, may be found necessary to assimilate the inhabitants of the deep gradually to living and propagating in inland ponds; and though it may require time, and numerous trials, before the experiment fully succeed, yet it is an object too important, even in an economical point of view, to be lightly given up. How many exotics now flourish in the open borders of our gardens, and in our shrubberies, which, not very many years ago, could only be reared under the protection of the green-house or stove! and how many animals, from regions much more genial, are now permanently domesticated in our variable climate! If it be not carrying the analogy too far, it may therefore be presumed, that the ova or fry of sea-fish, reared in the series of ponds we have supposed, may at last be brought to live and propagate in lakes and waters at a distance from the sea. The spawn of fresh water fish is an article of trade in China; and their methods of hatching the ova of fishes might be adopted with promise of success in the assimilation of the inhabitants of the deep to a change of element. It would be a new triumph to science, if an additional and inexhaustible supply of wholesome and nutritious food were thus provided in places at a distance from the sea, and at present precluded from its use.

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* *Quarterly Journal*, No. 38, p. 242.

It may be further noticed, that not only did the fish in Mr Arnold's pond improve materially in quality, but the few eels which were formerly almost its only tenants, have, since the introduction of fish from the sea, increased incalculably in number, and so as themselves to bring in a considerable revenue. The pond now produces a large rent, and is resorted to for the supply of the market when the weather prevents the boats from putting to sea.

On the subject of Food for the supply of the fishes in such ponds, Dr MacCulloch remarks, that, as far as this experiment goes, it proves that fish may be fed "merely by bringing different kinds together, as is the case in nature." Minute aquatic animals and larvæ abound in every piece of water, who find their nutriment in matters invisible to the eye and impalpable to the touch. These again form the food of the smaller fishes, aquatic helices, mytili, leeches, and the multitudinous inhabitants of lakes; and their fecundity is in general so great, as not only to keep up the species, but afford a considerable overplus for the food of others. Mr Pennant relates, that in the fens of Lincolnshire, and some of the rivers that creep out of them, the stickleback is produced in such quantity, that once in seven or eight years they are forced to migrate. "The quantity is so great," he adds, in one river, the Welland, "that they are used to manure the land, and trials have been made to get oil from them. A notion may be had of this vast shoal, by saying, that a man employed by the farmer to take them has got, for a considerable time, four shillings a-day by selling them at a halfpenny per bushel." * But should the smaller fishes, introduced or natives of the lakes, not afford a sufficient supply, the same ingenuity which can reclaim fish from the deep will be exerted with equal success in procuring them food.

Art. XXVIII.—*Notice of Captain Parry's Last Expedition to the Arctic Regions in* 1824 *and* 1825.

The return of Captain Parry from his last expedition to the Arctic Regions without having accomplished any of the lead-

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* *British Zoology*, vol. iii. p. 353.

ing objects for which it was fitted out, will probably terminate for a while those valuable and interesting voyages of discovery, by which the British government have added so much to our knowledge of the Polar Regions.

The expedition set sail from the west coast of Greenland on the 4th of July 1824; but such was the condition of the ice, that the Fury and Hecla were detained in Davis' Straits for eight weeks. Having disentangled themselves from the ice about the 9th of September, they entered Lancaster Sound, and, passing through Barrow's Straits, they arrived at the entrance of Prince Regent's Inlet. Here the weather became very severe, and after experiencing great obstruction from the ice, they, with considerable difficulty, reached Port Bowen on the 28th of September in North Lat. 73°, and West Long. 79°. Winter was now rapidly approaching, every exertion was made to prepare for it, and the ships were safely placed in their position for the winter on the 1st of October. The ships were completely surrounded with young ice so early as the 6th of October.

The monotony of an Arctic winter Captain Parry contrived to relieve by such amusements and occupations as were within the reach of his party. Once every fortnight a masquerade was got up in one of the ships; and as there was a good collection of books on board, the intellectual part of the ships' company were enabled to add instruction to their amusements.

The greatest degree of cold observed during the winter amounted to $48\frac{1}{2}$° below *zero* of Fahrenheit, and the winter was considered as comparatively mild. This circumstance will give a greater degree of value to the meteorological observations made on board the ships, as their combination with those formerly made, will enable us to deduce with very considerable accuracy the mean temperature of the parallel of 73°.

When the weather was favourable the hunting of the white bear, of which twelve were killed, formed an agreeable relaxation; and in the spring considerable numbers of white grouse were shot, which were considered, both by the officers and men, as a great luxury.

When the spring brought with it more genial weather, parties of discovery were sent out under Captain Hoppner, Lieutenant Sherer, and Lieutenant Ross. The party under Captain Hoppner, penetrated into the interior to the eastward; that under Lieutenant Sherer, went along the coast to the south, and succeeded in reaching Fitzgerald Bay, in lat. 72° 30′; while Lieutenant Ross advanced to the northward and proceeded beyond Cape York in 73° 30′.

The summer was ushered in with a shower of rain, so early as the 6th of June 1825. The thaw advanced with great rapidity, and the weather became agreeable and mild. Preparations were made for quitting their winter-quarters; and, on the 20th of July, when the ice was fairly broken up, the Fury and Hecla quitted Port Bowen, after a residence of ten months. On the 22d, they were driven back again nearly to Prince Leopold's Islands in Lancaster Sound. On the 23d they reached North Somerset; and, on the 24th, Cape Seppings, on the western entrance of Prince Regent's Inlet. Here the danger to which the ships were exposed now commenced. They worked down to the southward, along the west shore of the Regent's Inlet, till the morning of the 1st of August, when unfortunately the Fury was forced on shore by masses of ice. By great exertions she was got off, and she bore down a little farther to the southward, in order to be repaired. The severity of the weather, however, increased; and, notwithstanding that the greatest efforts were made to save her, she was abandoned on the 23d of August. All her crew were removed on board the Hecla, which had herself been in imminent danger.

Every hope of prosecuting the objects of the expedition now vanished, and it was the opinion of all the officers that they should return to England. The Hecla accordingly stood to the northward; and, on the 27th August, she anchored in Niell's Harbour, a little to the southward of Port Bowen. After two or three days, which were spent in refitting the vessel, the Hecla quitted Prince Regent's Inlet on the 1st of September. By the 17th they had got through the ice, and passed the Arctic circle; and, on the 1st October, they reached the Orkney Islands. On the 16th October Captain Parry arrived at the Admiralty, having landed at Peterhead in Scotland, and travelled to London by land.

During this voyage only two men were lost,—one perished by disease, and one was drowned. The rest of the crew of both vessels returned in perfect health and spirits.

The plants collected during the expedition, have been put into the hands of Dr Hooker for examination; but we understand that they do not contain any thing very new or important.

We look forward with much anxiety to the publication of the meteorological and magnetical observations taken during this expedition; particularly as they were made at a place intermediate, both in longitude and latitude, between Melville Island, and the stations of Winter Island, and Igloolik.

ART. XXIX.—HISTORY OF MECHANICAL INVENTIONS AND PROCESSES IN THE USEFUL ARTS.

1. *Description of the Double Weather Sluices invented by* ROBERT THOM, Esq., Rothesay. Communicated by the Author.

THIS apparatus is, to a certain extent, similar to the one last described: but it has a double operation, the sluices first opening, one after another, as the streams increase, until they reach a given height; and then shutting, one after another, as they continue to rise above that height. Again, when the streams begin to fall, the sluices open, one after another, until they (the streams) fall to a certain point, and then again shut, one after another, as they continue to fall below that point; the same continuous rise in the streams, first opening, and then shutting all these sluices in succession; and, in like manner, the same continuous fall first opening and then shutting them in succession.

This apparatus, in whole or in part, may, by a judicious adaptation, be applied to many useful purposes, as will be readily perceived by such as are conversant in these matters; but the object chiefly in view in contriving it, was its application to what are termed, "Compensation Reservoirs."

Suppose, for instance, that it is necessary to form a reservoir in the site of some rivulet or stream, for the purpose of collecting water for some important object, and which water is to be carried away in a direction different from the natural course of the rivulet, it is evident that the proprietors of land, or works on the rivulet, below where the proposed reservoir is to be made, will object to its formation, unless some compensation be made them for the water thus to be carried away. There may be many ways of making such compensations: for the sake of illustration, suppose the following: The proprietors agree that such reservoir may be made, providing that only the surplus water of floods be detained therein, and that all the rest shall be allowed to flow down the rivulet as formerly; that is, all the water necessary for such proprietors, shall be allowed to flow down the rivulet whilst it produces that quantity, and when it does not produce that quantity, they are to have all that it does produce, the same as if no such reservoir were there.

The usual way of accomplishing this, is to cut an aqueduct round one side of the reservoir, along which the water of the rivulet is always carried past the reservoir, except during floods, when the surplus water is allowed to flow over into it. A little consideration will show that a very great quantity of water is thus lost. In the first place, the proprietors below must have all they require, before any is allowed to flow over into the reservoir; but the rise of water in the rivulet that sends a part over into the reservoir, must also send more down the aqueduct; this additional quantity sent down is therefore lost. But, in all such situations, there must be other small streams falling into the rivulet, between the reservoir and works below; and the same rains that swell the rivulet above the reservoir, will also swell the streams below it; and, consequently, the whole additional water yielded by these streams is also lost.* As the quantity of water thus wasted, is generally much greater than that detained in the reservoir, and as the apparatus about to be described saves the whole, its importance may be easily conceived.

But, besides this, the proprietors on the rivulet below generally stipulate to have a certain supply of water from the reservoir during the dry season, as a *bonus* for allowing the reservoir to be made; and, as the regulating of this supply has heretofore been left to watermen, who, independent of neglect, caprice, or ignorance, are liable to be biassed by various considerations which are well known to have frequently occasioned vexatious disputes and litigation between the parties concerned, it becomes extremely desirable to be independent of such agents. The apparatus shown in Plate VI, Fig. 10. (given in Last Number) by regulating such

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* To explain this more fully, let ABZ, Plate I, Fig. 24, represent the course of the rivulet upon which the reservoir CDE is to be formed; AFB the aqueduct to carry the usual water of the rivulet past the reservoir; Z the mill or other work on the rivulet below the reservoir, which requires the greatest quantity of water; (and, of course, when it is supplied, all the others must be so,) G, H, I, K, streams that fall into the rivulet between the reservoir and mill Z; L a part of the bank of the aqueduct, lower than the rest, over which the surplus water of floods passes into the reservoir, and which is made of such height, that no water can pass over into the reservoir until enough passes to supply the mill Z. But, when the water rises above this, and a part flows over into the reservoir, an additional quantity must also pass down the aqueduct, which is therefore lost, the mill Z having enough before. Again, the same rains that swell the rivulet above the reservoir, will also swell the streams G, H, I, K, below it; all this additional water sent down by them is therefore also lost.

supply of itself, does away all this; and the quantity, once agreed upon, will continue regular and uniform.

AB, is a basin of water immediately behind the tunnel of the reservoir, in which basin the water is always kept at the same level, by the apparatus formerly described.

BC, one of a number of sluices of the same kind on that basin that turns upon pivots at C.

DE, a can, open at top, and having a very small aperture in its bottom.

F, a pulley.

DFG, a chain, which, passing over pulley F, has one end fixed to sluice BC, and the other to can DE.

H, a weight that keeps the sluice BC always shut, when the can DE is empty; when that can is full of water, it lifts weight H, and opens the sluice.

IK, a section of the rivulet, immediately before it falls into the reservoir.

LMN, a pipe which communicates between the rivulet at IK, and the can DE.

Z, this letter cannot be shown on the drawing, but is the supposed mill or factory, on the rivulet below the reservoir, that requires the greatest quantity of water.

Now, suppose the weather to be dry, and the water so low in the rivulet as only to reach the aperture 1, then the water that flows out there passes down pipe L MN, and runs out at N into can DE, which, being thus filled with water, opens sluice BC, which passes as much water as the rivulet then brings into the reservoir.* But, when the rivulet swells so as to flow out at aperture 2, then (the opening at N not being able to pass the whole) the water rises in pipe LM, and passes along pipe OP, and, falling into another can, opens a second sluice, which, with the first, passes as much water as the rivulet then brings into the reservoir. When the water in the rivulet rises so as to flow out at aperture 3, it rises also in LM, and, passing along pipe QR, flows out at R into a third can, and opens a third sluice, and these three pass as much water as the rivulet then brings, and which is here supposed to be the greatest quantity wanted at the place Z. Suppose, now, the flood should still continue to increase, the streams and surface water between the reservoir and Z will increase the rivulet at Z, as well as the higher streams increase it at IK; but there was formerly enough of water at Z: when, therefore, the rivulet rises so as to flow out at aperture 4, the water will rise also in the tubes NS, PT, RU, till it come to float S, which it lifts, and thereby shuts valve N; the water in can DE then passes out at the small opening in its bottom, and the weight H shuts sluice BC, which stops as much water in the reservoir as the streams below have increased. When the water rises in the rivulet, so as to flow at aperture 5, it rises also in the tubes till it

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* By a very simple contrivance any one can tell, by merely looking at them, whether the *same quantity* of water is flowing *from* and *into* the reservoir.

lift float T, which shuts another sluice. When the rivulet rises till the water flows out at aperture 6, it raises float U, and shuts the third or last sluice; the flood being now supposed so great, that the streams below the reservoir are of themselves sufficient for the supply at Z. When the streams begin to fall, the rivulet at IK will also fall; and when the water ceases to flow into aperture 6, the water falls so far in the tubes, as to let down float U, and open one sluice; when it ceases to flow out at aperture 5, the float T falls, and a second sluice opens; when it ceases to flow out at aperture 4, the third sluice opens, which, with the other two, passes all the water that the rivulet is then bringing into the reservoir Should the rivulet continue to fall, so as not to flow out at aperture 3, then the water ceases to flow along QR, and one sluice shuts; should it fall below aperture 2, the water also ceases to flow along OP, and a second sluice shuts, should the rivulet become quite dry, then the third or last sluice shuts. Any number of sluices may be used that are found necessary; and in this way the same quantity of water will always run in the rivulet at *Z*, as if no reservoir had been placed upon the rivulet above, except during floods, when all the water not required at Z would be detained in that reservoir. Besides the immense quantity of water thus gained during floods, the expence of cutting an aqueduct round the reservoir is also saved; nor is any bye-water necessary,* as the main sluice on the reservoir, that regulates the height of the water in the basin AB, acts also as a waster. When it is necessary to supply any fixed quantity of water from the reservoir, we have only to make an aperture in the basin of the proper size; and, as the water there stands always at the same height, the supply will always be the same.

2. *Description of a Rotatory Gas-Burner.*

Various attempts have been made to construct a gas-burner which should revolve upon the principle of Barker's mill, by means of the reaction of the gas issuing under the ordinary pressure at which it is burned. If the place round which the motion is performed is an ordinary gas-tight joint, the friction is so great, that a motion of rotation cannot be obtained, unless the gas has been greatly condensed, so as to issue under the pressure of many atmospheres. A rotatory burner of this description was made last year by Mr Deuchar, but it was nothing more than a philosophical experiment, quite inapplicable to gas, as it is generally used.

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* It is not necessary that the tunnel of the reservoir should waste the water as fast as it flows into the reservoir during the greatest floods, because the water begins to waste several feet below the top of the embankment; and, although the tunnel should not pass above one half of the water that flows into the reservoir during the greatest floods, yet as such floods only last for a short time, the water will scarcely ever rise in the reservoir more than a few inches during any one flood; and, before another comes, it is again down to its proper level; this, of course, depends upon the greater or less extent of the surface of the reservoir, as well as the size of the rivulet or feeder; but, in most cases, a bye-water will be found to be quite unnecessary, if a proper tunnel with a self-acting sluice be adopted.

The rotatory gas-burner, which is represented in Plate I. Fig. 25, is the invention of Mr Nimmo, brass-founder in Edinburgh. It displays great ingenuity, and revolves by the reaction of gas issuing at the ordinary pressure. In the section shown in the figure PQR is the gas tube communicating by its lower end PQ, with any gas pipe. This tube, which is conical at its upper end R, terminates in a sharp pivot at R, and has several large holes *a* made in it near the top, so as to allow the gas to escape. On the outside of the tube PQR, and fixed to it at PQ, is the water tube ABCDPQ, which is filled with water. These parts of the burner are all stationary.

The revolving part consists of two horizontal tubes, crossing one another at right angles. Only one of these tubes, EF, is seen in the section. These tubes communicate with the vertical tube GHMN, the lower end of which, MN, is open, and is immersed in the water tube ABCD, the whole resting upon the pivot below R, and revolving upon it as a centre. This revolution is effected in the following manner: The gas ascending the tube PQR, escapes through the openings in it at *a*; and being prevented by the water within the tube GHMN, from getting out at its open end MN, it fills the tubes EF, and issuing at the holes *h h,* at their extremities, its reaction upon the opposite sides of the tube produces a horizontal rotatory motion, the vertical tube GHMN, revolving freely in the water, in the tube ABCD.

If the contrivance now described, formed merely an elegant addition to our gas-light apparatus, it would even, in this point of view, possess considerable interest; but there is reason to think, that, by a proper adjustment of the velocity of rotation to the quantity of gas discharged, the flame may be supplied with the requisite quantity of air, more perfectly than can be done in a stationary burner. If this shall turn out to be the case, the rotatory gas-burner may be the most economical contrivance for burning gas.

3. *Curious Law respecting the Vibration of Pendulums.*

The very curious law, of which we propose to give a brief notice, has been discovered by Davies Gilbert, Esq. M. P. and explained in the *Quarterly Journal.*

As it appears from a very simple calculation, that every inch of variation in the barometer must change about two-tenths of a second the daily rate of a clock with a brass pendulum, in so far as buoyancy is alone concerned, Mr D. Gilbert requested Mr Pond and Dr Brinkley to observe the rates of their clocks, when the barometer was at its maximum and minimum height; and he learned with great surprise, that no variation could be observed.

Upon reconsidering the subject, however, it occurred to Mr D. Gilbert, that the acceleration of the time of vibration produced indirectly by an increased resistance, in consequence of reducing the arc of vibration, and the circular excess, might be a perceptible quantity. This had not escaped Mr Gilbert's notice, but he had regarded it as comparatively an evanescent quantity. When submitting it to calculation, however, he found that it was nearly equal to that of retardation arising from buoyancy, so that in a brass pendulum (Spec. Grav. 8.8) with an arc of vibration of 3° 53′ 10″ and in a mercurial pendulum with an arc of vibration of 3° 3′ 28″, *the retardation from buoyancy is exactly compensated by the acceleration arising from the reduction of the circular excess.*

Hence, if in every clock, the arc of vibration is so adjusted as to make the retardation from buoyancy equal to the retardation caused by the circular excess, and if the density and consequent resistance of the medium be supposed to change, the incremental variations of the times arising from these two causes will be equal and in opposite directions.

4. *Reverend Mr Lardner's method of securing Carriage Wheels on their Axles.*

This ingenious contrivance is represented in Plate I. Fig. 26, 27, 28. In Fig. 26, AB is the part of the axletree on which the wheel revolves, BC a stop or spud forming part of the axletree, and *within* which the wheel revolves, and CD a screw having a perforation with a linch pin, as shown in Fig. 28.

The nave of the wheel is shown in Fig. 27, where may be seen the groove *m* which receives the stop or spud BC. When the wheel is about to be placed upon the axle, this groove must be brought opposite the spud BC, Fig. 26, so as to pass over it. The wheel will then revolve within the spud, and cannot come off the axletree, unless the groove *m* first pass over the stop BC, during which process the wheel cannot revolve. A slide or wedge EF, made to fit the groove exactly, is inserted when the groove is not opposite the spud, so that the wheel cannot come off, unless this slide works out. A collar GH, Fig. 28, with an aperture corresponding to the stop BC.

ART. XXX.—ANALYSIS OF SCIENTIFIC BOOKS AND MEMOIRS.

I. *Account of the Earthquakes which occurred in Sicily, in March* 1823. By Sig. ABATE FERRARA, Professor of Natural Philosophy in the University of Catania.

THIS curious Memoir, of which we intend to give an abstract, may be divided into two parts, the first of which gives an account of the general phenomena and effects of the earthquakes, and the second relates to the physical explanation of the phenomena.

On Wednesday, the 5th of March 1823, at 26m. after 5 P. M., Sicily suffered a violent shock of an earthquake. The first shock was indistinct, but tending from below upwards; the second was undulatory, but more vigorous, as though a new impulse had been added to the first, doubling its force; the third was less strong, but of the same nature; a new exertion of the force rendered the fourth equal on the whole to the second; the fifth, like the first, had an evident tendency upwards. Their duration was between sixteen and seventeen seconds; the time was precisely marked by the seconds hand of a watch which I had with me. The direction was from north-east to south-west. Many persons who ran towards me from the south-west, at the time of this terrible phenomenon, were opposed by the resistance of the earth. The spear of the vane on the top of the new gate connected with the palace, and upon which I fixed my eyes, bowed in that direction, and remained so until the Sabbath, when it fell; it was inclined to the south-west in an angle of 20°. The waters in the great basin of the Botanical Garden, as was told me by an eye witness, were urged up in the same direction by the second shock; and a palm tree, thirty feet high, in the same garden, was seen to bow its long leafless branches alternately to the north-east and south-west, almost to the ground. The clocks in the observatory, which vibrated from north to south, and from east to west, were stopped, because the direction of the shock cut obliquely the plane of their respective vibrations; and the weight of one of them broke its crystal. But two small clocks in my chamber kept their motion, as their vibrations were in the direction of the shock. The mercury in the sismometer preserved in the observatory was put into violent motion, and at the fifth shock, it seemed as much agitated as if it were boiling.

To the west of Palermo, within the mountains, the earthquake retained little of its power; since at Morreale, four miles distant, trifling injury only was sustained by the (Benedictine) Monastery of S. Castrense, the house of the P. P. Conviventi, and the Seminary dei Cherici. At Parco, six miles distant, Mary's College, the Monastery, the parish Church, and a few peasants' cottages, were all that suffered. At Piana, the battlements of the tower were thrown down. But more of its power was felt in places on the sea-coast, as appears from its effects at Capaci, four miles distant, where the cathedral and several houses were ruined, and at Torretta, fourteen miles, where the cathedral, two storehouses, and some dwelling-houses, were destroyed. Beyond, its power continued to diminish; and at Castellamare, twenty-four miles, the state-house alone had the cleft, which was made in 1819, enlarged.

In maritime places east of Palermo, the shock was immense. At Altavilla, fourteen miles from Palermo, the bridge was shaken. At Trabia, twenty-one miles, the castle, and at Godiano, the cathedral and some houses, were destroyed,—enormous masses from Bisambra, a neighbouring mount, were loosened, and fell. At Termini, twenty-four miles, the shocks were very violent, exceeding all that had happened within the memory of its inhabitants. Those of 1818-19 were very strong, but the city received at those times no injury; now the convent of St Antonio, Mary's College, and various private houses, felt its effects.

The warm waters, as well those of the baths as those from the neighbouring wells, which proceed from the same subterranean source in the mountains along the coast of Termini, increased in quantity and warmth, and became turbid; consequences that always succeed convulsions of the earth, by which their internal streams are disordered. The clay tinged the fluid with its own colour, and equal volumes of the water yielded a greater quantity of the clay than before, when the colour was deeper.* Most of the houses in the little new town of Sarcari, two miles from the shore, and consisting of less than a hundred houses, were rendered uninhabitable; the walls were thrown down, and the more lofty buildings were all damaged. The effects of the earthquake are found to be greater in proportion to its advance eastward.

Forty-eight miles from Palermo, at Cefalu, a large city on the shore of a promontory, the effects were various and injurious. Without the walls, two convents, a storehouse, and some country houses, were injured, but no lives were lost. The sea made a violent and sudden rush to the shore, carrying with it a large ship laden with oil; and when the wave retired, she was left quite dry; but a second wave returned with such immense force, that the ship was dashed to pieces, and the oil lost. Boats, which were approaching the shore, were borne rapidly forward to the land, but at the return of the water, they were carried as rapidly back, far beyond their first situation. The same motion of the sea, but less violent, was observed all along the shore, as far even as Palermo. Pollina, a town with nine hundred inhabitants, occupying an elevated position at a little distance from the sea, was injured in almost every building; particularly in the church of St Peter and Nunciata, in the castle, the tower, and in other places. Nor did Finale, a little nearer the shore, suffer less; five of its houses fell in consequence, on the 11th of March.

Beyond the towns which have been mentioned, towards the interior of the island, the shock was vigorous to a certain extent, but kept decreasing as it proceeded throughout the whole surface. At Ciminna, south of Termini, a statue was shaken from its place on the top of a belfry in front of the great church, and a part of the clock tower falling, killed one person and badly wounded another. In Cerda, the shock affected the great church, and also some houses, and half of one of the three forts, placed near the city to support the earth on the side of a great declivity.

The only church in Roccapalomba, which is situated at the top of an acclivity, was ruined. The parish church, and some private houses in the little town of Scillato, were overthrown. In Gratteri, a large town south of Cephalu, injury was sustained by the church of St James and other houses. Considerable damage was sustained by various churches, and many private houses in Colesano, a town containing two thousand inhabitants, and situated on an inclined plain, on the eastern side of the mountains of Madonie. One of the Colleges de Maria was rendered uninhabitable. The hospital, a grand fabric, was made a heap of ruins. The loss is calculated at about fifteen thousand pounds Sterling. In the vicinity of Pozzillo and St Agata, through a large extent of land, many long fissures and caverns were made. Similar caverns and fissures in argillaceous chalk, were

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* The warm and mineral waters of St Euphemia, in Calabria, which sprung up after the memorable earthquakes in 1638, presented the same phenomena during those of 1783.—*Grimaldi descr. dei trem. del.* 1783.

opened near the little town of Ogliastro, sixteen miles south-east of Palermo. At Isnello, at the feet of the Madonie mountains, the injuries which were received in 1819 were increased; Geraci, among the same mountains, suffered a like fate in the ruin of the cathedral; Castelbuono and St Mauro, within the same regions, were damaged, both by the former and by the last convulsions; by the last, the cathedral, the church of St Mauro, and five private houses suffered much. The damage done to Castelbuono is reckoned at eleven thousand pounds Sterling.

The northern coast of Sicily, towards Cape Cefalu, after bending to form the eastern part of the great bay, included on the west by the mountains to the left of Palermo, extends into the sea towards Eolie, (the Lipari islands,) and presents, towards them, a hollow front, the western part of which is formed by Cape Orlando, and the eastern by Cape Calava. Places situated about this bay, suffered the most violent convulsions. Nato, containing four thousand souls, and situated on an elevation, was almost entirely laid waste, and a great number of private houses destroyed; the monastery, hospital, the churches of St Peter, Anime del Purgatorio, St Demetrius, and the cathedral, were in a great measure overthrown. The Quartiere del Salvadore suffered less. A transverse cleft was made in the earth, and fears were entertained, lest the whole elevation upon which the city is built should be overthrown. Only two persons lost their lives; for the people, warned by a slight shock which was felt some hours before, had all fled into the country. Directly in front of Volcano, one of the isles of Eolia, Patti, a city built on the declivity of a mountain, and at the distance of half a mile from the eastern extremity of Cape Calava, had its cathedral, bishop's palace, convents, and many private houses injured. With the copious showers of the 5th, fell some roofs; various houses in the country were ruined. Pozzodigotto, Meri, and Barcellona, were injured a little. At Barcellona, a wide cleft was made in the belfry of the church, and threatened its ruin. The shock at Milazzo, on the sea, was violent, as also at St Lucia, six miles from it, situated on an eminence, but without any bad consequences. Some damage was done to the hospital, several churches, and private houses at Messina. In the interior of Sicily, the motion was communicated as if it were far from the centre of force; in some places towards the south, some buildings which were old and out of repair, felt the effects, particularly at Caltauturo; and at Alimena, in the cathedral and convent of the reformed. The shock gradually wasted itself as it advanced; and at Catania, so slight was the impression made on the people, that they went to the theatre the same evening. It was perceived by a few persons only in Syracuse, and in some of the neighbouring towns. In the district of Modica, towards Cape Passaro, scarcely one felt it. No bad effects were produced by it in the southern parts of the island; in the western it was felt, but without injury. It was pretty strong at Alcamo, but slight at Trapani.

The ancient city of Palermo was founded upon a rocky tongue of land, between two large and deep bays. The extremity of this point constitutes at this day the centre of the modern city. Matter, transported thither by the water from the interior, and thrown up by the sea, together with the labour of men, has gradually filled up the lateral spaces, and extended the peninsula with this transported and alluvial earth, and formed the present soil. It is now composed in part of calcareous rock, and in part of mud or alluvial earth; both are traversed by canals and large conduits for the circulation of water for common use, and by common sewers communicating with the neighbouring shore. The adjacent parts present a surface composed of calcareous tufa, and an earthy aggregate, tender and friable; but, deeper down, it is more durable, and partly siliceous.

In the night of the 1st of September 1726, continues Professor Ferrara, an earthquake destroyed, or very much injured, all the buildings situated on the muddy soil; and many, which were out of repair, or badly constructed, placed on rock. Earth of the nature of the first, is less capable of receiving motion from a shock than the last, since it possesses less resistance. But facts show that this advantage is more than compensated by want of stability in edifices raised upon it. At Messina, in 1783, all the buildings upon a plain, and upon earth thrown up by the sea, were destroyed, while those on the neighbouring hills were not moved. The same happened at Calabria, and, in 1805, in the district of Molise. In this account we should notice the cavities made in the earth. They were esteemed by the ancients as preservatives against earthquakes, not by affording an outlet to the subterranean vapours, as some have thought, but by interrupting or diminishing the course of the shock.

Most of the injury, says our author, was done by the second impulse of the shock, when the spear of the vane on the new gate was bent, and the water in the basin in the Botanical Garden was forced violently up one side. Immediately after the shock, he remarks, the apparent injuries were not very great, but the blow was given; and the long and abundant showers of rain which succeeded continued to develop and increase the injuries, and now, though not very many buildings are entirely destroyed, yet there is scarcely one which has not received some damage. Here follow some notices of the dreadful consequences which befell many of the inhabitants, from the falling of the timbers, and stones, and walls; of the vases from the piazzas into the streets and many other things which it is unnecessary to mention more particularly. Nineteen persons were killed, and twenty-five wounded; in the earthquake of September 1, 1726, four hundred were killed and very many wounded.

Messina, which suffered so much in 1783, although violently moved by this last shock, experienced from it no bad effects; for this noble city has risen from her ancient ruins, robust and majestic. Catania, in 1818, was convulsed in a terrible manner, but its inhabitants were enabled to contemplate without a tear all the little injury sustained by their beautiful fabrics.*

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* After the fatal earthquake of 1693, in Catania, by which 18,000 persons perished, the people began to build of one story, and always after the plan of barracks. But, as the fear passed from their minds, they raised their houses two sto-

After the shock of the 5th, the black clouds which covered the heavens on the north and west, formed a dark band, measuring from the zenith towards the horizon 60°, and extending from north to south. It was terminated at its base by a circular line, passing from north to south, through the west, and elevated at the southern part about 30° above the horizon. The sky itself was very clear, and its extreme brightness was increased by the contrast with the dark band above, and by the sun just on the point of setting. A little below the band were two other lines, parallel and perfectly regular. This mysterious appearance inspired with fear the minds of the people, who are always seeking in the heavens for signs of future events. But it prepared a tempestuous night, which followed, with torrents of rain, with thunder, snow, hail, and wind.[*]

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ries, and sometimes even three, and not with much solidity. Since the middle of the last century, the excellent materials afforded them by Ætna, the good method and prudent regulation of the stories, have promised long duration to this city. It may possibly be injured, but cannot be easily ruined, although at the foot of the most formidable volcano in the world. After the catastrophe of the 5th of March in Palermo, the lieutenant, the pretor, senators, and police exerted all their zeal. They obliged proprietors to prop up their houses within twenty-four hours; or to demolish them if they were not susceptible of propping. The senate took upon themselves the charge of repairing the houses of poor proprietors, together with the expences.

[*] In all times, signs have been mentioned as announcing earthquakes near at hand. People read them in the air and upon the earth; and some philosophers even have given them credence. The frequent occurrence of these signs, without the expected phenomena, is a sufficient argument against them. But less uncertain are those which accompany the phenomena, as rain and thunder. To that of 1693 such fearful storms succeeded, that, for many hours, at Catania, the groans and voices of the miserable wretches buried under the ruins, were drowned by the roaring of the torrents of rain and the tremendous thunders. The same circumstances took place at Calabria in 1783; and we were witnesses of the same on the night of the 5th of March. An extraordinary quantity of electric fluid is developed, and being conducted from the deep cavities of the earth to the surface, by the force of equilibrium, produces there extraordinary vaporization, when hygrometers have shown extreme dryness. The atmosphere, charged beyond measure with vapours, will give room to their decomposition, which changes them into vesicles, and then into rain. Fiery meteors will be produced by the electric fluid, liberated by the passage of the vapours to water. If hydrogen gas escape from the earth, it may be inflamed by the electric spark, and present the appearance of fires. I should mention here, that, in volcanic regions, signs may sometimes precede earthquakes; but this happens from the proximity of the place of the subterranean operations to the surface of the earth, which circumstance connects the internal phenomena with those of the adjacent atmosphere. On the morning of the 8th of March 1669, at Pidara, a town on the side of Ætna, the air became obscure, as by a partial eclipse of the sun; soon after the earth began to shake, and continued so until the 11th, when an immense fissure opened near Nicolosi, a neighbouring town, a sparkling light appeared over the fissure; and, on that very day, while the terrible shocks were levelling Nicolosi with the ground, an enormous burning river, amidst horrid rumblings, roarings, and explosions, was belched out, which flowed fifteen miles, covering a great extent of land, and for four months spreading terror over Sicily.—*Bor. de. inc. Ætn.—Ferr. Descr. dell Ætna.*

On the night of the 6th, at forty-five minutes past one, in St Lucia de Millazzo, six miles from the shore which looks towards Vulcano and Stromboli, a severe shock was felt, and afterwards, at various intervals, horrible noises were heard, four distinct times, rumbling fearfully beneath them; and finally, at half past three o'clock, the shock was repeated. Both were felt at Messina, but without any subterranean noises. Nothing of it was felt at Palermo, or in any places in the west. At fifty-six minutes past ten, during the night of the 7th, another shock was felt at Palermo, sufficiently strong to put in motion the pendulum of a small clock, which I had stopped that I might regulate it in the morning. Its vibration, from north-east to south-west, showed me with certainty the direction of the shock. Light ones were felt on the 26th. On the 31st, at fifty-two minutes past two, P. M., one was felt at Messina, moderately severe, of five or six seconds duration, and undulating. Two others on the 1st of April, and one at Castelbuono on the 28th. I should add that they mention a slight one there on the 16th of February, but they are more certain of those of the 5th of March, one at one P. M. the other at three. These were the shocks which induced the inhabitants of Naso to leave their habitations and flee into the country, where they were when their city was laid waste.

(To be concluded in next Number.)

II.—Schow's *Essay on Botanical Geography*. Copenhagen. 1823.

As this valuable and elaborate work has not appeared in our language, we propose to lay before our botanical readers one of the most interesting portions of it, which has been translated for this Journal, from the Danish, by that active and intelligent naturalist, W. C. Trevelyan, Esq. F. R. S. E. This portion is entitled, " On the Phyto-Geographic Division of the Globe," and is divided into various sections, the most important of which we shall lay before our readers.

A Science, says M. Schow, is not established at once; its first ideas exist, are rejected, are touched upon cursorily, or are treated of without its being foreseen that these ideas, will, in their time, form a self-existent branch of our knowledge. Thus it has happened with regard to the geography of plants. That plants stand in relation to climate; that Species, Genera, and Families are distributed, not fortuitously, but according to determined natural laws over the earth, was too evident not to fall under the view of every attentive observer; but observations were too few; the tendency with most botanists to be content with the mere knowledge of the external forms of plants, and the low rank in which vegetable physiology stood, were the causes why the local relations of plants were not viewed as a connected whole, but the objects connected with it rather considered as curiosities. It is, therefore, in relations of travels, in some Floras, and in physiological works, that the first planto-geographical ideas are to be met with, scattered, and without the least pretension of making a connected whole.

Tournefort, (Voyage au Levant,) remarked, that on Mount Ararat the vegetation changed according to the elevation; that at the foot the plants of Asia Minor; at the middle, those of France; and at the summit the plants of Lapland showed themselves. *Linné* in his treatise "*de Telluris Habitabilis Incremento,*" pursued this a little farther. In the "*Philosophia Botanica,*" and in the Essay "*Stationes Plantarum,*" he proposed a terminology with reference to the localities of Plants. In another treatise, *Coloniæ Plantarum,*" he speaks especially of the migration of plants; in "*Flora Lapponica,*" he gave, not merely an enumeration of the plants which occur in Lapland, but also hints of the variations, which difference of situation and of elevation above the sea, cause in vegetation. Similar general views are found in *Haller's* "*Historia Stirpium Helvetiæ,*" and in *Forskäls* "*Flora Ægyptico-Arabica.*"

The penetrating Adanson necessarily fell upon botanico-geographical ideas in his work entitled "*Familles des Plantes;*" and he brought forward several observations, which might direct attention to the distribution of the families of plants. *Saussure,* who instituted many inquiries connected with vegetable physiology, was consequently attentive to the influence of climate on plants; he gave notices of the height of plants above the sea, and was probably the first who made use of barometrical measurements with this view. *Reynier* wrote an essay in the "*Journal de Physique,*" in which the influence of difference of elevation on plants, in particular, is well treated of. *Ramond* gave some information concerning the height of plants above the sea in the Pyrenees. *Young,* in his tour, treats of the limits of the most important cultivated plants; he determined the most Northern limits of the Olive, the Vine, and Maize. *Giraud Soulavie* distinguished in the "*l'Histoire naturelle de la France meridionale,*" between the regions of the Orange, the Olive, the Vine, the Chesnut, and the Alpine region, and thus gave a not unimportant hint towards the division of a country in a vegeto-geographic view. In several manuals, for example *Wildenow's* "*Grundris,*" and *Senebier's* "*Physiologie vegetale,*" T. 5, may be found a chapter under different titles, for vegeto-geographic materials, but these are mixed with others, and cited in a very desultory manner.

Thus it stood with the geography of plants at the end of the last century. In the present century, on the other hand, it has made great advances. *Stromeyer* in 1800 published his dissertation, in which he brings forward a summary and sketch of what he calls the *Geographical History of Plants,* and treats of one branch of it, namely, on the limits of the vegetable kingdom. *Treviranus's* "*Biologie,*" second volume, contains several planto-geographical ideas; he was doubtless the first, who, with any degree of perfection, paid attention to the distribution of the vegetable families on the globe; he divided, indeed, its surface into different regions or principal Floras; but his want of materials caused the results, for the most part, to be uncertain, and some, altogether erroneous. *L. v. Buch,* in his travels in Norway and Lapland, attended to the planto-geographic phænomena;

he determined the relations of plants to their elevation by the help of the barometer, and inquired into the medium temperature which individual plants required. *Decandolle* in his "*Flore Francaise,*" divided France into several regions, according to the difference of vegetation, and treated of the influence of difference of elevation on vegetation. At last appeared *Humboldt* in 1807, with his "*Essai sur la geographie des Plantes,*" and "*Tableau des regions Equinoctiales.*" The first was at the most but a very loose sketch, neither was the latter at all a complete comparison between climate and vegetation; but as he elevated the most interesting of sciences,—as he, in a striking manner, connected so many physical phenomena, which previously had been handled separately,—so he excited a general interest for these inquiries, and this work, therefore, decidedly forms an epoch in the science. His "*Tableau de la Nature*" co-operated also to produce this effect. Next followed *Wahlenberg's* "*Flora Lapponica,*" a classical work, which advanced the whole of the geography of plants. This author was doubtless the first who clearly showed that the annual medium temperature is not a sure scale for vegetation, but that attention must also be paid to the distribution of heat in the different parts of the year. He was the first who instituted an ample comparison between vegetation in all its relations; and lastly, he was the first, who, in any perfection, showed the mutual relations of families of plants, and it is only to be lamented, that in this he preferred the Linnæan to Jussieu's natural families. The same author has since published two equally important works, on the north of Switzerland, and the Carpathian Mountains; he has proceeded in them on the same principles as in the "*Flora Lapponica;*" corrected several of them, for example, his theory on the temperature of the earth as a scale for vegetation, and given his views greater extension, by comparing Sweden with Switzerland, and both with the Carpathians. In a treatise in "*Magazin der Gesellschaft naturforschender Freunde,*" he has made remarks on the difference between the vegetation of the coast, and the inland, (littoral and continental vegetation.) *Engelhardt* and *Parrot* have given in their travels some information concerning the planto-geographic relations of Caucasus. In 1814, *R. Brown* published his "General Remarks on the botany of Terra-Australis." In this treatise, the relations of the families of plants are discussed with great acuteness and science; the author's deep study of the natural families, and the many opportunities he had for comparing the plants of New Holland, with those of other parts of the globe, ought to give this work a high degree of perfection. On the other hand, he has not so much as touched upon the influence of climate on vegetation.

Hitherto, with the exception of single hints in R. Brown's work, and Treviranus's imperfect essay, botanists stopped at single countries, and did not venture to deduce results for the whole of the globe. This step *Humboldt* made in 1815, in the introduction to the botanical part of his travels; and although, from the plan of the introduction, the representation of the general laws must be disjointed, it could not but lead to general views, and thus, as well as by its richness in ideas, again make an epoch in the science. Shortly after, 1817, appeared his essay "*sur les lignes isothermes,*" which reduced the knowledge of the distribution of heat on the globe into a system, and as it also contains botanico-geographic materials, it is an invaluable work to the planto-geographer. At the same time *Decandolle* published some interesting information on the planto-geography of France, and on the knowledge of the influence of height on vegetation, in the "*Memoires de la Societé d'Arcueil;*" and in the following year, *R. Brown,* on the Herbarium of Professor Smith, gave a view of the vegetation in the vicinity of the Congo, like that on New Holland, with particular regard to the distribution of the families of plants. There are here also ample inquiries with respect to the species which occur in several far separated countries. With similar views regarding Denmark and Guinea has Professor *Hornemann* enriched the science; and *von Buch* has made us acquainted with the Flora of the Canary Isles in a planto-geographic point of view. Lastly, *Decandolle* in the "*Dictionnaire des Sciences Naturelles,*" has published the view of the science already spoken of.

To prevent misapprehension, and to obtain a nearly similar degree of difference throughout the Floras in general, I think it most proper to fix certain rules concerning what is requisite to form a *Flora,* or what I would rather call a *Phyto-geographic region.* I am therefore of opinion, that we should require for this, (1.) That at least half of the species should be peculiar: (2.) That at least a quarter of the genera should be proper to the region, or at least have there so decided a *maximum,* that their species in other regions might merely be considered as representatives: (3.) That individual families of plants be either peculiar to the region, or else have there their *maxima.* Nevertheless, where this last property is wanting, while the difference in genera and species is very considerable, we might admit of a region.

The regions may, again, according to a minor degree of difference in the vegetation, be divided into *provinces,* for which, for example, one fourth of peculiar species, and a few peculiar genera, might be sufficient.

In order to have a complete view of the phyto-geographic divisions of the globe, the boundaries and circuit of each, its climatic and other physical relations, should be described; there should, besides, be mentioned what are the characteristic families and genera which prevail, and that both in regard to species in general, and individuals; and lastly, a view should be given of the whole habit and character of the vegetation. Towards this, the following is merely a loose sketch. The regions and provinces are best named after the vegetable forms which characterize them, (for the prevailing vegetable forms are very often the same in different countries.) I have here attempted this; at the same time, however, I have added the commonly used geographical terms,* and adopted these last only in cases when I thought that a certain division of the earth ought to form a distinct region, but knew not the vegetation intimately enough to determine the characteristic forms.

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* Wildenow, Decandolle and Treviranus have used only the latter.

I. *(Regnum Saxifragarum et Muscorum, vel Flora Alpino-arctica,)* This region includes, in the first place, all the countries within the polar circle, together with some parts of America and Asia which lie south of it, but have a polar climate; (namely, Lapland, the North of Russia and Siberia, Kamtschatka, Canada, Labrador, Greenland, and Iceland;) next, part of the Scotch and Scandinavian mountains, as far as they fall within the Alpine region; and, lastly, the mountains in the central and southern parts of Europe, in like manner, as far as they are related to the Alpine region. The Alps, indeed, possess many plants which are wanting in the Northern Polar countries; they may even amount to three-fourths of the whole number of species which grow there; but, as the Genera, with few exceptions, are the same as in the Polar Flora, and likewise the characteristics of each agree very closely together, these two parts of the earth can scarcely be considered otherwise than as two provinces of the same region. As these two provinces do not immediately join each other, so they might perhaps be treated, the one as a colony, the other as the mother-country, which comparison, however, is merely ideal, for hardly will it be in any person's power to prove that those Alpine plants of the south of Europe, which also occur in the Polar regions, have migrated from one of these parts of the globe to the other; indeed, I do not consider this to be in the smallest degree probable. What distinguishes this region, is the abundance of mosses and lichens; the characteristic families, *Saxifrageæ, Gentianeæ, Alsineæ, Cariceæ, Saliceæ*; an entire absence of tropical families; a considerable decrease of the characteristic forms of the Temperate Zone; forests of fir or birch, or else a total absence of forests, scarcity of annuals, abundance of cespitose plants, proportionally *larger* blossoms of *pure* colours. The two Provinces are: (a) The Arctic Flora, *Provincia Caricum.* The great abundance of Carices and some peculiar genera, as *Diapensia, Coptis,* are the most important distinguishing marks. As *subdivisions,* we might take the following countries, whose Floras, however, might reciprocally be distinguished by some peculiar species: Lapland, Iceland, Greenland, the northern part of North America, and of Siberia, Kamtschatka. (b) The Alpine flora of the south of Europe, *Provincia Primulacearum, et Phyteumarum.* The most important marks of distinction are; a larger number of *Primulaceæ,* namely, a great many species of the genera *Primula* and *Androsace,* of which the polar lands have only a few species, and the genus *Aretia,* there entirely wanting; the tolerably numerous genus *Phyteuma,* the genera *Soldanella, Cherleria,* and others, which are likewise wanting in the Polar countries; the greater number of *Rhododendra,* &c. The subfloras would be; the Pyrenean, Swiss, Tyrolese, Carpathian, Grecian mountains, Apennine, and, probably, also the Spanish mountain Flora; and also the Caucasian, in so far as I can determine from *Biberstein's* Flora, and from *Engelhardt's* and *Parrot's* travels.

II. (*Regnum Umbellatarum et Cruciferarum.*) This region comprehends the whole of the north of Europe, (with the exception of such parts as belong to the preceding,) to the Pyrenees, the mountains of the south of France, the Alps, the mountains of the north of Greece; and besides the greatest part of Siberia, and of the country about Caucasus. Its eastern boundaries I dare not fix. *Gmelin*, indeed in his Flora * says, that the vegetation is essentially changed at the river Jenisey; but, as this Flora contains so great a number of European species, and has only 15 genera which are wanting in Europe, so this expression can hardly be understood literally, and Siberia, or at least the greater part of it, may thus belong to the same region as the north of Europe. The country about Caucasus and Krim, falls only partly within this region, for, according to *Biberstein's* Flora the southern parts of those districts have a greater resemblance to the south of Europe.

It might be doubted whether that part of the globe, included within these limits, forms a particular region, or only a province of the next region, which includes all the countries which surround the Mediterranean Sea; for, although, indeed, this latter region has a great many species, genera, and even families, which are entirely wanting in the north of Europe and Asia, so, on the other hand, this part of the earth stands in so low a rank, in regard to plants peculiar to it, that not only above half of its species are also found in the south of Europe, but very few peculiar genera appear, and not one peculiar family. But as, on the other hand, this resemblance is not complete, and however some families are rather more numerous here than in the countries on the Mediterranean, so it may perhaps be answered, that it may be considered as a particular region, though its great want of peculiar forms ought to be attended to. I have called this the region of the Cruciferæ and the Umbellatæ, because these two families in this region, form a larger quotient of the total number than in any other; and because in this way it may particularly be separated from the vegetation of North America on the same parallel. From the next region it is moreover distinguished by *Fungi* being more common, by *Rosaceæ, Ranunculaceæ, Amentaceæ*, and *Coniferæ* forming a rather larger quotient; that it approaches nearer to the polar forms, especially in the abundance of *Cariceæ*; that the meadows are more flourishing; that almost all the trees are deciduous in winter; and lastly, by a number of negative characters, namely, the absence of tropical forms, which have representatives in the next region, and fewer species of the families which belong to the characteristics of the latter. From the Polar region it is distinguished partly by the want of most of the Polar forms before mentioned, and partly, also, by its greater agreement with the following region.

This region may easily be divided into two provinces; (a) *Provincia Cichoriacearum*, province of northern Europe. This sub-group of the *Compositæ* appears to be rather more numerous in Europe than in Asia, where on the contrary, the *Cynarocephalæ* are more common; the other distinguishing marks, are merely formed of some few peculiar genera. The countries belonging to this province, Great Britain, the north of France, Holland, Germany, Denmark, the Scandinavian Peninsula, as far as it does not belong to the preceding region, Poland, Hungary, the great-

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* *Flora Siberica*, T. 1. Præf. p. xliii.

er part of European Russia, differ only inconsiderably in regard to their vegetable productions; (b) *Provincia Astragalorum, Halophytorum, et Cynarocephalarum,* province of northern Asia. To this belongs a part of the Caucasian countries, and of the remaining part of Asiatic Russia. The abundance of the three groups of plants above mentioned, characterize this province, as well from the preceding province as from the following region.

(To be concluded in next Number.)

III. *Memoir on the Red Snow of the Arctic Regions.* By Professor AGARDH of Lund. "*Uber den in der Polar-zone gefundenen Rothen Schnee.*" *Nova Acta Academia Nat. Curios.* vol. xii.

SINCE we have, in former numbers of this *Journal,* brought forward the observations of authors upon this singular vegetable production, (as it is now universally acknowledged to be,) and since we have ourselves entered rather fully upon the subject in the yet unpublished *Botanical Appendix to Captain Parry's Second Voyage,* we shall here subjoin an analysis of Professor Agardh's valuable *Memoir,* which is just published.

" *Rain,* he says, charged with extraneous substances, is not an unusual phenomenon. The most general appearance of this kind, is what is denominated a *shower of sulphur.* Upon examining this, no sulphur has ever been found, but the farina of the pine, *(Pinus sylvestris.)* Some years since, rain of this kind fell at Lund, which I had the opportunity of examining, and found it mixed with this pollen, although the pine forests, that must have produced it, could not have been at a less distance than from five to six Swedish miles.

Next to this kind of rain, that which has been denominated *a shower of blood,* is the most frequent; but, with the nature of this, we are as yet but imperfectly acquainted. That which Peiresc observed in the year 1608, near Aix in France, was occasioned by insects, as was probably that which fell at Schonen in 1711, and which was examined by the clergyman Hildebrand; notwithstanding that the learned Bishop Swedberg looked upon it as a supernatural phenomenon, and as a portentous sign from the Divinity. In such cases, it is absolutely necessary that we observe whether the red particles fell with the rain, or whether they afterwards became incorporated with it. For another red fluid deserves to be mentioned, that which is known under the name of " blood red water," (blutrothe wasser,) but which the common people aver to be water changed into blood, and of which many authors have written; but that appears, or rather most certainly is, of two kinds. That which is the most common, occurs in spring or in hot summers, in ponds, and is formed, according to Linnæus, of an immense number of animalcules, the *Monoculus Pulex,* Lin. *(Daphinia Pulex, Latr.)*;* but according to my

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* It is singular that Linnæus, who appears to be so well acquainted with this *Monoculus Pulex,* should have ascribed to it the colouring of the water. I have

observations of *Monoculus quadricornis, L.* (or *Cyclope quadricornis* of Latr.) which literally dye the water with the number of their red bodies. Linnæus mentions another blood-red water in his *Westgotha Resa,* which formed a pulverulent mass in the cavities of the calcareous mountains moistened by rain-water. That, however, which is found on the shore, is a dye extracted from a species of fucus.

These observations are brought forward in connection with the *red snow,* which for some years past has been seen near the North Pole, and which has so much excited the attention of naturalists, that one would conclude the phenomenon to be of very rare occurrence; and yet the *red snow* is very common in all the alpine countries of Europe, although De Saussure was the first, if I mistake not, who paid any attention to it. He found it in 1760, on Mont Breven in Switzerland, and afterwards observed it to be so common on the Alps, that he was surprised it had not been noticed by other travellers, especially by the accurate Scheuchzer. Ramond found Red Snow on the Pyrenees, and the botanist Sommerfeldt told me that he had seen it in Norway. The Italian Giornale di Fisica, Nov. and Dec. 1818, gives some very interesting accounts of Red Snow that fell on the Italian Alps and the Apennines. In March 1808, for instance, the whole country about Cadore, Belluno and Feltri was, in one single night, covered to the height of twenty centimetres with a rose-coloured snow: but both before and after it pure white snow fell, so that the red formed a layer between the white. At the same time a similar phenomenon was witnessed on the mountains of Valtelin, Brescia, Carinthia, and Tyrol. Another is mentioned as occurring between the 5th and 6th of March 1803 at Tolmezzo in the Friaul, and one still more remarkable in the night between the 14th and 15th of March 1813, in Calabria Abruzzo, in Tuscany, and at Bologna, and upon the whole chain of the Apennines. On the 15th of April Red Snow fell on the mountain of Toual in Italy.

Hence it appears that this phenomenon is of sufficiently frequent occurrence, and that the cause of the red snow found in the voyage of Captain Ross on the 17th of August 1819 at Baffin's Bay, in 75° 54′ N. latitude, being so much noticed, is attributable to the acuteness of the naturalists and chemists who had the opportunity of examining its origin. According to the account of Captain Ross, the mountains that were dyed red with this snow were about eight English miles in length, and about 600 feet high. The red colour reached to the ground, in many places to a depth of ten or twelve feet, and appeared so for a great length of time.

This is all that was known respecting red snow in its natural state; but it was reasonable to expect some elucidation from chemical analysis, Thus De Saussure had found, that the colouring matter of the red snow of the Alps gave out, when burnt, a smell like that of plants, and thence,

only found a *Cyclops* in such water, and which agreed in every thing with *C. quadricornis* of *Latr.* whilst it differed from Linnæus's *Monoculus quadricornis,* in being *red,* whereas that is brown. The animal must either undergo a change in colour, or there are two species.—*Ag.*

as well as from distillation in alcohol, inferred that it was of vegetable origin, and probably consisted of the farina of some plant, although he could neither account for its having ascended to such elevated regions, nor mention a plant whose farina was of that colour.

The Italian naturalists who examined that snow which fell in Italy, found that it contained siliceous earth, clay, and an oxide of iron, as well as a considerable portion of some organized substance. This too accords with Sementini's analysis of some *bloody* rain that fell in Calabria. Upon examining the colouring substance of the red snow discovered by Captain Ross, Wollaston and Thenard came to similar results, and the first was led to conclude that it contained seeds of a moss.

From the hands of the chemist this substance came into those of the botanist. The celebrated Francis Bauer, in the Journal of Science and Arts, No. xvi. gave a full description of it, and from the similarity in form, as well from chemical comparison, was induced to consider the red snow as a fungus of the genus *Uredo,* which he calls *Uredo nivalis,* and nearly related to the *Ustilago segetum* of *Dittm.*

Robert Brown had indeed previously expressed his opinion that this substance had a great affinity to the *Tremella cruenta* of *Engl. Bot.,* and that it might accordingly rank among the *Algæ.* Of this Mr Bauer did not seem to be aware.

Sprengel's opinion, that it came nearer to *Vaucheria radicata,* seems to be farthest removed from the truth.

On my various examinations of this substance, the question has frequently struck me, what might be the true nature of this substance? without being even able to satisfy my mind upon it, as I had not seen any thing with which I could compare it; nevertheless, Mr Brown's opinion always appeared to be the most correct, namely, that it should be placed with the *Algæ.*

At length a treatise was communicated to me, from the Royal Academy of Sciences at Stockholm, of Baron Wrangel, upon a new species of lichen, which he called *Lepraria kermesina,* but which Linnæus had confounded with *Byssus jolithus.* I found a most striking agreement between this new species of lichen and the plant called *Uredo nivalis,* and expressed this opinion, together with that, that the *lepraria* was also a true *alga.* Yet I had not then seen the plant. When, however, I was in Stockholm, in the summer of 1823, Professor Berzelius gave me some of the colouring matter of the red snow which he had received from Dr Wollaston, and Baron Wrangel showed me his *Lepraria kermesina.* The *Uredo nivalis* was preserved with the snow-water in a small well closed and sealed bottle, which had not been opened from the time it was filled; yet, after a lapse of five years it retained its red colour, and was not altered in form. The water was perfectly fresh and without smell. When the bottle remained stationary, the substance settled at the bottom of a brownish-red colour, two or three lines in thickness, leaving the water perfectly clear. But, with the least motion, it again mingled with it.

In order to examine this remarkable substance with more accuracy, I placed a drop of the water, mixed with the brownish-red colouring matter, under the microscope, when it was immediately seen to consist of a number of round globules, sessile, of a blood-red colour, shining but opaque, perfectly agreeing with Mr Bauer's figure. Some, however, of the globules were not coloured, but clear as water and transparent. The size of ours was somewhat different from that stated by Bauer, $\frac{1}{100}$ of a line, and some of the globules were scarcely half so large as others. In general, if we may be allowed to make a relative comparison, their diameter was ten times greater than those of *Tremella cruenta.* The mode in which these globules were clustered was very irregular; sometimes they were seen single, sometimes two or three in a line, at other times in irregular groupes, especially when the sediment is shaken up and the globules mingled together.

Lepraria kermesina is a plant which Baron Wrangel had found in the province of Nerike, sometimes resembling a thin crust or scurf on white limestone; sometimes dissolved with the rain-water upon these same stones, of a blood-red colour, and leaving a faint smell of violets, which gave occasion to Baron Wrangel to imagine his plant to be the *Byssus jolithus* of many authors. This is the same plant of which Linnæus speaks in his Journey to Westgotha. By accurately observing this plant with the microscope, I not only found my supposition respecting the near relationship of it with *Uredo nivalis* to be confirmed, but I fully satisfied myself that both belonged to one and the same species. From this, it appeared to me clear, that, as the *Lepraria kermesina* did not fall with the rain, it was as little likely to be the case with the Red Snow.

Although it has not been clearly proved, yet, as I have shown in another place,* it is very probable, that, in the production of the lower orders of *Algæ,* as of the *Animalia infusoria,* (which come so near the one to the other,) they sometimes not only pass into each other, but that they are different states of one and the same thing. Next to warmth, light has the most important effect in their formation. Further we know, that when plants of a higher formation grow on white limestone it induces a red colour in the flowers. It will, therefore, have a similar, or more decided, action on those plants, such as the *Algæ,* where colour is more essential. We find, for example, the *Anthyllis vulneraria, var. coccinea,* only on chalky ground; so, also, among the *Algæ* the *Tremella cruenta,*† *E. Bot,* the red coloured *Byssus cobaltiginea* and the *Lepraria kermesina* occur only on limestone or calcareous ground. That the light here produces the red colour is proved in the *Lepraria kermesina,* for the colour, in such places where the light was weakest, (as in the crevices of the limestone, where it could scarcely gain admittance, or on the under-side of stones,) passed from

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* See the author's very curious work on the *Metamorphosis of Plants,* published at Lund.

† *Tremella cruenta* is most assuredly, in this country, found in situations far removed from limestone, or any thing approaching to a white colour, upon damp black rocks in shady places, and dark brick walls in the shadiest parts of large towns and cities.—H.

red to green. Nor is the colour determined wholly by light; it is aided by the nature of the body on which it strikes, but in a manner quite unintelligible to us.

M. Agardh then goes on to argue, that as white bodies, very dissimilar in appearance and nature, produce the same effect in the formation of red colouring matter, so we must not be surprised to find, that a plant, such as *Uredo nivalis,* which is found on the highest Alps in the most northern latitudes, in the cold of winter, and only on the surface of the snow, is again found in the plains, in summer, and on glittering limestone.* Hence it must be inferred, that the existence of the *Alga* of the red snow must be accounted for by the gradual melting of the snow from the intensity of light; and not, as some suppose, that it is washed down from the neighbouring rocks, or, as might be inferred from the information given from Italy, that it has fallen from the atmosphere. In regard to the first supposition, were such the case, De Saussure and the English navigators would have noticed such a red stream running down the sides of the mountains, a fact which Saussure denies, and upon which the English are silent.

As to the accounts given by so many men of science, that the Red Snow falls from the air, I need only refer to one circumstance, namely, that all the accounts agree in asserting, that this Red Snow fell in the night, which is as much as to say, that no one has seen it fall. Why, we may ask, should the snow only fall red in the night, when no one can discern it to be red, and not in the light of day, before which white can become red?

I am, on the other hand, of opinion, that the *Lepraria kermesina* is called into existence by the vivifying power of the sun's light, after its warmth has caused the surface of the snow to dissolve, combined with that incomprehensible property in white snow, of producing a *colour*; nevertheless, that it first attracts the eye when there is a some considerable quantity, in the same way as we do not see the colour of the drops of water till they have accumulated in the ocean. This opinion is not only confirmed by De Saussure's observation, who expressly says, " qu'on ne trouve la neige rouge que dans une certaine période de la fonte des neiges, car lorsqu'il ne s'en est pas beaucoup fondu, la quantité du residu rouge est très petite, et s'il en est trop fondu, on n'en trouve rien;" but also by the recollection, that the time that this coloured snow appeared in Italy, namely in March and April, is the time when the snow begins to melt.

An assertion of Captain Ross's does, indeed, appear to come in opposition to this, namely, that the Red Snow extends very far below the surface, in some places reaching to the ground at a depth of twelve feet; but then, this is directly contradicted by another traveller of the same expedi-

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* This at least we guess to be the meaning of the author, but the theory itself seems to us to be very abstruse; and probably from too imperfect an acquaintance with the German language, we may not entirely have given the passage correctly. —H.

tion, on board the Alexander, who expressly states, that the Red Snow was never more than one or two inches below the surface. The remark made in Italy, that the White snow fell as well before as after the Red, may be easily explained, by what has been said before. We shall, too, account for the great extent of country which it covered in one night, better from supposing a cause to act upon an homogenous surface, than by supposing, that the Red Snow fell in one night over the whole mountainous parts of Italy.

That this snow was seen after only one night I have in part accounted for, by observing, that its red colour could not be noticed before it was formed into sufficient masses; and its rapid appearance will the less surprise those naturalists who are accustomed to examine the *Infusoria*, and who well know how quickly an innumerable multitude of these beings can be produced under favourable circumstances.

It now remains for us to determine, as correctly as possible, the nature of these minute bodies, about which opinions are so much divided.

The idea of De Saussure, that the colouring substance of the Red Snow is the farina of a plant, deserves but little attention, as there is no plant which has the farina, or pollen, of that colour. De Saussure, indeed, endeavours to strengthen his opinion, by saying, that the farina may have changed its colour from the intensity of the light upon the Alps; but allowing this to be possible, chemical analysis is in opposition to it.

The opinion of Mr Bauer has greater weight with us, namely, that the Red Snow is a *Fungus*. Yet, still, I cannot agree with him. The fungi are the offspring of darkness, and are never formed or kept in water. They rather prefer a close and moist air, are produced by putrid substances; properties the very reverse of what we know of the Red Snow; which is formed in the purest waters, with the strongest light, in the clearest atmosphere, and without any previous decay.

That which Baron Wrangel has described, and which I have shown to be identical with the Red Snow, he considers to be a *Lichen* of the genus *Lepraria*, a conclusion to which he may have been led by the crustaceous covering which this plant forms upon limestone. This crust, however, I take to be a sediment that is deposited on the evaporation of the water; and De Saussure's observation, according to which it is also formed on the melted snow, shows, at the same time, that it is not peculiar to stones. To this it may be added, that the sporules of the genus *Lepraria* have a different form, and yield a different chemical analysis from the globules of the Red Snow.

Hence it follows, that this substance must be either an *Alga* or an *Animalcula*, between which I know no certain limits. There are forms amongst them which may, with equal propriety, be ranked with either or both. There are *Algæ* which become *Animalcules*, and *vice versa*. Lastly, there are *Infusoria*, which, at one period of their existence, are endowed with the power of movement, while, at another, they exist only in the character of a vegetable.

To conclude, the colour of the Red Snow is not without analogy among the *Algæ*. In autumn, as is well known, there is produced on shady walls a green powdery substance, composed of globules, which afterwards, according to circumstances, change either into *Oscillatoria muralis*, or into *Ulva crispa*. This substance comes nearest to *Lepraria kermesina*. Farther, it has a great affinity with *Tremella cruenta, E. Bot.* (which must not be confounded with *Ulva montana* of Lightfoot): both are red, and both consist of globules; but *Lepraria kermesina* differs in this particular, that its globules are free, not sunk in a gelatine. I have accordingly placed *Lepraria kermesina* of Wrangel in my *Systema Algarum* as a peculiar genus, under the name of *Protococcus kermesinus*.

If my views of the origin of this substance, which may be called *the Blossoms of the Snow, (Blume des Schnee's,)* be correct, our surprise will not be diminished, though the object of it may be changed. If we can no longer believe, that the *Infusoria* or *Algæ* drop from the clouds, we must nevertheless allow, that the snow of a whole district of mountains, may, in a few days, be covered by a red vegetation, of a very different appearance from that of its own dazzling whiteness. We cannot, indeed, cease to wonder at the power that is active on every point of the earth's surface, and fills even the snow of winter with life and vegetation. It is generally known, that the colour of the vegetable kingdom becomes duller and paler the less powerful is the light that shines upon them; and that the fields of the north are ornamented with few attractive colours, while those of the tropics glow with the most splendid. But even the north comes nearer to the source of light by means of its Alps, and as it were, heightens the intensity of its beams by its snows; so that even the winter can sometimes produce the same effect as the warmest summer. NATURE, in all the different and variable forms which she assumes, is in one thing only alike; she is ever new, and ever worthy of admiration.

ART. XXXI.—PROCEEDINGS OF SOCIETIES.

1. *Proceedings of the Royal Society of Edinburgh.*

November 14, 1825.—The Royal Society resumed its sittings for the winter.

A paper by Dr YULE was read, entitled Some Observations on Subterranean Plants, with a Specimen and Drawing of a nondescript Rhizomorpha.

November 28th.—At a General Meeting of the Society, held this day, the following Office-bearers were elected:—

Sir Walter Scott, Bart., *President.*

Right Hon. Lord Chief-Baron, Lord Glenlee, Dr T. C. Hope, Professor Russell,	*Vice-Presidents.*

Dr Brewster, *Secretary.*
Thomas Allan, Esq. *Treasurer.*

James Skene, Esq. *Curator of the Museum.*

Physical Class.

Alexander Irving, Esq. *President.*
John Robison, Esq. *Secretary.*

Counsellors.

Sir William Arbuthnot, Bart.	Dr Home.
James Jardine, Esq.	Professor Wallace.
Sir William Forbes, Bart.	Dr Edward Turner.

Literary Class.

Henry Mackenzie, Esq. *President.*
P. F. Tytler, Esq. *Secretary.*

Sir William Hamilton, Bart.	Sir Henry Jardine.
Rev. Dr Lee.	Sir John Hay, Bart.
Right Hon. the Lord Advocate.	Dr Hibbert.

December 5th.—Mr HENRY MACKENZIE read a Supplement to his former Paper on Dreams.

A paper, by the Reverend Dr FLEMING, was read, entitled "Observations on the Defoliation of Trees." This paper is printed in the present number, p. 72.

Dr TURNER read a paper on a Method of Detecting Lithia in minerals by means of the Blowpipe, and he exhibited to the meeting the experiments on which it was founded. This paper is printed in the present number, p. 113.

Dr HIBBERT read a Notice of certain Remarkable Concretions found in the Sandstone of Kerridge, in Cheshire. One of the very remarkable specimens from that locality was exhibited to the Society. This paper is printed in the present number, p. 138.

Dr HIBBERT exhibited a Specimen of the Vertebræ and Ribs of the Plesiosaurus, a species of gigantic Crocodile lately found at Whitby, and in his possession.

At this meeting the following gentlemen were elected Ordinary Members of the Society:—

John Archibald Stewart, Esq. Younger of Grandtully.
James Hall, Esq. Advocate.
Sir William Jardine, Bart.

2. *Proceedings of the Society for Promoting the Useful Arts in Scotland.*

March 22, 1825.—There was read a Description of Mr WHITELAW's New Compensation Pendulum.

A letter from Mr JOHN GIBB, Civil Engineer, to JOHN ROBISON, Esq. was read, "On the Application of Granite to the Construction of Railways. See this Journal, No. v. p. 152.

Models of a Fire Engine and a Fire Escape, by Mr WALTER BALLANTYNE, were exhibited.

April 5th.—A Description of an Improved Rain-Guage, by Mr THOM of Rothesay, was read, and the instrument itself exhibited.

A Notice of a Method of Extinguishing Fires, was read by Major ALSTON.

A Model, showing the Application of the Lever to work Chain Pumps &c. by Mr W. Ballantyne, was exhibited.

Mr Thom's Rain-Guage was also exhibited, and an Improved Syphon, by Mr Hunter of Thurston.

April 19*th.*—The various models and machines described to the Society, during the Session, were exhibited at this meeting. The Society adjourned till the 6th of December.

December 6th.—The Society of Arts resumed its sittings for the winter.

An Account of a Rotatory Gas Burner, invented by Mr Nimmo, brassfounder in Edinburgh, was read. See this number, p. 152.

Professor Wallace gave a Description of a new Revolving Bookcase.

There was read, an Account of Mr Whitelaw's New Compensation Pendulum.

The following Machines were Exhibited.

1. The Rotatory Gas Burner was exhibited to the Society in operation.
2. Professor Wallace's Revolving Bookcase was exhibited.
3. Mr Whitelaw's New Compensation Pendulum and Clock was exhibited in complete operation. A description it will be given in our next number.

December 7th.—At a general meeting held this day, the Right Honourable the Lord Provost in the chair, the Society awarded a Gold Medal to Mr David Whitelaw, watchmaker, 16, Prince's Street, Edinburgh, for his Clock with Improved Compensation Pendulum.

The Society also awarded a Gold Medal to Professor Wallace for his Eidograph, an Instrument for Reducing and Enlarging Drawings.

The Society likewise awarded a Silver Medal to Mr Shiells, for his Triangle for Directing the Jet of Fire Engines, described in this Journal, No. v. p. 150.

Art. XXXII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *First Comet of* 1825.—The following elements of this comet have been calculated by M. Shumacher, from the observations made by M. Gambard:—

	D.
Passage of perihelion,	1825, May 31. 473
Long. of perihelion	273° 29′ 30″
Long. of node	17 48 10
Inclination of orbit	57 26 40
Perihelion distance	0 89 96

Motion retrograde.

M. Pons saw this comet so late as the 14th July 1825.

2. *Second Comet of* 1825.—This comet was discovered by M. Pons on the 15th July in Taurus, and has been observed by various astronomers. M. Capocci observed it about the 25th of August. He describes it as sur-

rounded with a very extensive nebulosity, and as having a tail more than a degree in length. The following are its elements:—

Passage of perihelion at Naples,	1825, December 8^d. 895 Mean time
Perihelion distance - - - -	1.20808
Log. of do. - - - - -	0.08209
Long. of perihelion - - -	317° 24′ 40″
Long. of descending node - - -	35 19 50
Inclination of orbit - - -	32 44 20
Motion - - - -	Retrograde.

This comet became distinctly visible to the naked eye in October last.

3. *Third Comet of* 1825.—This comet was discovered by M. Pons on the 9th August, at 2 A. M. in the constellation Auriga. The following are Inghirami's observations at Florence:—

	Mean Time.	App. R. Ascen.	North Decl.
August 20.	15h 42′ 25″	89° 25′ 0″	22° 51′ 32″
23.	15 9 21	91 36 39	16 29 45
24.	15 6 25	92 22 12	14 16 26
25.	15 34 58	93 0 13	12 5 57

4. *Fourth Comet of* 1825, *the periodical Comet of Encke.*—This comet was discovered by M. Plana of Turin, on the 10th August, and by M. Pons on the 14th. M. Pons states, that it seemed to change its form, appearing sometimes elongated, and sometimes round. M. Valz seems to have observed this comet so early as the 13th July.

M. Encke predicted the return of this comet; and the error of his calculations, when compared with the observations made in August, is not a minute of a degree.

5. *Fifth Comet of* 1825.—M. Pons discovered another new comet at Florence, on the 7th November. He observed it in the constellation Eridanus, having 54° of right ascension, and 14° of south declination. It was moving in a south-westerly direction, at the rate of about twenty minutes a day, and it requires a good telescope to see it.

6. *Stars without any Proper Motion.*—From a comparison of some of the double stars observed by Sir William Herschel, with the present relative position of those stars, Dr Brinkley is of opinion that *several stars have no sensible proper motion,* and by comparing Dr Bradley's observations with his own, he concludes, that in the last seventy years there had been no sensible changes of place of Rigel, Orionis, Polaris, and ζ Ursæ Majoris, &c. Dr Brinkley has since deduced therefrom the quantity of Luni-solar precession, and also the displacement of the ecliptic on the equator; and it is probable that many other important consequences will arise from a more extended inquiry into the subject. See *Dublin Phil. Journal,* No. I. p. 263.

7. *Miss Herschel's Catalogue of Nebulæ.*—The catalogue with which Miss Herschel is now occupied is not of stars in general, as our notice in No. V. p. 178 would lead our readers to suppose, but only of *Nebulæ.*

8. *Mr Pond's Method of Determining the Direction of the Meridian.* This method consists in placing two very distinct and well defined objects nearly at equal distances on each side of the north meridian line, and at a distance from each other nearly equal to twice the greatest elongation of the pole star. These objects are placed by means of a telescope, fixed like a transit on a horizontal axis, and pointed first to the pole star, at its greatest elongation, and then at its reflected image. In thus passing from the star to its image, the central wire, which must necessarily describe a strictly vertical circle, will pass over some terrestrial object, which, if well defined, will serve for the mark; but if not, a mark must be set up so as to be bisected by the wire. The same being done on the other side of the north meridian, the distances of the marks from the central wire must be accurately measured with a micrometer. The horizontal angles between the marks being measured by a theodolite, a meridian mark is to be erected exactly between them.

9. *Remarkable Effect on the Cambridge Transit Instrument.* In adjusting the transit instrument recently put up in the New Observatory at Cambridge, Mr Woodhouse observed, that the line of collimation deviated occasionally to the east or west of the meridian mark without any visible cause. He at last found that this effect arose from the approach of the assistant's body to the lateral braces used to steady the instrument in an invariable position at right angles to its axis. The expansion of the brace nearest him thrust the axis of the telescope aside. Mr Woodhouse proved that this was the cause of the deviation, by producing the same effect with hot cloths wrapped round the alternate braces, and he, therefore, provided a proper apparatus to protect the braces from the solar heat, during the approach of the sun to the meridian.

OPTICS.

10. *Committee for the improvement of Glass for Optical purposes.* We understand that the Royal Society of London, and the Board of Longitude, are taking effectual measures for the improvement of glass for optical purposes. A regular Glass-house has been built for this purpose, and a series of experiments will be immediately begun, under the direction of a committee of members of the Royal Society, from whose talents and diligence we anticipate the happiest results.

11. *Traces of Polarized Light in Halos.* M. Arago is said to have remarked unequivocal traces of polarization by refraction in the light of a halo, seen round the sun towards 11 o'clock in the morning; and he concludes, that halos cannot, therefore, be formed by reflection.

12. *Telescopes without Irradiation.* M. Arago has announced, that he has constructed telescopes in which there is no irradiation. The diameter of one of the satellites of Jupiter, and that of its shadow on the planet,

were found to be the same. Observations on Venus prove also that there is no irradiation in his telescope.

13. *Optical structure of Edingtonite.* Mr Haidinger, the discoverer of this new mineral, which he has described in our last Number, and which has been analyzed by Dr Edward Turner, was so good as to put into my hands three very minute crystals of it for the purpose of examination. It has one axis of double refraction coincident with the axis of the octohedron, which is its primitive form. The character of its action upon light is negative, like that of calcareous spar. This result affords another proof, if any were wanting, of the infallibility of the optical law of primitive forms. D. B.

14. *Phosphorescence of certain Fluids.* The following fluids have been found by Dr Brewster to be phosphorescent when poured into a cup of heated iron.

1. Albumen (white of an egg) diluted in water.
2. Isinglass, solution of.
3. The two preceding solutions mixed.
4. The Saliva.
5. Soap and Water.
6. Solution of Rhubarb.
7. Solution of common Salt.
8. Solution of Nitre.
9. Tallow. The phosphorescence of tallow may be distinctly observed when a candle is put out in a dark room.
10. Alcohol.
11. Ether burns with a blue flame.
12. Oil of Dill seed.
13. Oil of Olives.
14. Solution of Alum, very faint.

In making these experiments, Dr Brewster found that alcohol *would not inflame* when poured upon a red hot iron, while ether burned with great readiness.

ELECTRICITY.

15. *Electricity produced by Evaporation.*—M. Pouillet concludes, from various experiments,

1*st*, That simple evaporation, whether slow or rapid, never gives signs of electricity.

2*d*, Alkaline solutions of soda, potash, barytes, strontia, &c. give electricity; and the *alkali* remaining after evaporation, is *positively electrified*.

3*d*, Other solutions of salts or acids, give also electricity, and the body combined with the water then becomes negatively electrical. *Bull. de Soc. Phil.* July 1825, p. 101.

In M. Pouillet's Memoir, he speaks of the large compound lenses as "la belle invention de M. Fresnel." M. Pouillet ought to have known that they were invented long before in Scotland.

16. *Electricity of the Atmosphere.*—M. Pouillet has shown that electricity is developed during the vegetation of plants, shewing itself the moment that the germ appears above ground. He, therefore, concludes that this is a fertile source of atmospherical electricity.—*Id. May*, p. 69.

17. *Electricity of Flame.*—M. Pouillet has shown that, in a vertical flame formed by the combination of hydrogen with oxygen, the visible part of the flame, and the part without it, to the distance of a centimetre, is positively electrified, while, in the interior of the flame, resinous electricity alone is found. *Id.*

18. *Subterraneous Passage of Lightning.*—On the 28th May 1824, a tree in Vernon, Connecticut, was struck with lightning. After passing down the tree, and tearing up the earth at its root, the electric fluid passed "50 or 80 feet under the surface of the earth without following any such substances as commonly guides its course there, as roots, stones, &c. The fluid seems not to have been guided at all by any attracting substance, but to have been carried forward nearly in a straight course by a momentum it had received, through a medium opposing the most powerful resistance, a medium in which it is commonly supposed to be dissipated and lost." The electric fluid left unequivocal traces of its passage through a distance of nearly 50 feet. Through the distance of other 30 feet there can be no doubt of its having passed, as its effects upon a wall were distinct at that distance; and it cannot be supposed that it came out of the ground and leaped 30 feet to the wall. This account is given by Professor Kellogg, in Professor Silliman's *Journal*, vol. ix. p. 84—86.

GALVANISM.

19. *Analogy between the Phenomena of Galvanism and those of Fermentation.*—M. Schweigger has observed this analogy in the following points:

1. Galvanic piles, like fermentable mixtures, exhibit their effects only by the reciprocal action of three different bodies.

2. The products of galvanic action are two, an oxidated body, and a *hydrogenated* body. The same happens with the products of fermentation, which are alcohol and carbonic acid.

3. The presence of electro-negative bodies favours the decomposition of water, whilst, according to Dobereiner, electro-positive bodies determine the formation of it.

M. Schweigger is of opinion, that the same results may be obtained with fermentable mixtures, as with electrical batteries; but several experiments, made subsequently by M. Dobereiner, stand in opposition to this hypothesis. Schweigger's *Journal sur Phys.* &c. vol. x. cah. 3d. 1824, and vol. xi. cah. 4, p. 457.

20. *Avogadro's Multiplying Voltimeter.*—This instrument, which differs little from the galvanometer of Schweigger, consists of a sewing needle fixed in the base of a small triangle of paper, passing through two holes in the plane of the paper. It is suspended by a fibre of silk, and is placed above the conducting wire. M. Avogadro prefers that arrangement, as it facilitates the observation of the deviation of the needle, when measured on a graduated semicircle. M. A. has applied the voltimeter to determine the order of the metals, relatively to their electricity, by contact. *Mem. dell. Acad. Reale di Torino,* tom. xxvii. p. 43.

METEOROLOGY.

21. *Mean Temperature of the Equator.* From a comparison of various observations, M. Humboldt made the mean temperature of the equator 81° 5, while Dr Brewster, in his formulæ, makes the mean temperature of the equator in the old World 82° 8. This curious subject, however, has been ably discussed in a memoir on refraction and temperature, by Mr Atkinson, who, from a careful examination of Humboldt's observations by the method of minimum squares, has obtained the following results:—

"1. The whole of Humboldt's observations, both in North and South America, at or near the level of the sea, indicate that the mean temperature of the equator at the same level is 86° 55 of Fahrenheit.

"2. All the observations, nine in number, made within 11° of the equator, where the height does not exceed 3500 feet, indicate that its temperature is 84° 53. But if Caripe be excluded, as it probably ought, the remaining 8 give 85° 273, for the mean temperature under the equator.

"3. If those places only be taken, which are within the same limits, and whose height is less than 2000 feet, they indicate that the mean temperature is 84° 93."

It thus appears, says Mr Atkinson, from data, furnished by himself, that Humboldt has fallen into an error, when he asserted that the mean temperature of the equator cannot be fixed beyond 81° 5′.

22. *Diminution of the Temperature with the Altitude.*—Mr Atkinson has shown that the depression of the thermometer due to the height of 1666 feet is 6°. 412, deduced from 128 observations. From 29 other places he proves that the depression of temperature for 1468 feet is 5°.682. These results give nearly 200 feet for 1 degree, and it is remarkable, how very closely they approach to proportionality to the altitudes to which they belong, thus confirming Mr Ivory's law. Mr Atkinson's formula for the depression of temperature due to any given altitude, h is $\left\{251.5+\frac{3}{2}(n-1)\right\} n=h$, where n is the measure of that depression.

23. *Fall of a Meteoric Stone, at Nantgemory, Maryland.*—On February 10th 1825, between 12 and 1 o'clock, an explosion was heard, louder than that of a cannon, then a loud whizzing noise, and in less than 15 minutes, a stone fell, and penetrated about 23 inches into the earth.

When taken out it was rough and warm, with a strong sulphureous smell. It weighed 16 lbs. 7 oz. The explosion and the noise were heard over an extent of 50 miles square. At a distance of 25 miles from the place where it fell, it caused a whole plantation to shake. Prof. Silliman's *Journal*, vol. ix. p. 351.

24. *Hoar frost on Iron rails.*—Dr MacCulloch has observed that hoar frost exhibits a particular arrangement upon iron railing. The minute crystals were aggregated into pyramidal groups, and each pyramid stood on all the four edges of the iron bar, and was equally inclined to the two adjacent planes, to the common section of which it stood perpendicular. The temperature was a little below freezing, and there was a moderate fog, with a high barometer. Brande's *Journal*, No. 39, p. 40.

25. *Mean height of the Barometer at the level of the Sea.*—In 1799, M. Humboldt found that the mean height of the barometer, at the level of the sea at Cumana, was 758,59 millimetres at 37° of Fahrenheit. M. Boussingault found the height to be 760,17 at La Guayra, and M. Arago found it to be 760,85 at Paris.

26. *Rain without Clouds.*—On the 5th September 1799, at 3 o'clock P. M. M. Humboldt saw *large drops of rain fall* at Cumana, when the sky was quite blue, and without the slightest trace of clouds.

27. *Fall of Meteoric Stones in Italy.*—In January 1824, between 9 and 10^h P. M., meteoric stones fell in the commune of Renalzo, twenty-one miles from Cento. Their fall was preceded by a bright light, by three loud explosions like the noise of cannon, which were heard over an extent of several miles, and by a confused noise, like that of a number of bells. The phenomenon lasted 20 minutes. Three stones were found, one of which weighed 1½ lbs. *Bull. des Sc. Phys.* September 1825, p. 183.

28. *Baron Krusenstern's opinion of Mr Adie's Sympiesometer.*—As we had the good fortune to give the first account of this ingenious instrument, invented by Mr Adie of Edinburgh, we are happy to be able to lay before our readers the opinion of such a competent judge as Baron Admiral Krusenstern, the celebrated Russian navigator, who thus speaks of it in his new memoirs, p. 47 :—" Although the marine barometer is generally considered as one of the most important instruments in navigation, yet the commanders of vessels have not always the means of providing themselves with one of them, as its price is so high as 12 guineas. But its place may be supplied by the *Sympiesometer*, an instrument invented some years ago by Mr Adie, a skilful optician in Edinburgh, which will be found of great utility, even when there is a barometer on board the ship." After giving an account of the principle of construction of the instrument, Baron Krusenstern adds : " it is therefore to be presumed, that this intrument which is recommended by its moderate price, by its occupying little space, and by its not being affected by the rolling of the vessel, will be particularly use-

ful to small ships, which, deceived by the appearance of fine weather, venture into the ocean, and expose themselves to dangers of which they often become the victim.' See Zachs' *Corresp. Astron.* vol. xii. p. 137.

29. *Mr Jones's Improved Hygrometer.* This instrument, an account of which was read at the Royal Society, has for its object to ascertain the temperature at which dew is deposited from the atmosphere. It therefore differs from Mr Daniell's only in having the frigorific action applied immediately to the tube of the thermometer which is used to measure the temperature. The tube is large and cylindrical, slightly flattened, and extended at the end. This end of the tube is turned upwards, the stem of the thermometer being twice bent at right angles. This end is made of black glass and exposed, but the rest of the tube is covered with muslin, which, being moistened with ether, the mercury is cooled, and dew at length settles on the exposed part, at which instant the degree indicated in the scale is read off. See p. 127 of this Number.

30. *Remarkable Waterspout.* This extraordinary phenomenon was seen on the 6th July 1822, in the plain of Arsonval, a village about six leagues W. S. W. of St Omer, and six from Boulogne. About 1^h 35′ P. M. clouds coming from different parts collected rapidly, and formed a single one which covered the whole horizon. From these clouds a thick vapour immediately descended in the shape of an inverted cone, and having the bluish colour of burning sulphur. The apex of the cone next the earth revolved with great velocity, and formed an oblong mass, of about *thirty* feet detached from the cloud. It rose with a noise like the bursting of a large bomb, leaving a hollow in the ground, of from 20 to 25 feet circumference, and from 3 to 4 feet deep in the middle. It then set off in the direction of W. to E. knocked down a barn, and gave to the neighbouring farm-house a shock like that of an earthquake. It overthrew from 25 to 30 trees, and laid them in such a variety of directions, as to prove that it advanced with a rotatory motion. It next travelled through a distance of two leagues without touching the ground, carrying off huge branches of trees which it threw out with great noise to the right and left. Having reached the highest point of the wood Fauquembergue, it carried off the tops of several oaks, which it took along with it, below the village of Vendome, at the foot of the hill on the east of the forest. In that commune it did no other harm than to carry off a very large sycamore tree, root and branch, to a distance of 600 paces.

Continuing its route like a ball fired *en ricochet,* it attacked the village of Audinctun, where it demolished the roofs of three houses, and carried away several trees, among which were five ashes of great height. After quitting the valley, at the mouth of which these two villages are situated, it ascended the mountain de Capelle, and several ploughmen saved themselves by lying down and holding firmly by their ploughs, one of which was driven so deep into the ground, that three horses were unable to pull it out. M. Demarquoy, who has described this phenomenon minutely, observes that its form (the form of its section we presume,) was oval, its length being about 30 feet, and its other diameter about 20. The spout turned, in its progress, each of its faces to all points of the horizon. Globes of fire issued from its centre, and often globes of vapours like sulphureous ones. Its noise was like that of a loaded waggon dragged at a gallop over a paved road. Every globe of fire or vapour that issued from it, was accompanied with an explosion like that of a musket, and the wind, which was violent, added to this a terrible whistling noise. Near Mont Capelle, it penetrated into the vallies of Witernestre and Lambre. The first contains about forty houses, thirty-two of which, with their barns, were overturned, and an enormous quantity of trees beat down, torn up and carried to a great distance. At Lambre, the revolving motion of the meteor was seen, and also its sulphur brown colour, and from its centre, like that of a fire, there issued flashes of bituminous vapour. The trees round the church were broken and uprooted. The house of the curate was unroofed, and eighteen houses, most of them built of brick, were sapped to their foundations, and exhibited the extraordinary phenomenon of the separation of the walls, which were thrown outwards. After quitting Lambre, the spout divided itself; one part was dissipated, but the other went to Lillers, about three leagues from Lambre, where it broke and uprooted nearly 200 trees on the fine meadows of M. Defoulers, before it vanished. At three o'clock the weather became calm, the sky serene, and the thunder terminated with the waterspout. *Bull. des. Sc. Phys.* Avril 1824, p. 236—239.

II. CHEMISTRY.

31. *Highly calcined Charcoal a conductor of Caloric.* M. Cheuvreusse has found, that charcoal when highly calcined is a perfect conductor of caloric. When the charcoal is not much calcined and is dry, it does not conduct caloric. M. Cheuvreusse proposes to use the first of these charcoals in place of copper in galvanic piles, and also for the purpose of carrying electricity into the ground from conductors.—*Ann. de Chim.* Tom. xxix. p. 440.

32. *Selenium in the Sulphur of the Lipari Islands.* M. Stromeyer has discovered Selenium in sulphur from the Lipari Islands, alternating in white and brownish orange layers, with sal ammoniac. It is probable that the orange tint of the sulphur arises from the Selenium.

33. *Iodine Discovered in a Mineral.* M. Vauquelin has found 18½ per cent. of Iodine in the mineral from Mexico which was labelled *virgin silver* in serpentine.—*Ann. de Chim.* xxix. p. 99.

34. *New Experiments on Flame.*—It appears from a series of experiments by Mr Davies of Manchester, that there is considerable foundation for the opinion of Mr Sym, that the flame of a candle is a conical surface, the interior of which is not luminous, a section of the flame being a narrow luminous ring surrounding an obscure disc. Mr Davies found that

there is no oxygen in the interior space within the red flame, as phosphorus and sulphur, though they readily melted, yet never would inflame when placed within it. These inflammable bodies, however, always burned when the flame was blown upon them with a blowpipe, so as to supply them with oxygen. The moment the supply of oxygen was exhausted, they were again extinguished. Mr Davies explains the great power of the oxy-hydrogen blowpipe, by stating, that in it the flame, instead of being a superficial film of inflammation, is a solid mass of fire.—*Ann. of Phil.* Dec. 1825, p. 447.

35. *Prussian Blue in the Soda of Sicily.* In three parcels of soda from Sicily, M. Brandes has obtained Prussian blue. When he heated the soda with warm water in a white iron vessel, he obtained much more of the Prussian blue than when he dissolved it in a porcelain dish. *Arch. des Apoth. ver.* 1822, No. 3. p. 215.

36. *Analysis of Benzoin.* The following analysis of Benzoin has been given by M. Stoltze in the Berlin *Jahrbuch,* 1824, p. 55.

	White Benzoin.	Brown Benzoin.
Yellow resin soluble in absolute ether	798.25	88. 0
Brown resin insoluble in ether	2.50	697.25
Pure Benzoic acid	198.00	197.00
Extractive matter		1.50
Water and loss	1.25	1.75
	1000.00	990.00

37. *On Rinmann's Green.* This colour is an intimate mixture of the protoxide of cobalt and the oxide of zinc, which assumes a very lively green tint, after it has been heated to redness. In order to form this green, suddenly, as if by the eruption of a volcano, mix together two parts of nitrate of zinc, and one part of the subacetate of cobalt, and expose the mixture to a spirit of wine lamp in a glass globe, with a short neck. This mixture soon becomes liquid, and appears at first of a rose-red colour, then purple, then blue. In an instant it inflames, detonates, becomes dry, and assumes a green colour. The product is scattered upon the vessel in the form of small rolled leaves of tea. *Bull. des Sc. Nat.,* May 1824, p. 292.

38. *Oxalic acid found in great quantities in lichens, &c.* M. H. Braconnot has discovered that oxalate of lime forms nearly one-half of the weight of a great number of lichens, to which it bears the same relation that carbonate of lime does to corallines, and phosphate of lime to bones. The oxalate diminishes progressively in the family of lichens, as the species loses their crustaceous granular texture, and acquire a foliated membranaceous aspect, but the latter still contain a remarkable quantity. About 17 parts of yellowish white oxalic acid were obtained from 100 parts of the pulverised lichen. *Ann. de Chim.* xxviii. p. 318.

39. *Action of Nitric Acid on Charcoal.* Professor Silliman having announced the formation of hydrocyanic acid, by the action of nitric acid in charcoal, M. Frisiani was led to the same result in the following manner: in treating with nitric acid the residue of the calcination of sulphate of barytes with charcoal, he smelt bitter almonds. This made him suppose that the prussic acid was formed. He repeated the experiment in a glass bottle, and heating the liquor with sulphate of iron, he obtained prussian blue. The boiled nitrates and that of barytes, decomposed by charcoal, do not produce the same effect. *Giorn. de Fis.* &c. 1824, p. 240.

40. *Temperature of different Animals.* M. Despretz has obtained the following results on the temperature of different animals, that of the air being 59° Fahrenheit.

Two Carps, temperature of water 51°.4	53.°0 Fahr.
An adult Guinea Pig	96.4
3 male children, aged between 1 and 2 years,	95.2
4 young persons aged 18	98.6
9 men aged 30	98.85
4 men aged 68	98.83
A dog 3 months old	103.06
Three pigeons	109.37

Respecting the cause of animal heat, M. Despretz has drawn the following conclusions:

1. That respiration is the principal cause of animal heat, producing seven-tenths of it in very young animals, and often as much as nineteen-twentieths of the whole effect; the remaining heat being produced by assimilation, the motion of the blood, and the friction of the different parts.

2. That besides the oxygen employed in the formation of the carbonic acid, another portion of gas, sometimes very considerable in relation to the first, disappears also; more oxygen disappearing in general in young than in adult animals.

3. That there is an exhalation of azote in the respiration of mammiferous, carnivorous and granivorous animals, and in the respiration of birds; and that the quantity of azote exhaled is greater in granivorous than in carnivorous animals. *Bull. des Sc. Nat.* &c. Avril 1825, p. 244—246.

41. *Analysis of the Piney Tallow from Malabar.* This curious substance is obtained by boiling the fruit of the *Vateria Indica* or *Piney*, a tree common on the coast of Malabar. The tallow rises to the surface in a melting state, and forms a solid cake on cooling. In this state it is generally white, sometimes yellow, greasy to the touch, with some degree of waxiness, almost tasteless, and has rather an agreeable odour, somewhat resembling common cerate. It melts at a temperature of 97½° Fahrenheit. It is so tenacious and solid, that 9 lbs. of it cast in a rounded form, could not be cut asunder by the force of two strong men with a fine iron wire, and it was very difficult to effect a division of it, even with a saw. Its specific gravity at 97½° is .8965 and at 60° .9260. According to the analysis of Mr

Babington, from whose paper on the subject we have taken these particulars, piney tallow consists of

Carbon	77.0	10	atoms
Hydrogen	12.3	9	
Oxygen	10.7	1	
	100.0		

Mr Babington remarks that 500 cwt. of piney tallow, may be obtained in the town of Mangalore, for 50 rupees, which is about 2½d per pound. *Quarterly Journal*, No. 38, p. 177.

III. NATURAL HISTORY.

MINERALOGY.

42. *New Analysis of Dioptase.*—The former analyses of Vauquelin and Lowitz, differ widely from the following results now obtained by Vauquelin.

	Lowitz.	Vauquelin, 1st Analysis.	Vauquelin, 2d Analysis.
Silex,	33	28.57	43.181
Carbonic Acid,		18.67	
Lime,		24.18	
Oxide of Copper,	55	28.58	45.455
Water,	12		11.364
	100	100.00	100.000

Vauquelin's second analysis was made up by decigrammes.

43. *Mr Swedenstierna's Collection of Minerals.* This valuable collection of minerals has been purchased by the Prince Royal of Sweden, who has presented it to the university of Upsal, of which he is the head.

44. *Remarkable Law in Mineralogy.* M. A. F. Kuffner, of the University of Casan, has discovered a very remarkable relation between the weight of the atoms of minerals, the volumes of their primitive forms, and of their specific gravities. This law is represented by the equation $\frac{w\,s}{v}=\frac{w'\,s'}{v'}$, w, w' being the weights of the atoms of two different substances, s, s' their specific gravities, and v, v' the volumes of their primitive forms, the semi-axis being supposed equal to unity. In order to compare the specific gravities of minerals deduced from this law, with the observed specific gravities, we obtain from the above equation the formula $s'=\frac{w\,s}{v}\times\frac{v'}{w'}$, so that, by having the values of s, w and v for one substance, such as calcareous spar, and the values of v' and w' for another substance belonging to the same system of crystallization, such as quartz, we shall obtain s' as the specific gravity of quartz. In the system of octohedrons with a rhombic base, M. Kupffner chose the one of the three Perpendicular axes which gives a result most conformable with his law.

In this way he obtained the results in the following table:—

	Weight of		Specific Gravity.	
	Atom.	Volume.	Calculated.	Observed.
	RHOMBOIDS.			
Calcareous Spar	1262.7	3.1643	——	2.696
Oligist Iron	978.4	4.6452	5.108	5.01–5.22
Quartz	596.4	1.4318	2.58	2.63
Apatite	1470.3	4.280	3.132	3.130
Beryl	27523	6.956	2.721	2.72
Emerald	16986	——	2.775	2.775
Corundum	321.16	1.245	4.177	4.07
	II. REGULAR OCTOHEDRONS.			
Iron (Oxidulé)	2835.29	1.333	——	4.946
Sulphuret of Iron	2966.1	1.333	4.728	4.749
———— Silver	6211.06	2.00	6.808	6.90
		Vol. of Rhomb. Dodecahedron		
Sulphuret of Zinc	5513.6	2.00	4.069	4.061
Alum	11870.77	2.00	1.772	1.75
Amphigene	5645.37	1.333	2.484	2.468
Muriate of Ammonia	8915.52	1.333	1.566	1.5–1.6
Copper	1597.26	1.333	8.78	8.78
Silver	1344	1.333	10.44	10.47
	III. OCTOHEDRONS WITH SQUARE BASE.			
Oxide of Tin	1870.58	2.945	——	6.934
Meconite	5735.76	3.3412	2.648	2.65
Idocrase (Siberia)	12530.6	9.6157	3.38	3.39
	IV. OCTOHEDRON WITH RHOMBIC BASE.			
Sulphate of Barytes	2916·18	1.4259	——	4.481
Topaz	7971.78	3.1017	3.585	3.55
Arragonite	1262.7	0.39913	2.8972	2.9267 2897
Sulphate of Strontian	2296.9	0.99321	3.963	3.958
———— Lead	3791.3	2.516	7.082	6.0717
Carbonate of Lead	3339.3	2.3533	6.45	6.45
Epidote	10198.0	3.915	3.519	3.453
Pediot	14800.13	5.466	3.386	3.441
Cymophane	3670.8	1.5188	3.792	3.796
Sphene	23033.2	8.462	3.520	3.51
Carbon. Copper Blue	8600.7	3.5830	3.818	3.8
Euclase	8072.9	2.735	3.105	3.063
Copper Pyrites	2274.4	1.077	4.34	4.315
Feldspar	7235.8	2.037	2.580	2.578
Sulphate of Lime	2164.12	——	——	2.3117
———— Magnesia	2643.4	0.5062	1.756	1.75
———— of Zinc	3133.1	0.6758	1.977	2.0
Carbonate of Soda	7162.2	1.1718	1.477	1.5
Fluate of Lime	3948.4	1.333	3.095	3.09
Muriate of Soda	6868.6	1.333	2.082	2.08

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IV. GENERAL SCIENCE.

45. *Copley Medals adjudged to Mr Barlow and M. Arago.*—The Royal Society of London has adjudged the Copley medals to Mr Peter Barlow of Woolwich, and to M. Arago of the Academy of Sciences, for their discoveries respecting the effects of rotation on the magnetic forces, of which we have given a full account in this number, p. 13.

46. *Figures in Amber.*—Artists whose profession leads them to work in amber, are able to produce in its interior certain figures which add greatly to the value of the specimens which contain them. The process by which these figures are created, consists in boiling the amber in oil. In this way flaws are produced, which represent very curious objects. *Mag. der. Pharm.* Mai 1824.

47. *Establishment of two Royal Scientific Prizes.*—At the Anniversary Dinner of the Royal Society of London, on the 30th November last, Mr Peel announced his Majesty's intention of granting the sum of *one hundred guineas* annually, to establish two scientific prizes, to be awarded every year for the most important discoveries and inventions.

ART. XXXIII.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE AUGUST 19, 1825.

46. Sept. 5. For a New Polishing Apparatus for household purposes. To JOSEPH ALEXANDER TAYLOR, London.

47. Sept. 16. For an Improvement in the Loom for Weaving Tape. To THOMAS WORTHINGTON junior, and JOHN MULLINER, Manchester.

48. Sept. 17. For an Improved Blowing-machine. To CHARLES POWELL, Monmouthshire.

49. Sept. 21. For Improvements in the construction of Rail-Roads and Carriages. To WILLIAM HENRY JAMES, Birmingham.

50. Sept. 30. For Improvements in the making of Buttons. To BENJAMIN SANDERS, Worcester.

51. Oct. 1. For Improvements in manufacturing Carpets. To ADAM EVE, Lincolnshire.

52. Oct. 1. For Improvement upon a Machine for working Fancy Net. To HUGH MARTIN and THOMAS LEE, Renfrewshire.

53. Oct. 4. For an Engine for Cutting Nails, Sprigs, and Sparables. To JAMES WILKS and JOHN ECROYD, Rochdale.

54. Oct. 10. For an Improvement in the Construction of Riding Saddles. To GEORGE THOMPSON, Wolverhampton.

55. Oct. 10. For an Improvement in the Construction of Wheels. To GEORGE HUNTER, Edinburgh.

56. Oct. 10. For a new method of manufacturing Pipes for the conveyance of Water. To SAMUEL BAGSHAW, Newcastle-under-Lyne.

57. Oct. 13. For a process of converting Iron into Steel. To NATHANIEL KIMBALL, London.

58. Oct. 13. For Improvements in the manufacture of Steel. To JOHN MARTINEAU the younger, Middlesex, and HENRY WILLIAM SMITH, London.

59. Oct. 13. For Improvements in the manufacture of Buttons. To Thomas Dwyer, Dublin.

60. Oct. 16. For Improvements in Machinery for propelling Vessels. To John Reedhead, Devonshire.

61. Oct. 28. For Improvements in the process of Refining Sugar. To Henry Constantine Jennings, Middlesex.

62. Nov. 5. For Improvements in the construction of Diving Bells. To Thomas Steele, Cambridge.

63. Nov. 5. For Improvements in the construction of Hats. To John Bowler, Surrey, and Thomas Galon, Middlesex.

64. Nov. 15. For a Machine for Impelling Power without the aid of fire, water, air, steam, gas, or weight. To William Jefferies, Middlesex.

65. Nov. 17. For a Cement for Building. To John Phillips Beavan, Middlesex.

Art. XXXIV.—CELESTIAL PHENOMENA,

From January 1st 1826, to April 1st 1826. Adapted to the Meridian of Greenwich, Apparent Time, excepting the Eclipses of Jupiter's Satellite's, which are given in Mean Time.

[The Calculations hitherto given in this work were adapted to the Meridian of Edinburgh; but as the longitude and latitude of this place have never been well ascertained, there can be no advantage in suiting the calculations to a hypothetical meridian. The practical astronomer must repeat the calculations for his own use; and the general observer, or amateur in astronomy, requires only the approximate time of the Celestial phenomena, and can have no difficulty in determining this, for any part of the kingdom, from the times for Greenwich. The longitude of Edinburgh Royal Observatory, according to the best observations, is 3° 10′ 21″ W. and its Latitude 55° 57′ 57″ N.]

N. B.—The day begins at noon, and the conjunctions of the Moon and Stars are given in Right Ascension.

JANUARY.

D.	H.	M.	S.	
1	0	21	0	☾ Last Quarter.
1				♃ Stat.
1				Conj. ☿ and ☉
1	20	35	26	☽ i ♍
2				Conj. ☽ ♂
2	16	49	50	Im. 1. Sat. ♃
3	15	0	0	Conj. ♀ *b* ♐
4	11	18	7	Im. I. Sat. ♃
4	11	41	23	☽ Conj. *δ* ♍
6				☽ Conj. Ceres.
6				☽ Conj. ♀
6	16	15	49	☽ Conj. 1 *μ* ♐
6	16	51	26	☽ Conj. 2 *μ* ♐
6	20	0	0	☽ Conj. ☿
7	14	0	37	Im. II. Sat. ♃
7	21	39	0	● New Moon.
8	22	10	6	☽ Conj. *β* Capric.
8				☽ Conj. ♅
9	18	43	8	Im. I. Sat. ♃
10	5	0	0	☉ Conj. ♅
11				☿ Stat.
11	13	11	27	Im. I. Sat. ♃
14	16	35	14	Im. II. Sat. ♃
15	14	0	0	♀ Conj. *o* ♐
15	16	38	0	☽ First Quarter.
17	14	51	54	☽ Conj. *δ* ♈
18	15	4	49	Im. I. Sat. ♃
19	20	0	0	☽ Conj. ♄

D.	H.	M.	S.	
19	10	49	1	Im. III. Sat. ♃
19	18	4	51	☽ Conj. ι ♉
20	0	11	0	☉ enters ♈
20	9	18	4	☽ Conj. ζ ♉
20	9	33	11	Im. I. Sat. ♃
21	1h	4h	7h	☽ Conj. η, μ, ν ♊
21	14	8	0	Im. IV. Sat. ♃
21	18	30	54	Em.
22				☿ Greatest Elong.
22	3	0	0	♀ Conj. ♅
23	6	15	0	♂ in Quadrature.
23	12	2	0	○ Full Moon.
23	23	55	3	☽ Conj. 1 α ♋
24	1	2	47	☽ Conj. 2 α ♋
24	20	11	8	☽ Conj. ο ♌
25	4	48	31	☽ Conj. π ♌
25	16	58	13	Im. I. Sat. ♃
26	11	23	47	Im. III. Sat. ♃
26	14	46	19	Em.
26	16	0	0	☿ Conj. ο ♐
26				☽ Conj. ♃
27	11	26	37	Im. I. Sat. ♃
29	1	39	14	☽ Conj. i ♍
30	8	9	0	☽ Last Quarter.
31	14	41	44	☽ λ ♎
31	17	27	26	☽ Eclipses δ ♏

FEBRUARY.

D.	H.	M.	S.	
1	11	3	8	Im. II. Sat. ♃
2	15	22	17	Im. III. Sat. ♃
2	16	0	0	☿ Conj. ♅
2	23	23	58	☽ Conj. 1 μ ♐
3				☽ Conj. Ceres.
3	13	20	7	Im. I. Sat. ♃
3	0	0	31	☽ Conj. 2 μ ♐
4	2	16	19	☽ Conj. d ♐
5				☽ Conj. ☿ ♅ & ♀
5	6	24	55	☽ Conj. β ♑
6	12	22	0	● New Moon.
7	10	0	0	♀ Conj. θ ♑
7	8	6	9	Im. IV. Sat. ♃
7	12	25	30	Em.
8	13	38	36	Im. II. Sat. ♃
9				☽ Conj. κ ♓
10	15	13	41	Im. I. Sat. ♃
12	9	42	5	Im. I. Sat. ♃
13	22	57	24	☽ Conj. δ ♈
14				♄ Stat.
14	14	11	0	☽ First Quarter.
15	16	14	17	Im. II. Sat. ♃
16	2	58	39	☽ Eclipses ι ♉
16	4	0	0	☿ Conj. θ ♑
16	4	0	0	☽ Conj. ♄ α near App.
16	18	0	0	☽ ζ ♉
17	10	53	31	☽ Conj. η ♊
17	17	8	56	☽ Conj. ν ♊
17	17	7	22	Im. I. Sat. ♃
18	18	31	0	☽ Conj. ζ ♊
18	14	56	0	☉ enters ♓
19	11	35	47	Im. I. Sat. ♃
20	9	43	43	☽ Conj. 1 α, ♋
20	10	50	52	☽ Eclipses 2 α ♋
21	11	0	0	☿ Conj. γ ♑
21	5	44	50	☽ Conj. ο ♌
21	14	12	51	☽ Conj. π ♌
22	0	25	0	○ Full Moon.
22	12	0	0	☿ δ ♑
23				☽ Conj. ♃
24	6	36	48	Em. III. Sat. ♃
26	8	7	53	Im. II. Sat. ♃
26	13	29	34	Im. I. Sat. ♃
27	15	33	5	☽ Conj. κ ♎
27				☽ Conj. ♂
27	20	6	6	☽ Conj. λ ♎
28	2	0	0	♃ Conj. ☉
28	10	11	0	Em. I. Sat. ♃
28	16	31	0	☽ Last Quarter.

MARCH.

D.	H.	M.	S.	
1	7	15	21	☽ Conj. ϱ Oph.
2	5	31	53	☽ Conj. 2 μ ♐
3				☽ Conj. Ceres & π ♐
3	7	14	22	Im. III. Sat. ♃
3	10	34	16	Em.
4	12	49	24	☽ Conj. β ♑
5	13	35	20	Em. II. Sat. ♃
5	21	45	0	♄ in Quadrature.
5				☽ Conj. ☿
6				☽ Conj. ♀
7	12	5	47	Em. I. Sat. ♃
8				☽ Conj. ☿ and ♀
8	4	30	0	● New Moon.
9	6	34	15	Em. I. Sat. ♃
10	0	0	0	♀ ♃ Conj. ☉
10	3	15	0	☿ ♃ Conj. ☉
10	5	0	0	☿ Conj. ♀
10	11	12	50	Im III. Sat. ♃
10	14	32	11	Em.

D.	H.	M.	S.	
12	16	11	59	Em. II. Sat. ♃
13	6	19	57	☽ Conj. δ ♈
14	13	59	44	Em. I. Sat. ♃
15	11	1	45	☽ Eclipses ι ♉
15	14	0	0	☽ Conj. ♄
16	2	51	17	☽ Eclipses ζ ♉
16	8	28	13	Em. I. Sat. ♃
16	9	30	0	☽ First Quarter.
17	2	5	16	☽ Eclipses ν ♊
17	15	11	25	Em. III. Sat. ♃
17	17	51	22	☽ Conj. ζ ♊
19	20	11	19	☽ Conj. 1 α ♋
19	21	19	35	☽ Conj. 2 α ♋
20	15	11	0	☉ enters ♈
20	16	28	12	☽ Conj. ο ♌
21	0	59	56	☽ Conj. π ♌
21	15	53	47	Em. I. Sat. ♃
22	21	0	0	☿ ε ♓
23	8	7	36	Em. II. Sat. ♃
23	10	22	17	Em. I. Sat. ♃
23	18	42	0	○ Full Moon.
24	12	0	0	☿ Conj. ζ ♓
24	17	47	12	☽ Conj. i. ♍
26	23	8	32	☽ Conj. ϰ ♎
27				☽ Conj. ♂
27	3	32	32	☽ Conj. λ ♎
28	13	41	50	☽ Conj. ϱ Ophiuch.
29	10	55	31	☽ Conj. 1 μ ♐
29	11	31	54	☽ Conj. 2 μ ♐
29	14	5	18	Im. IV. Sat. ♃
30				♂ Stat.
30	2	3	0	☽ Last Quarter.
30	10	44	33	Em. II. Sat. ♃
30	12	16	28	Em. I. Sat. ♃
30	13	53	0	☽ Conj. d ♐
31	18	18	6	☽ Conj. β ♍

Times of the Planets passing the Meridian.

JANUARY.

	Mercury.		Venus.		Mars.		Ceres.		Jupiter.		Saturn.		Georgian.	
D.	h.	′	h	′	h	′	h	′	h	′	h	′	h	′
1	23	44	22	50	18	37	21	48	16	15	10	15	0	38
15	22	22	23	5	18	3	21	0	15	13	9	10	23	37

FEBRUARY.

1	22	26	23	25	17	22	20	26	13	57	7	56	22	30
15	22	58	23	40	16	48	19	55	12	56	7	0	21	39

MARCH.

1	23	36	23	55	16	12	19	18	11	56	6	8	20	48
15	0	19	0	7	15	32	18	57	10	58	5	18	19	58

Declination of the Planets.

JANUARY.

	Mercury.		Venus.		Mars.		Ceres.		Jupiter.		Saturn		Georgian.	
	°	′	°	′	°	′	°	′	°	′	°	′	°	′
1	20	22 S	22	59 S	7	5 S	19	38 S	7	15 N	21	18 N	22	29 S
15	21	0	23	7	9	36	20	36	7	28	21	15	22	23

FEBRUARY.

1	22	21	20	19 S	12	13 S	21	26 S	8	1 N	21	14 N	22	13 S
15	19	36	15	47	13	58	21	55	8	40	21	16	22	6

MARCH.

1	12	33 S	9	49 S	15	20 S	22	18 S	9	22 N	21	21 N	22	0 S
15	1	13 S	3	0	16	15	22	36	10	3	21	28	21	55

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a globe, and determine their risings and settings.

ART. XXXV.—REGISTER OF THE BAROMETER, THERMOMETER, AND RAIN-GAGE, *kept at Canaan Cottage.* By ALEX. ADIE, Esq. F. R. S. Edin.

The Observations contained in the following Register were made at Canaan Cottage, the residence of Mr Adie, by means of very nice instruments, constructed by himself. Canaan Cottage is situated about 1½ mile to the south of Edinburgh Castle, about 3 miles from the sea at Leith, and about 1¼ of a mile N. of the west end of Blackford Hill. The ridge of Braid Hills is about 1 mile to the south, and the Pentland Hills about 4 miles to the west of south. The height of the thermometer is about 260 feet above the level of the sea. The morning and evening observations were made about 10 A.M. and 10 P.M.

SEPTEMBER 1825.

D. of Week.	Day of Month.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	66	57	61.5	48	72	60	29.96	29.99	
F.	2	63	57	60	49	68	58.5	30.02	30.02	
S.	3	62	49	55.5	51	69	60	30.00	29.97	
S.	4	58	47	52.5	45	63	54	29.95	29.97	
M.	5	62	48	55	38	64	51	29.95	29.94	
T.	6	60	51	55.5	39	65	52	29.78	29.68	
W.	7	63	54	58.5	45	69	57	29.46	29.25	
T.	8	61	50	55.5	49	65	57	29.25	29,28	.03
F.	9	61	56	58.5	45	68	56.5	29.19	29.30	.12
S.	10	64	53	58.5	53	70	61.5	29.22	29.26	.25
S.	11	61	53	57	44	63	56.5	29.28	29.45	.39
M.	12	63	51	58.5	48	70	59	29.54	29.78	.11
T.	13	58	55	56.5	47	64	55.5	29.78	29.55	.03
W.	14	55	55	55	55	57	56	29.48	29.43	.35
T.	15	57	57	57	54	61	57.5	29.43	29.50	.21
F.	16	66	54	60	51	72	61.5	29.52	29.52	
S.	17	64	61	62·5	52	71	61.5	29.49	29.46	.22
S.	18	66	60	63	55	70	62.5	29.45	29.33	
M.	19	61	60	60.5	52	69	60.5	29.32	29.37	.20
T.	20	58	58	58	55	63	59	29.35	29.33	.28
W.	21	60	54	57	52	66	59	29.18	29.22	.46
T.	22	59	58	58.5	50	62	56	29.32	29.76	
F.	23	51	53	52	34	59	49.5	29.82	29.55	
S.	24	66	60	63	49	69	59	29.52	29.65	
S.	25	64	55	59.5	56	66	62	29.60	29.58	
M.	26	56	52	54	51	61	56	29.51	29.68	.19
T.	27	57	47	52	47	67	57	29.95	30.16	
W.	28	56	53	54.5	40	59	49.5	30.18	30.19	
T.	29	56	50	53	43	63	53	30.04	29.98	
F.	30	57	51	54	44	61	52.5	29.85	29.70	.01
	Sum,	1811	1612	1716.5	1443	1972	1707.5	888.49	888.85	2.85
	Mean.	60.37	53.73	57.22	48.1	65.73	56.92	29.616	29.628	

OCTOBER 1825.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
S.	1	53	54	53.5	45	57	51	29.66	29.57	.03
S.	2	64	58	61	50	68	59	29.43	29.40	.05
M.	3	66	54	60	50	70	60	29.44	29.38	.10
T.	4	64	53	58.5	50	68	59	29.46	29.70	.12
W.	5	60	57	58.5	49	65	57	29.60	29.73	.05
T.	6	60	53	56.5	50	66	58	29.67	29.51	
F.	7	51	48	49.5	48	58	53	29.32	29.65	1.08
S.	8	55	52	53.5	45	60	52.5	29.45	29.38	
S.	9	53	59	56	46	62	54	29.48	29.48	
M.	10	58	51	54.5	47	62	54.5	29.68	29.91	.10
T	11	53	57	55	49	61	55	29.98	29.95	.15
W.	12	50	55	56.5	48	65	56.5	29.77	29.75	.01
T.	13	56	52	54	44	60	52	29.98	29.88	
F.	14	57	48	52.5	45	62	53.5	29.70	29.98	.06
S.	15	55	52	53.5	44	58	51	30.11	30.16	
S.	16	55	50	52.5	50	60	55	29.98	30.00	.05
M.	17	52	38	45	40	53	46.5	29.80	29.83	.07
T.	18	48	47	47.5	35	55	45	29.40	29.06	.10
W.	19	45	38	41.5	37	49	43	29.09	28.92	
T.	20	40	37	38.5	33	42	37.5	29.16	29.31	
F.	21	40	40	40	32	45	38.5	29.39	29.72	
S.	22	43	47	45	28	47	37.5	29.82	29.74	
S.	23	52	50	51	43	56	49.5	29.88	29.76	.02
M.	24	54	38	46	48	56	52	29.55	29.48	
T.	25	40	38	39	30	48	39	29.66	29.85	
W.	26	40	36	38	30	45	37.5	29.80	29.79	
T.	27	46	53	59.5	32	51	40.5	29.81	29.71	.05
F.	28	54	50	52	49	57	53	29.77	29.73	
S.	29	52	48	50	44	56	50	29.58	29.35	
S.	30	57	44	50.5	45	65	55	29.20	29.35	.05
M-	31	51	44	47.5	42	54	48	29.61	29.67	.10
		1632	1501	1566.5	1328	1781	1554.5	918.23	918.64	2.19
		52.64	48.42	50.53	12.52	57.45	50.14	29.62	29.634	

NOVEMBER 1825.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	50	39	44.5	41	51	46	29.38	29.38	
W.	2	44	41	42.5	36	46	41	29.31	28.60	.39
T.	3	42	36	39	38	43	40.5	28.58	29.06	
F.	4	42	31	36.5	33	45	39	29.49	29.73	
S.	5	38	52	45	27	50	38.5	29.43	28.55	.45
S.	6	43	33	38	38	45	41.5	28.62	28.84	
M.	7	36	34	35	31	40	35.5	28.84	28.97	
T.	8	34	37	35.5	30	39	34.5	28.87	28.69	.42
W.	9	37	25	31	28	42	35	28.83	29.12	
T.	10	29	29	29	19	35	27	29.14	29,18	
F.	11	35	28	31.5	27	38	32.5	29.40	29.52	
S.	12	35	37	36	24	37	30.5	29.62	29.62	
S.	13	45	39	42	29	48	38.5	29.50	29.51	
M.	14	42	35	38.5	32	47	39.5	29.68	29.93	
T.	15	34	43	38.5	26	40	33	30.03	29.90	
W.	16	45	40	42.5	34	48	41	29.92	29.88	
T.	17	47	41	44	38	50	44	29.53	29.56	.18
F.	18	42	46	44	37	53	45	29.31	29.03	.08
S.	19	43	38	40.5	35	45	40	29.42	29.66	.10
S.	20	42	53	47.5	34	47	40.5	29.71	29.22	.08
M.	21	43	39	41	36	62	49	29.23	29.18	.14
T.	22	39	35	37	35	43	39	29.60	29.95	
W.	23	46	43	44.5	32	50	41	29.76	29.70	
T.	24	43	39	41	38	46	42	29.82	29.76	
F.	25	40	45	42.5	31	44	37.5	29.95	29.73	
S.	26	53	36	44.5	39	55	47	29.00	29.28	.22
S.	27	35	34	34.5	31	37	34	29.46	29.24	
M.	28	33	34	33.5	31	35	33	28.83	28.75	1.00
T.	29	34	32	33	33	37	35	28.85	29.10	.85
W.	30	33	30	31·5	30	40	35	29.20	29.42	
		1204	1124	1164	973	1338	1155.5	880.31	879.06	3.91
		40.13	37.47	38.80	32.53	44.6	38.52	29.343	29.302	

PLATE IV.

Fig. 1.

ORAN UTAN, OF SUMATRA

Fig. 2.

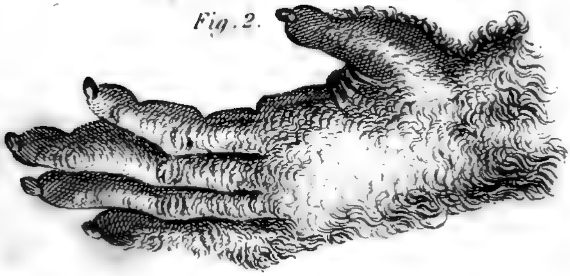

Fig. 3.

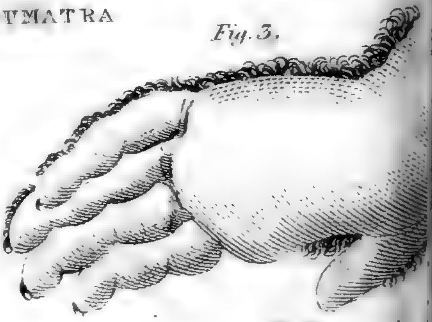

Fig. 4.

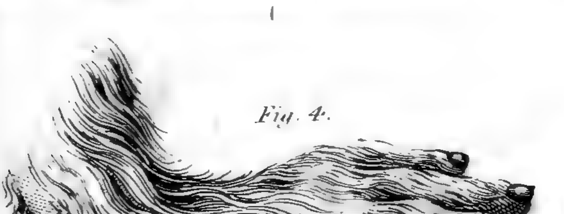

Fig. 5.

Fig. 1. one fourth the real size.—Figs. 2.3.4.5. one sixth the real size.

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THE

EDINBURGH

JOURNAL OF SCIENCE.

Art. I.—*Account of an Orang Outang, of remarkable height, from the Island of Sumatra.* By Clarke Abel, M. D. Communicated in a letter to Dr Brewster. With a Plate.

Dear Sir,

I have great pleasure in sending you a notice respecting an Orang Outang, of remarkable height, from the island of Sumatra. The notice is taken from a paper which I had lately the honour of reading to the Asiatic Society, and which will be published in the forthcoming volume of its transactions. I have little to remark, in addition to what the notice contains, except that the youth of the animal was equally proved by the state of its teeth, and by the apophysis of the bones of its hands and feet being incompletely ossified. The general conclusions to which I have come, from a consideration of all the circumstances I have collected respecting this animal, is,—that it is identical with the Orang Outang, described by Wurmb in the *Batavian Transactions ;* that Cuvier is right in considering Wurmb's animal as the adult of the young eastern orangs seen in Europe; but that he is mistaken in supposing that it is also the adult of the African species. These are points, however, which require more time and materials than I at present possess, to establish; for, as I have great hopes of obtaining another specimen of the Sumatra animal in a perfect state, I hope it will soon be in my power to furnish more satisfactory data for forming an opinion respecting the many histories and opinions regarding gigantic man-like apes, which adorn the pages of the older travellers, and still occupy the speculations of philosophers. I am, Dear Sir,

Your very obedient humble servant,

CALCUTTA, 10*th May* 1825. CLARKE ABEL.

MY attention was first directed to this Orang Outang, by the following notice of the animal in the *Hurkara Newspaper*, which was sent to it, as I have ascertained, from one of the persons personally concerned in his capture. "A party having landed on the north coast of Sumatra, from the Mary Anne Sophia, Captain Cornfoot, for the purpose of watering, fell in with an animal of the monkey species, of a most gigantic size. It was upwards of seven feet in height, and after receiving seven shots, was killed. After the fifth shot, it climbed a tree, and reclined against its boughs, to all appearance in great pain, and vomited a considerable quantity of blood. Its lower jaw, and the skin of the back and arms, which are brought round to Calcutta, I have seen. Some of the teeth of the upper jaw have also arrived here, and are about to be deposited in the museum of the Asiatic Society. There are some of them about three inches long. The lower jaw is immense; and the skin to which I before referred is so large, that, although cut off from the wrists, each arm is now considerably longer than mine, and I am a man not a quarter of an inch under six feet. The back is remarkably broad, and is covered with long coarse brown hair. When the animal made its appearance, it seemed as if it had come from some distance; and to all appearance it had been walking through a swamp, its legs, up to the knees, being muddy. Its gait was slovenly, and as it went it waddled from side to side."

In addition to the foregoing information, I may mention, that I have conversed with Captain Cornfoot, commander of the Mary Anne Sophia, and received from him a verbal description of the animal, which, in most respects, corresponds with others that have been published. His statement regarding the height of the animal is, that it was a full head taller than any man on board, measuring seven feet in what would be its ordinary standing posture, and eight feet when it was suspended for the purpose of being skinned. Captain Cornfoot dwells much upon the human-like expression of its countenance, and especially on the beautiful arrangement of its beard. He also obliged me with some account of its capture, as reported to him by his officers, and feelingly described the piteous action of the animal on being wounded, and of its apparent tenacity of life. It seems that, on the spot where this animal was killed, were five or six trees, which occasioned his hunters great trouble in procuring their prey; for, in consequence of the extreme agility and power of the animal in springing from branch to branch, and bounding from one tree to another, his pursuers could not fix their aim, until they had cut down all the trees but one. When thus limited in his range, the orang outang was shot, but did not die till he had received five balls and the thrust of a spear. One of the first balls probably penetrated his lungs, as he, immediately after the infliction of the wound, slung himself by his feet from a branch, with his head downwards, and allowed the blood to flow from his mouth. On receiving a wound, he always put his hand over the injured part, and distressed his pursuers by the human-like agony of his expression. When on the ground, after being exhausted by his many wounds, he lay as if dead, with his head resting on his folded arms. It was at this moment that an officer attempted to give the coup de grace by pushing a spear through his body, but he immediately jumped on his feet, wrested the weapon from his antagonist, and shivered it in pieces. This was his last wound, and last great exertion; yet he lived some time afterwards, and drank, it is stated, great quantities of water. Captain Cornfoot also observes, that the animal had probably travelled some distance from the place where he was killed, as his legs were covered with mud up to the knees.

In the accounts which I have received of the circumstances observed by the persons immediately concerned in the capture of the animal, the only discrepancy of any consequence regards its height. The measurement of his skin, however, goes far to determine this point; and the difference of statement is capable, perhaps, of being accounted for, by supposing different points to have been taken as the limit of his dimensions by the different parties, or a greater or less bending posture of the animal. The skin, dried and shrivelled as it is, measures, in a straight line from the top of the shoulder to the point whence the ancle has been removed, 5 feet 10 inches; add to this the *perpendicular* length of the neck, as it is in the preparation of the head, 3½ inches; length of the face, from the forehead to the chin, 9 inches; and of the skin now attached to the foot, from the line of its separation from the body to the heel, 8 inches,—measurements which I have made myself, and we have 7 feet 6½ inches as his approximate height.

I now proceed to describe the animal.—In order to assist the Society in forming as correct an opinion as circumstances will allow of the form and appearance of the different parts which have been preserved, I have caused the drawings in Plate IV. to be made of them, which I now offer to their examination. They have been hastily executed, and imperfectly finished, but are, I believe, correct with regard to the proportions. I particularly cautioned the artist to draw nothing but what he saw; and, therefore, the hair of the head looks more lank and matted than it would naturally be.

Description of the Remains of the Animal.

The face of this animal, with the exception of the beard, is nearly bare, a few straggling short downy hairs being alone scattered over it. It is of dark lead colour, excepting the margins of the lips, which are lighter. The eyes are small in relation to those of man, and are about an inch apart. The eye-lids are well fringed with lashes. The ears are 1½ inch in length, and barely an inch in breadth, are close to the head, and resemble those of man, with the exception of wanting the lower lobe. The nose is scarcely raised above the level of the face, and is chiefly distinguished by two nostrils, ¾ of an inch in breadth, placed obliquely side by side. The muzzle projects in a mammillary form. The opening of the mouth is very large. When closed, the lips appear narrow, but are in reality half an inch in thickness. The hair of the head is of a reddish brown, grows from behind forwards, and is five inches in length. The beard is handsome, and appears to have been curly in the animal's lifetime. Its colour is lighter than that of the head, approaching to a light chesnut. The beard is about three inches long, springing very gracefully from the upper lip, near the angles of the mouth, in the form of mustachios, whence descending, it mixes with that of the chin, the whole having at present a very wary aspect. The face of the animal is much wrinkled.

The palms of the hands are very long, are quite naked from the wrists, and are of the colour of the face. Their backs are covered with hair to the last joint of the fingers, and this inclines backwards towards the wrists, and then turns directly upwards. All the fingers have nails, which are strong, convex, and of a black colour. The thumb reaches to the first joint of the fore finger.

The soles of the feet are bare, and of the same colour as the hands; they are covered on the back with long brown hair to the last joint of the toes. The great toe is set on nearly at right angles to the foot, and is relatively very short. The original colour, however, of the hands and arms, and the soles of the feet, is somewhat uncertain, in consequence of the effect of the spirit in which they have been preserved.

Description of the Skin of the Animal.

The skin itself is of a dark leaden colour. The hair is of a brownish red, but when observed at some distance, has a dull, and, in some places, an almost black appearance; but, in a strong light, it is of a light red. It is in all parts very long; on the fore arm it is directed upwards. On the upper arm its general direction is downwards, but, from its length, it hangs shaggy below the arm. From the shoulders, it hangs in large and long massy tufts, which, in continuation with the long hair on the back, seems to form a continuous mass to the very centre of the body. About the flanks, the hair is equally long, and, in the living animal, must have descended below the thighs and nates. On the limits, however, of the lateral termination of the skin which must have covered the chest and belly, it is scanty, and gives the impression that these parts must have been comparatively bare. Round the upper part of the back, it is also much thinner than elsewhere, and small tufts at the junction of the skin with the neck, are curled abruptly upwards, corresponding with the direction of the hair at the back of the head. In the dimensions which I am about to give of the skin, I have stated that it measures from one extremity of the arm to another, 5 feet 8 inches; to this is to be added 15 inches on each side for the hands and wrists, which will render the whole span of the animal equal to 8 feet 2 inches.

The following are the measurements which I have made of the different parts:

Of the Face. Plate IV. Fig. 1.

	Feet.	Inches.
Whole length of the face,	0	9
Length of the forehead from the commencement of the hair to a point between the eyes,	0	4½
From between the eyes to the end of the nose,	0	1½
From the end of the nose to the mouth,	0	3
From the mouth to the setting on of the neck,	0	4½
Circumference of the mouth,	0	6

Dimensions of the Skin.

Greatest breadth about the centre of the skin,	3	2
Greatest length down the centre of the back,	3	2
Length from the extremity of one arm, where it is separated from the wrist, to the other,	5	8
Breadth of the skin from the situation of the *os coccygis* to the setting on of the thigh,	1	4
Across the middle of the thigh,	1	0
Greatest length of the hair on the shoulders and back,	0	10

Measurement of the Hands and Feet.

Front Measurement of Hand. Fig. 2, 3.

Length of hand from the end of the middle finger to the wrist in a right line,	1	0
Circumference of hand over the knuckle,	0	11
Length of palm from the wrist,	0	6½
Length of middle finger,	0	5¼
— of fore finger,	0	4¾
— of little finger,	0	4¼
— of ring finger,	0	5
— of thumb,	0	2½

	Feet.	Inches.
Back Measurement of Hand.		
Length of ring finger,	0	6¾
— of middle finger,	0	6¾
— of little finger,	0	5¾
— of fore finger,	0	6
— of thumb,	0	4
Front Measurement of Foot. Fig. 4, 5.		
Length from the end of the heel to the end of the middle toe,	1	2
— of palm of foot,	0	9¾
— of middle toe,	0	4¼
— of ring toe,	0	4¼
— of little toe,	0	3½
— of fore toe,	0	3¾
— of great toe,	0	2¾
Circumference over the knuckles of the toes,	0	9¾
Back Measurement.		
Length of middle toe,	0	6
— of fore toe,	0	5½
— of ring toe,	0	6
— of little toe,	0	5
— of great toe,	0	4½

Measurement of the Lower Jaw.

Circumference of the jaw round the chin,	0	11½
Length of the ramus from the head of the jaw to its base,	0	4
— of the coronoid process to the base of the jaw,		4
Breadth of the ramus or ascending portion of the jaw, at a level with the teeth,	0	2⅓
Distance from the head of the bone to the process,	0	1¾
Depth of the jaw at the symplysis menti,	0	2½

Measurement of the Teeth.

Teeth in each jaw 32, namely 2 canine, 10 grinders, 4 incisive teeth.

Canine Teeth.	In.	10ths.
Whole length of lower canine teeth,	2	7
Greatest length of fang,	2	0
Smallest do.	1	6
Greatest length of enamel, or exposed part of the tooth,	1	1
Part exceeding the other teeth in length,	0	4
Lateral breadth measured on a level with the jaw,	0	6
Breadth from before inwards,	0	7
Incisive Teeth.		
Whole length of the lateral,	1	5
Of enamel exposed,	0	7
Breadth of cutting surface,	0	4
Of central teeth,	0	4

	Inches.	10ths.
The front teeth of the upper jaw greatly resemble those of the lower, with the exception of the middle incisive teeth which are twice the width of the lateral ones, and narrow at their inner surface, - - - - - - -	0	6

Art. II.—*Memoir on the Mechanism of the Human Voice.*

By M. Felix Savart.

It gives us particular satisfaction to have such frequent opportunities of presenting to our readers an account of the ingenious and valuable researches of M. Savart, relative to some of the most profound and less cultivated branches of Physical Science. His Memoir on the Human Voice, which is printed in the last number of the *Ann. de Chimie et de Physique*,* exhibits, in a striking point of view, the sagacity of its author, who advances step by step from the theory of the simple whistle of the hunters, to the explanation of the most complicated organ of the human frame. We could have wished that our limits would permit us to give the whole of this memoir; but, as this is out of the question, we shall endeavour to convey the substance of it to our readers, which they will perhaps comprehend more readily than if they were in possession of more minute details.

The formation of the human voice has been regarded by some as similar to a stringed instrument, while others have considered it as resembling the mouth-piece of organ-pipes; but M. Savart has shown that both these explanations are inadmissible, and he thus proceeds to an investigation of the subject.

When the length of an organ-pipe is from twelve to fifteen times its diameter, the velocity of the current of air has a slight influence on the number of oscillations, and it is difficult to make the sound vary a semitone. In short tubes, on the contrary, the influence of the velocity of the current of air is much greater, and cubical pipes can be made to give out several sounds, and embrace the interval of an entire

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* For September 1825, p. 64—87.

Fig. 16.

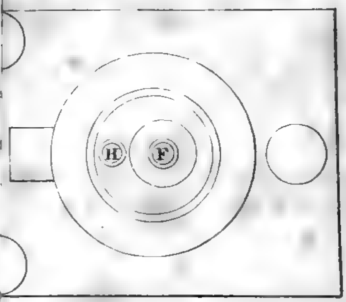


Fig. 1.

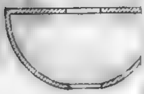


Fig. 6

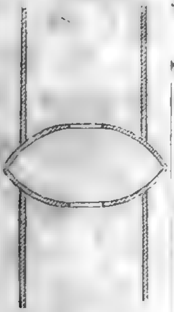


Fig. 20.

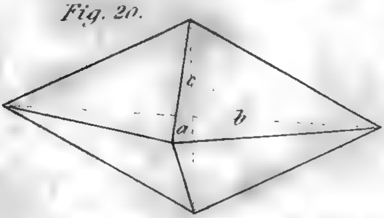


Fig. 21.

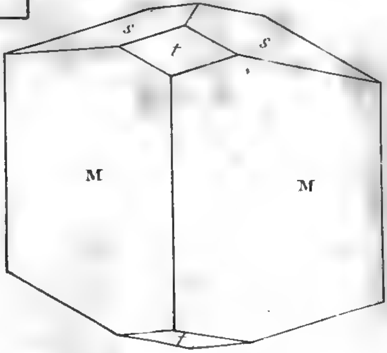


Fig. 25.

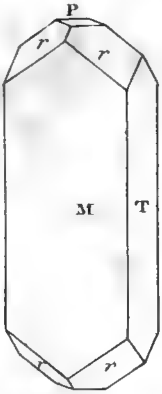


Fig. 24.

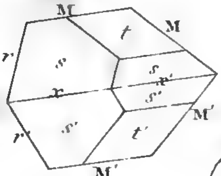


Fig. 26.

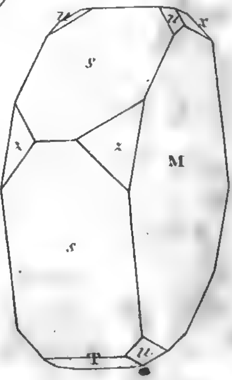


Fig. 14.

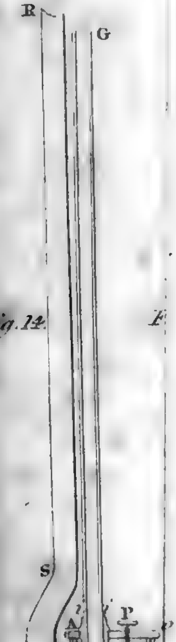


Fig. 22.

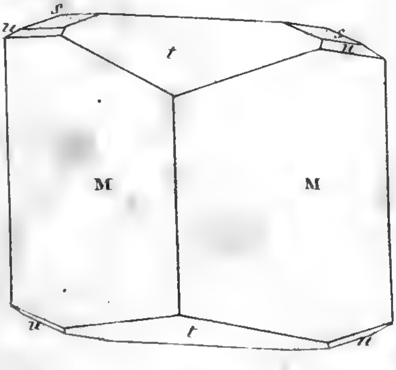


Fig. 27. See Nº IX

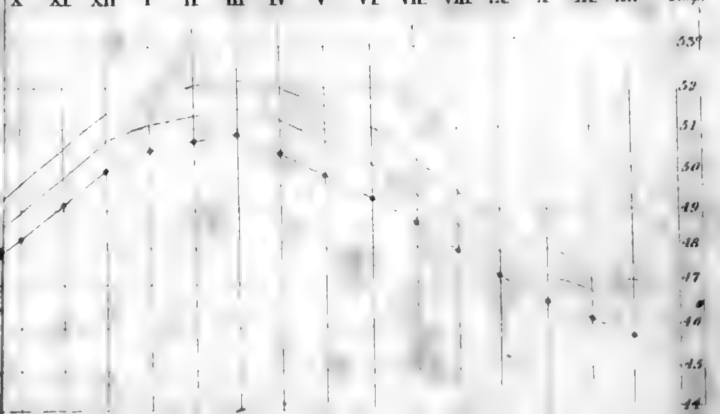
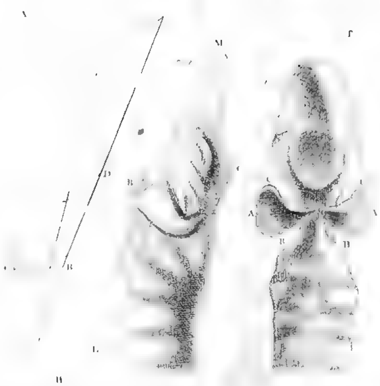


PLATE V



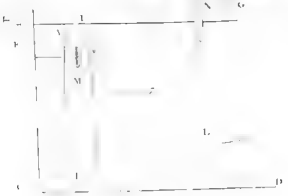
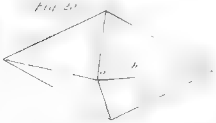


Fig 12
Midships Frame

Fig 10

Fig 20



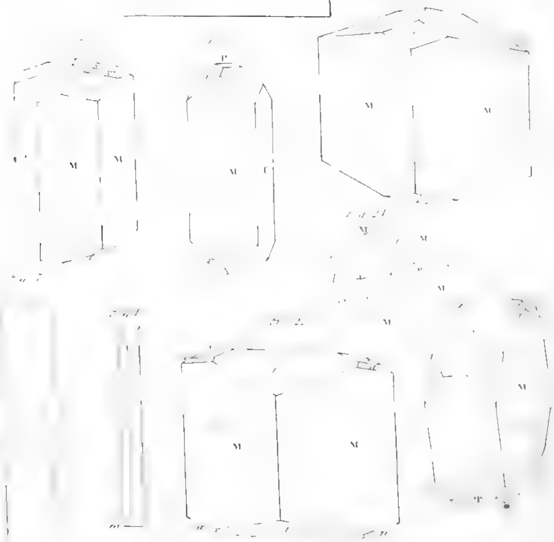
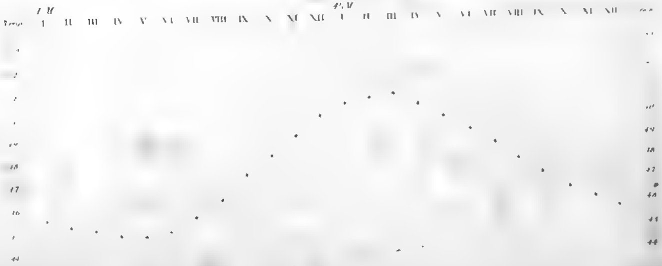


Fig 27



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W.H. Lizars Sc

fifth, although there is always one sound which is given out more easily, and which is more pure and more intense than all the others.

The hunters, in order to imitate the voices of certain birds, employ a small instrument, in which the current of air exerts an influences till more considerable. This instrument, made of bone, wood, or metal, has commonly the form of a small cylindrical tube about 8–10ths of an inch in diameter, and 3–10ths high. At each of its ends it is shut up by a thin and smooth plate perforated at its centre, with a hole about 1½ tenths in diameter. Sometimes it has the form shown in Plate V. Fig 1, which is the section of a hemispherical vase with two opposite orifices. The hunters place this instrument between the teeth and the lips, and by drawing in the air with more or less force through the two orifices, they succeed in obtaining different sounds.

This effect may be produced with more certainty, by adding to it a cylindrical portvent, as in Fig. 2. By this means, we may obtain all sounds comprised in an extent of an octave and a half to two octaves, passing, in general, through the interval from ut_6 to ut_4. The gravest sounds are generally dull and feeble, and the most acute are unsupportably piercing. The sounds become more grave by increasing the orifices.

The sounds produced in this instrument seem to arise from this,—that the current of air which passes through the two orifices, dragging along with it the small mass of fluid contained in the cavity, diminishes its elastic force, and, consequently, destroys its equilibrium with the pressure of the external air, which, reacting upon it, drives it back, and compresses it till, by its own elasticity, and under the influence of the continued current, it undergoes a new rarefaction, followed by a second condensation, and so on continually. These ultimate states of rarefaction and condensation being sufficiently near one another, ought to give rise to waves, which, spreading out in the external air, produces the sensation of a determinate sound. It ought also to be noticed, that the thinner the sides of the whistle are, they vibrate with more energy, and if, in a hemispherical one, we replace the plane side by a thin leaf of parchment, the sounds are emitted more easily, and are more grave, more full, and more agreeable.

When the sides of the orifice are made as in Fig. 3, the sounds are more grave, and less loud. Here the margin of the orifice seems to act like the bevel in organ-pipes. When the margin is rounded as in Fig. 4, the same effect takes place.

In long organ-pipes, the substance of the pipe has little or no influence on the number of vibrations of the column of air; but, in short pipes, the substance exerts a powerful influence. If we construct a cubical pipe, with paper or parchment stretched over small square frames joined together, to form a cube, the sound which it yields is as acute when the parchment is stretched, as if the sides had been solid; but if their tension is diminished by humidity, the sound may be made to descend more than two octaves before it ceases to be heard. In the quiet of night there seems to be no limit to this lowering of the sound. By strewing sand on the sides of the cube, they exhibit a nodal, elliptical, or circular line, and the upper and under surfaces vibrate most energetically.

If we take a prismatic tube nine inches long, and eighteen lines of a side, and form half its length next the embouchure of a membrane, thin, and well stretched, then, though it should give the sound re_4, yet it produces much more grave ones, even those between ut_3 and ut_4, or even some of those of the octave from ut_2 to ut_3.

The sounds of membranous pipes partake of the quality of those of a flute, and of free mouth-pieces. They have no analogy with those of any musical instrument, and such pipes are in some respects the reverse of stringed-instruments. In the latter, the air in the case is put into vibration by the solid sides which inclose it, while, in membranous pipes, the air is the body which is put directly into motion, and which then communicates its vibrations to the sides which contain it.

If we fix a portvent at the convex surface of the hunter's whistle, and add a pipe at the other as in Fig. 5, 6, and 7, this combination will give a sound which will be exactly that which corresponds to the column of air contained in the pipe, provided that, among the sounds which the small whistle may give, there is one which is the same as one of those which the column of air may give. This result, deducible from theory, is confirmed by experiment.

The sounds obtained by this method have a particular character, distinct from those of all ordinary organ-pipes. They may become very intense and very loud, especially when the apparatus is made of metal, and the dimensions of the columns of air properly chosen.

This instrument, like organ-pipes open at both ends, can only give the series of sounds ut_1 ut_2 sol_2 ut_3 mi_3 sol_3 $la\sharp_3$ ut_4 &c. It may, nevertheless, happen, that the small vessel which serves as the mouth-piece may sound independently of the column of air; but then the sounds are feeble, and want distinctness. From what has been now said, it may be easy to conceive, that a tube like Fig. 7, composed of elastic materials, may give out all possible sounds comprised within certain limits, depending on the tension of the sides and the volume of air.

When the pipe, in which the air sounds is pierced with lateral holes, if we blow uniformly by the portvent, the sound may be varied when the holes are shut and *vice versa*, so that it would not be impossible to construct a musical instrument upon this principle.

The fundamental sound of a pipe shut up at one end, and of an uniform diameter, is in general more grave by an octave than the sound which the same pipe gives when it is open at both ends. This, however, is not the case with pipes of unequal diameter, such as conical and pyramidal ones, when they are made to vibrate at their narrowest part. In these the interval, between their sounds when open and shut, becomes as much greater, for an equal length of tube, as the inclination of its sides increases. A conical pipe 4½ inches long, and truncated at its summit, and having its larger end 2 inches in diameter, and its smaller one six lines, gives, when open, the sound ut_5, and when shut mi_3. By widening its large end, or lessening its small one, the other dimensions remaining the same, the sound may be lowered even more than two octaves.

In order to determine the exact form of the larynx, I took a cast of it by running into it plaster of Paris, and of this cast Fig. 8 is an exact representation of the natural size, and Fig. 9 a side view of it. The ventricles AA′ sometimes rise still higher than in the figure, and their summit touches the fat body at the base of the epiglottis. I have seen two cases, in which they were one Paris inch long from the bottom to the summit. In general they are only half that height, viz. 5 or 6 lines. The intervals BB, Fig. 8 and 10, are filled by the vocal ligaments, and the thyro-arytenoidian muscles, and the intervals CC′ by the superior muscles. In the side view Fig. 9, there is a better view of the extent of the fold of the mucous membrane, which stretches from the epiglottis to the corresponding arytenoid. This fold occupies the space A′BB′ and terminates superiorly at the line AC. Fig. 10 represents a section of the larynx on the line AL, Fig. 9, dividing it into two parts. This figure gives a distinct idea of the interior form of the larynx, which has a very great resemblance to the apparatus in Fig. 7.

These facts being established, it becomes easy to explain the formation of the human voice, by considering the vocal organ as composed of the larynx Fig. 10, of the posterior mouth, and of the mouth as a conical tube in which the air is made to vibrate with a motion analogous to that in the flute-pipes of organs. The vocal tube possesses all the properties that are necessary, in order that the mass of air which it contains may be susceptible, in spite of its small volume, to yield a sufficiently great number of sounds, and even very grave ones. Its inferior part is formed with elastic sides, which can assume all degrees of tension, while the mouth, by opening more or less, and consequently changing the dimensions of the column of air, exerts also a notable influence on the number of vibrations conjointly with the lips, which, by their approach and recession, transform at pleasure the vocal tube into a conical tube, sometimes open and sometimes almost shut.

It deserves to be remarked, that the sound of a conical tube, slightly truncated at its summit, of the same capacity nearly as the vocal tube of man, and of the same length, viz. 4½ inches, does not require to be much lowered, in order to become one of those which the voice can produce. A similar tube, open at both ends, gives the sound ut_5, and there are many human voices which are no higher than la_4 which is graver only by a third minor. If we shut a great part of the base of the tube, the sound will, by this means, easily descend to ut_4, and even below it, and it would require to be lowered only about an octave more, in order to equal the gravest sounds of the human voice. But if we consider that the column of air in the vocal tube is inclosed, particularly on the lower part, by extensible sides, and which are themselves capable of vibrating and influencing the motion of the air by dividing it, we may easily conceive, that the sound may be easily lowered an octave more. If we construct, indeed, a pyramidal tube, such as AB Fig. 11, nearly of the same length as the vocal tube, viz. 4½ inches, approaching to the same capacity, and membranous in the lower third CD of its length, we may make it produce all the sounds of an ordinary voice, either by making the tension of the membranous part vary, or by shutting more or less its great orifice, an aperture, however, being always left.

The only difference between this and the vocal tube consists in the kind of embouchure. In the vocal tube it is analogous to that of the instrument Fig. 7. The trachea TT′, Fig. 10, is terminated above by a slit which may be made more or less narrow by the approach or recess of the arytenoid muscles, and by the contraction of the thyro-arytenoid muscles, represented by BB′, Fig. 10. This aperture obviously performs the same part as the aperture in mouth-pieces. The jet of air which comes out of them, traverses the interval between the ventricles, and strikes against the superior ligaments CC′, which, though rounded, perform the same part as the bevel in organ-pipes. The air in the ventricles VV then enters into vibration, and yields a sound which, if it were insulated, would be feeble, but it acquires intensity because the undulations, which set out from the interval situated between the superior ligaments CC, propagate themselves in the vocal tube placed below, and these produce a kind of motion analogous to that which exists in short, and partly membranous tubes.

In order, however, that the definitive sound thus produced, may unite all the qualities which it possesses, it is necessary that the tension of the extensible part of the sides of the vocal tube has a proper relation to that of the sides of the ventricles, and also to that of the superior and inferior ligaments; and that the extent of the orifices, across which the air escapes, may also vary, and so as to produce the best possible result. It is for these purposes that nature has formed all these parts of elastic or muscular tissue. The thyro-arytenoidian muscle forms of itself alone the lower and external sides of the ventricle; and it does not concur, as has been supposed, in the formation of the superior liagment: Though its form is sufficiently regular, yet it is difficult to describe it, and even to dissect it well; and, consequently, the descriptions of it hitherto given are very incomplete, and often incorrect. This muscle presents an internal face formed by a plane of fibres almost parallel, and stretched between the superior part of the re-entering angles of the thyroide, and the inferior anterior part of the arytenoid. The upper margin of this face, the plane of which forms, with the axis of the trachea, an angle of from 20° to 25°, is united to the vocal ligament. The external face is inclined upon the internal one, so that they leave between them an angle whose summit is turned downwards. The fibres which form this second face, stretch like a fan, and obliquely from above downwards, and from before backwards; and their upper extremities lose themselves successively in all the extent of the large fold formed by the mucous membrane between the epiglottis and the arytenoid. Sometimes the most anterior stretch even to the base of the epiglottis. These fibres, consequently, rise much higher than those which form the internal plane, and they again cover almost all the extent of the external side of the ventricle, excepting in front and above, where they seldom reach, on account of the obliquity of the kind of fan which they form. In short, in the interval which the plane of the parallel and internal fibres leaves between it and the plane of the oblique external fibres, there is found a small elliptical cavity which forms the bottom of the ventricle, where the fibres seem still to be arranged nearly parallel. The uses of this muscle are easily conceived: When it contracts, it gives to the bottom and the external side of the ventricle, as well as to the margin of the orifice by which the air escapes from the trachea, the degree of tension necessary for the sound which it is wished to produce. By the extremities of its oblique fibres, it acts also upon the fold of the mucous membrane which forms the upper part of the extensible portion of the vocal tube. Its action upon this part is supported by that of a small muscle, which ought to be called the *superior thyro-arytenoidian*, for it stretches obliquely from below upwards, from behind to before the external and inferior part of the arytenoid, to the upper part of the rounded angle of the thyroid, where it is fixed by very short tendinous fibres. This is a small conical muscular bundle whose base is behind. It is always more developed on one side of the body than on the other. Several oblique fibres of the thyro-arytenoidian are confounded with that small muscle, into which they are inserted almost perpendicularly. Others go beyond this into the mucous fold. It is obvious, that the use of this muscular bundle is to stretch the external sides of the ventricle conjointly with the oblique fibres of the thyro-arytenoidian, to which they serve as a point of support.

The superior ligaments CC have no proper muscle, but they are formed of a substance sufficiently rigid, and they are thick enough not to require any foreign support. Though their free margin is rounded, yet this cannot at all injure the production of sounds, as we have already noticed.

One of the most remarkable arrangements of the vocal apparatus of man is, that the larynx is terminated above by two folds of the mucous membrane, which float in the middle of the air which sounds around them, and of whose motion they necessarily partake. It cannot be doubted that these folds ought to have a great influence on the faculty of modulating and articulating sounds, as well as upon the timbre of the voice; for the inferior larynx of all birds that have a varied song, or which are capable of learning to speak, present an analogous arrangement, whilst in birds whose voice is limited, nothing like this is to be found, even when their larynx is provided with the proper muscles. These floating membranes, being susceptible of a variable tension, ought to be principally used for modifying, sometimes suddenly, and sometimes gradually, the number of vibrations of the air. When they are stretched, their height diminishes, and, consequently, the sounds become more acute, at first, because the sides which contain the column of air are then more resisting, and afterwards because the extensible part of these sides has a less extent. At the same time that the effect is produced, the orifice by which the air escapes from the trachea becomes narrower, and the external side of the ventricles assume also a greater degree of rigidity, for it is the same muscle which produces all these movements. When these folds are unstretched, the contrary phenomena take place, and the sounds become more grave.

From the explanation we have now given of the mechanism of the voice, it is evident that, if we remove the upper parts of the vocal tube, and reduce it to the ventricles alone, we shall not diminish the number of sounds which the voice may yield; the gravest will only become feeble. This explains why we may make similar incisions in living animals without their ceasing to emit different sounds. The air contained in the ventricles may sound independently of that which is in the vocal tube; and, it is to be presumed, even if that tube undergoes no alteration, that certain sounds may be produced from the ventricles alone, particularly those which are occasioned by grief, and, perhaps, also those which are heard when we sing above our voice. This ought to happen every time that the extensible part of the vocal organ cannot take the degree of tension necessary to produce the required sound. This assertion is the more probable, that there are animals, such as frogs, in which the vocal organ is reduced to the ventricles alone. The larynx of these animals resembles a small kettle-drum. Its convex side is cartilaginous. It is situated inferiorly, and traversed by an elongated orifice which can open at pleasure: The lower side is membranous, and has an orifice corresponding to that of the convex side. The air having arrived below this membrane, traverses the two orifices, and sets in vibration the air contained in the cavity. The mechanism is the same as in Fig. 1, and as in the human ventricle. This apparatus, simple as it is, would yet be capable of yielding fine sounds, if the animal which possesses it had a more complicated respiratory system.

The facts on which we have founded the explanation of the Human Voice, may be equally employed to give an account of the sounds which different species of mammiferous animals may emit, whose organ is analogous to that of man. With respect to those which, like the Alouates, have osseous pouches communicating with the ventricles of the larynx, it is very easy to conceive, from the researches which we have already published relative to the vibrations of air, how it may happen that the masses of air inclosed in these cavities, may give sounds so grave, and, at the same time, so intense. When these pouches are membranous, as in most species of apes, it is equally easy to understand, from what we have said of membranous tubes, that animals which possess these organs, ought to be able to emit sounds very dull, and, at the same time, very grave.

As this subject requires to be treated in detail, I have merely mentioned these applications, and I shall only farther remark, that the most singular dispositions of the organs of voice in different animals, appear to be explicable upon the principles laid down in this memoir.

Art. III.—*Account of a Volcano in the Himalayah Mountains.* Communicated to Dr Brewster by a Correspondent in India.

I now send you an interesting account of the volcanic appearance in the Purneah District, that you may have seen alluded to in the Newspapers. The mountain is one of the highest in the whole range, and is visible occasionally from the eastern side of the Burhampooter, south of the Garrow hills, and also, I believe, from Bhougilpore, but too indistinctly to admit of our seeing the column of smoke observed by Mr Barnes. Several years ago, when examining this peak from Deenhutta, with a good telescope, I observed a singular-looking fissure in the side of it so remarkable, that I took a sketch of it at the time. I think it is highly probable that this is an extinguished crater; and if the smoke actually proceeds from a volcano, it may even be the one in action, as it is on the east side of the peak, and the peak might prevent this appearance being seen from the southward.

In the early part of February 1825,* my brother and myself were on our return from the hill north of Rungapannee, when, early in the morning, just as the sun rose above the horizon, I observed a thick cloud, apparently smoke, rising perpendicularly from the highest point of the mountain, which, after ascending to a considerable height in a thick dense column, took an easterly direction from the upper part of it, as if it had been carried away by the wind, detached parts of it being separated like small white clouds. The column of smoke continued to exhibit the same aspect as when it was first seen, and exactly resembled the smoke of a fierce fire, after ascending far above the influence of the propelling power. At this time the atmosphere was beautifully clear for many successive days; and the appearance above described continued precisely the same, only at times the column of smoke seemed to be larger and more dense than at others, but always rising straight up as if rushing from a crater, and the top always dispersing in the air on reaching a certain height.

From having been long in the habit of observing the snowy mountains whenever they were visible, and accustomed to view them for many years past, I may say that I am perfectly familiar with their appearance; and I was so forcibly struck with the different aspects they assumed on the day above mentioned, that I thought it possible that a volcano was in action. This opinion, and the desire which every man would feel to witness so grand and sublime a spectacle, has led me to observe it very closely ever since, whenever I could discern the peak; and although no eruption of flame has been seen from this place, which is three miles due west of Rungapannee, yet the smoke has continued in the same form and the same direction as above stated. It was once carried westerly by the wind, and only once that I remember; but at all other times the head of it was wafted to the east.

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* The letter, of which this is an extract, is dated Thoon ke Purneah, June 13th 1825.

The very same appearance continued to present itself until the warm weather began; but the atmosphere was then so hazy as to obscure the mountain altogether during its continuance, nor have the rains, which are only just setting in, brought them yet within view.

I am not in the habit of observing, and still less of describing, the phenomena of nature, and I fear you may not fully comprehend the impression which I wish to convey; but if you figure to yourself a vast column of smoke rushing violently from the flue of a strong furnace, black at the bottom, and burning clearer as it ascends, and the wind dispersing the top of the shaft when it rises above the influence of the fire, and you will have its appearance in a few words.

The peak on which this phenomenon is seen, is that remarkable rocky one due north of Rungapannee, and the most elevated of the whole range seen from thence. But I am of opinion that, if it really be a volcano, the crater is situated on the north side of the highest point, because when the smoke was seen the peak on our side was distinctly visible, and the smoke seemed to me behind it. It is probable that some lower eminence, concealed from us by the highest point, may be the seat of it.

It is hardly possible to believe that the appearances now described can arise from a cloud, as it is not usual for clouds to retain the very same form and shape for months together, nor to appear in the same identical spot. The summits of all the other peaks remained clear and bright as usual during the whole time that the smoke was observed.

ART. IV.—*Researches on the Refractive Power of Elastic Fluids.* * By M. DULONG.

THE object of these researches, was to ascertain if the refractive power of gases followed any law analogous to that which had been found for their specific heats, and if the act of com-

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* This paper is a Translation and Abstract of an Account of M. Dulong's Researches, given in the *Nouv. Bull. des Sciences,* September 1825.

bination altered the force of refraction possessed by the elementary principles when considered separately.

This last question had already been the subject of a Memoir, published in 1806, by MM. Biot and Arago; but at that time we possessed only very uncertain data respecting the proportions of the greater number of compound bodies, and it has since been demonstrated, that, in the passage of elastic fluids to the liquid or solid state, considerable changes are produced in the refractive powers.

We cannot, therefore, expect to discover the relation in question, unless by observing bodies in the gaseous state. The philosophers whom we have quoted, having, besides, examined only a very limited number of different species, it became indispensable to have recourse to new determinations.

The method of observation employed by M. Dulong, was susceptible both of sufficient precision and of ready application. It is founded on the law announced by MM. Biot and Arago, and which M. Dulong has himself verified in other gases, *that the refractive power of the same gas is proportional to its density.* Hence it follows, that if we determine the density of a gas when it refracts exactly as much as air, at the same temperature, and at a convenient pressure, we can determine, by simple proportion, the ratio of the refractive powers of the two gases under the same pressure. We thus obtain, indeed, only the ratios of the refractive powers; but that is the only element which is necessary for the question which M. Dulong proposes to resolve.

The apparatus which he employed, consists of a hollow prism of glass, with an angle of about 145°, into which different gases may be successively introduced. A vertical tube, filled with mercury, communicating with the interior of the prism, permits us to dilate at pleasure the elastic fluid which it contains. The tension of the gas is ascertained either by the barometer of the air-pump, which forms part of the apparatus, or, in some cases, where the communication with the pump ought to be intercepted, by a small vertical tube, opening at its lower end into the reservoir of mercury which we have mentioned. An astronomical telescope, furnished with cross wires in the focus of its object-glass, is placed on a stand of masonry before the prism, at such a height that we can perceive across it a distant mark. If the telescope and prism are invariable, or if the telescope is pointed to the mark when the prism is filled with air, at 0^m 76 of tension, for example, then if another gas is made to replace the air, and such a density given to it as to restore the coincidence of the intersection of the wires at the mark, we are certain that the deviation is the same for the same refracting angle, which can only happen when the refractive powers are equal.

In this process the limit of error depends on the magnifying power of the telescope; but as M. Dulong has remarked, that we cannot determine to less than the $\frac{1}{200}$ part the purity of the gas, it would be useless to estimate smaller fractions in the measure of their refractive powers.

This method is applicable, with some modifications, to gases such as chlorine, which attack all metals, as well as vapours which cannot support atmospheric pressure.

In order to verify the law that, in the same gas, the refractive powers are proportional to the density, M. Dulong determines the refractive power of seven *mixtures, formed by gases which do not combine;* and as the results of observation always agree with those which are deduced from the refractive powers of the ingredients of the mixture, we may conclude, that each gas preserves a refractive power exactly proportional to its density.

The refractive power of atmospheric air, for example, M. Dulong has found to be equal to that of azote, oxygen, and carbonic acid united, each of them being calculated for its corresponding density in air. But as this equality is never met with in any combination, we thus obtain direct proof, that the elements of air are not combined together.

The following table contains the refractive power of twenty gases, as measured by M. Dulong, in relation to that of air of equal density.

Names of Gases.	Refractive Powers.	Densities.
Atmospheric Air,	1	1
Oxygen, - -	0.924	1.1026
Hydrogen, -	0.470	0.0685
Azote, - -	1.020	0.970

Chlorine,	2.623	2.47
Oxide of Azote	1.710	1.527
Nitrous Gas,	1.03	1.039
Hydrochloric Acid,	1.527	1.254
Oxide of Carbon,	1.157	0.972
Carbonic Acid,	1.526	1.524
Cyanogen,	2.832	1.818
Olefiant Gas,	2.302	0.980
Gas of Marshes,	1.504	0.559
Muriatic Ether,	3.72	2.234
Hydrocyanic Acid,	1.531	0.944
Ammonia,	1.309	0.591
Oxi-Chloro-Carbonic Gas.	3.936	3.442
Sulphuretted Hydrogen,	2.187	1.178
Sulphurous Acid,	2.260	2.247
Sulphuric Ether,	5.280	2.580
Carburetted Sulphur,	5.179	2.644

The refractive power of air at 0°, and at 0^{m} 76, being known either from the astronomical observations of Delambre, or by the direct measures of M. Biot and Arago, we may deduce from the preceding numbers the value of the absolute refractive powers of all the above gases, as well as the indices of refraction for the passage of light from a vacuum into each of the gases.

The refractive powers of simple or compound gases do not seem to have any necessary relation to the density. The olefiant gas, for example, and the oxide of carbon, have nearly the same density, but the refractive power of the first is nearly double that of the second.

It has been long known, that, in comparing solids or liquids of a different nature, the refraction is not proportional to the density, and hence it has been concluded that every body exercises upon light an action depending on its own nature. But the different capacities of bodies for heat related to a unity of mass, had led to an analogous conclusion relative to the attractions which were admitted between bodies and the matter of heat. But since, in calculating the capacities of each particular molecule, it has been found that they were equal, or in simple relations, it would not be surprising if the same idea, applied to refractive power, would lead to the discovery of very simple relations where none had been discovered.

But if an analogous law really existed, it would show itself in the numbers of the preceding table, for the gases having been observed at the same temperature and pressure, the inequalities in the refractive powers could arise only from the inequality of the effects of each of the molecules considered individually.

M. Dulong next proceeds to examine if there is any appreciable relation between the refractive power of compound gases and that of their elements. The following table contains the refractive powers as calculated and observed in nine different compounds.

	Observed Refract. Power.	Calculated Refract. Power.	Difference.
Ammonia,	1.309	1.216	+0.093
Oxide of azote,	1.710	1.482	+0.228
Nitrous gas,	1.030	0.972	+0.050
Water, vapour of	1.000	0.933	+0.067
Oxi-chloro-carb. gas,	3.936	3.784	+0.152
Muriatic ether,	3.72	3.829	—0.099
Hydrocyanic acid,	1.521	1.651	—0.130
Carbonic acid,	1.526	1.609	—0.093
Hydrochloric acid,	1.527	1.547	—0.020

In *five* of the preceding gases, the refractive power of the compound is greater than that of its elements, whilst in the other *four* it is the reverse. The particular kind of condensation which accompanies the combination does not appear to have any connection with this variation; for, in hydrochloric acid, for example, there is a diminution, and, in nitrous gas, an augmentation, though the proportions of these two compounds are the same, and the condensation is nothing in both.

The only remark which this kind of approximation leads us to make is, that, in the binary alkaline or neutral combinations, the observed refractive power is greater than that deduced from the elements, while in acid compounds it is weaker.

Muriatic ether, which may be regarded as neutral, and the oxi-chloro-carbonic gas, which is decidedly acid, are exceptions to the law. But we ought to remark, that those combinations are formed of three primitive elements, which are probably reunited in two binary combinations having a common element. But it is these binary combinations, the immediate elements of the combinations in question, that ought to be compared with one another.

This seems to show very clearly, that the refraction depends not on the mass of the molecules, like specific heat, but on the electric state which belongs to them.

In reasoning on the hypothesis of emission, the sum of the attractions of the molecules of an elastic fluid on light ought to be independent of the form of these molecules, since these are liable, as in crystallized bodies, to present certain faces in a determinate direction. But if the refraction depended on these attractions, we cannot conceive how the action of a binary compound should be sometimes greater and sometimes less than the sum of that of its elementary molecules. We may, therefore, regard this fact as a new difficulty attached to the hypothesis of Newton.

ART. V.—*Description of the Grotto of Ganges.** By M. MARSOLLIER.

WHEN we set out to visit the subterraneous grotto, we experienced at first nothing but fatigue. It was necessary to climb for nearly three quarters of an hour. The sun, the reflection from the rocks, the footpath traced only by the tread of the goats, the rolling stones, the torches, the cords, the provisions of which each carries his part,—all this adds to the difficulty of the expedition.

On the summit of a rock in the middle of the mountain there rises a small wood of green oak, which affords an agreeable shade, and protects, with its mysterious shadow, the mouth of the cavern. This opening has the form of a cask, the top being about 20 feet in diameter, and its depth about 30 feet. This hollow is finely fringed with trees, plants, and wild vines with their grapes, and excites the regret that we are

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* Translated from Marsollier, as given in Renaud de Vilback's *Voyage dans le Languedoc,* Paris, 1825.

to leave nature in her finest aspect, in order to descend to her darkest abyss.

We descended by grasping firmly a rope stretched, and fixed to a rock, till we reached the place where a rope-ladder has been firmly fastened. This difficulty being got over, we find ourselves at the entrance of the first chamber. This entrance descends progressively, and is covered with maidenhair. Towards the right is a kind of cave, which is not continued far; but, in front, there are seen magnificent columns, having the appearance of a row of pillars, and forming galleries. These pillars may be about thirty feet high.

It is in this first chamber, divided into two by these columns, that the torches are lighted, and that, after having breakfasted, we quit for a long time the light of day. From the first we pass to the second chamber by a very narrow passage, where the body is obliged to force itself through obliquely. This second chamber is immense. In ascending, there is seen to the left, a curtain of a height which cannot be measured, covered with brilliants, folded with grace, and touching the earth at its front, as if the drapery had been arranged by the most skilful artist. Petrified cascades, as white as enamel—others of a yellow hue, which seem to fall about us in heaps of waves;—several columns, some truncated, and others in the shape of obelisks;—the roof loaded with festoons and stars;—some transparent like glass, and others as white as alabaster—crystals—diamonds—porcelain, a rich and strange assemblage, which seem to realize those pictures which were the amusement of our earliest years.

In proceeding to the left, we pass into a third chamber of considerable width, but of great length. Its form is that of a winding gallery, in which, after we have walked for some time, we come to a small rugged arch, where we are obliged to stoop. This place, which is called the oven, has two openings, and the crystallizations, which are white, resemble muslins of all patterns. In advancing, we leave on the right a second oven of less interest, and enter a large chamber where nothing is to be seen but rocks uprooted, crushed to pieces, and suspended, as if it had been the scene of the most violent convulsions. Every thing is here gloomy and sad, till we reached the place where M. Lonjon caused a mine to be sprung. The passage is so narrow that we are obliged to creep, and it conducts to a small room which holds about twelve persons.

Behind three columns, there is a reservoir, the water of which is salt and muddy, and a prodigious number of bats occupied along with us that small space. Upon the rocks we observed several crystallizations in the form of plants. They were white and shining, and formed a fine contrast with the dark ground to which they were applied. This chamber had an opening on the side opposite to that at which we entered.

Before us we saw a space, the dimensions of which the eye could not measure, and, in order to reach it, there was no other path but over a precipitous rock fifty feet high. Over this was the first stair by which we could descend. The rope-ladder was brought, and fixed to a stalactite. We encourage one another, advancing and drawing back, a frightful precipice presenting itself on all sides. A stone thrown down took a considerable time to descend, and we heard it leaping and rolling from rock to rock till it was heard no more. The slightest giddiness, and the slightest inattention, might here decide the life of the spectator.

A peasant of Ganges, as expert as he was bold, was the first who ventured down. M. Brunet followed him, and, at the end of three toises, the person who descended ceased to be visible, and the time which they took seemed to be enormous. At the depth of twenty feet, the rocks suddenly ceased, and the ladder, without any support, swung and turned upon itself. The profound silence—the glimmering light—which diminished without dissipating the darkness—the dread which this profound solitude excited—the alarming noise of some broken stalactites which fell from the roof and rolled from rock to rock—every thing contributed to give to our expedition a romantic character. We now directed our attention to an immense space enriched and covered with stalactites and stalagmites of every form, and of the most dazzling whiteness; but we had still more than fifty feet before we reached the bottom. Steep rocks so smooth that the foot could not support itself, and where the hand could not be fixed, held out the prospect of certain death to the person who should be rash enough to attempt to descend ; we, therefore, decided, though with much regret, on reascending by our ladder.

Marsollier describes another small grotto on the road to St Bausile to Ganges, and then the preparations for a new expedition.

The Devil's Pass now presented itself. This was the place where we had been stopped, and to which we gave this name, from the dangers which it presents. Notwithstanding, indeed, all the labour which had been bestowed, this passage had only a place for the foot. A projecting rock pressed the knees together ; and, as there was a precipice behind, it was necessary to walk sideways upon this inclined plane, the feet being wholly without. We have never seen any person pass here without terror.

This difficulty being surmounted, we admired a transparent column twenty-five feet high, as white as alabaster, and all formed like cauliflowers placed above one another, till they formed a pyramid. Here a new difficulty awaited us, and it was necessary to descend : The plain was inclined—the ladder could be of no use—the ground was slippery—a precipice was beneath—and it was necessary either to fall right down, or to run the risk of being lost in a deep hole, or dashed against the rocks. We, therefore, pushed down a piece of wood to lengthen the declivity, and, upon that alone, we found it necessary to slide directly down, holding by the left hand a rope, which every one fixed the best way he could. Upon reaching that piece of wood, a broken stalactite, a foot in diameter, was the first place where we considered ourselves in safety, having now reached a sort of solid ground.

Here we were first surprised by an altar as white as the purest porcelain, and three feet in height, of a form perfectly oval, and having regular steps. The table of that altar was of the most dazzling enamel, consisting of leaves placed one above the other, like the leaves of an artichoke. At a greater distance were seen four twisted columns, of a yellowish hue, and transparent in several places, notwithstanding their size.

Four men were not able to grasp them. Their height could not be estimated, but we supposed they touched the roof.

This chamber is as large as the half of Ganges. Our eyes were able neither to measure the height nor the depth of it. We perceived cavities which human industry could not make us penetrate. Seated upon this altar, we were surrounded with such a prodigious quantity of objects, that we were lost in mute admiration. Among others was an obelisk, as high as a church, terminated with a spire. It was perfectly round, and of a reddish colour, chiseled throughout the whole of its height, and in the most exact proportion. We saw, also, masses as large as churches, sometimes in the form of cascades, sometimes resembling clouds. In other places were seen columns broken in all directions, and covered with ramifications of enamel; cauliflowers, muslins, and every species of the most singular and varied combinations.

One of the wonders of this grotto is, a colossal statue placed upon a pedestal, and representing a woman holding two infants. This statue would be worthy of the greatest Sovereign of Europe, if it could be removed without losing that form which we have so distinctly observed it to possess.

In every part of the grotto are seen fringes, curtains, coats of enamel and crystals, laces and ribbons, so delicately arranged, that it was necessary to prove that man had never penetrated these regions, before one could believe that they were not the work of the most skilful artist.

This chamber is round, and may be compared to a Basilica surrounded with chapels more or less elevated. In the middle there rises a dome, which we conjecture to be about 300 feet high. The description of the grotto of Antiparos, which was believed to be fabulous in M. de Tournefort, and which appears from the travels of M. le Comte de Gouffier not to have been exaggerated, is a feeble image of the grotto of Ganges.

Art. VI.—*Notice respecting the Eggs of the Boa Constrictor, and of a young Brood hatched from them in Assam.* Communicated to Dr Brewster by a Correspondent in India.

I had the good fortune of obtaining yesterday, at Bishnath (13th June 1825,) a Boa Constrictor *sixteen* feet long, but it has been so much injured, that I fear the skeleton of it will be a very incomplete one. About *eighty* or *ninety* of its eggs have also been brought in to us, and I hope to be able to hatch for you a brood of young boas of a proper size for sending home. One of the young ones, taken from a broken shell, showed symptoms of vitality. It is about *eighteen* inches long. I had previously seen the same species of snakes upwards of twenty feet in length, in Gorackpore. We were attacked last night, by a flotilla of wild elephants coming from the other side of the river. They broke through my line of boats in spite of all our clamour, and one of them sunk a canoe, and crushed to death a man that was in it.

I have now (6th July 1825,) hatched a brood of young boas from the eggs which I have already mentioned to you as having got at Bishnath. There are *twenty-eight* of them here, (at Gowahutty,) and about twenty more at the snake-catcher's house. They are about eighteen inches in length, and sufficiently lively; but I fear it will be very troublesome to bring them up, as they require to be *crammed* with fish or other food; an operation which no one but a snake-catcher who has got over the vulgar prejudice against being bitten by such snakes as these are, would like to perform. There are also here some very fine hooded snakes, resembling the Cobra de Capello, but larger than any of that species that I have before met with, being *ten* or *twelve* feet long.

It is here considered to be a very uncommon thing to find the eggs of the boa, as none of the snake-catchers have ever seen them before. They were soft, and indented by pressing against each other. Their size is about that of a goose's egg, and they resembled in appearance the Fungi called Dead men's—— I forget what in Scotland. At the end there was a sort of tag, as if the egg had been attached to something.

The young snakes hatched from the eggs are still doing well, (July 18, 1825,) only *one* of them having died out of *twenty-eight.* On the fourteenth day after birth, they cast their first skins. They increase considerably in size, but the snake-catchers are of opinion, that they will take many years to acquire their full growth.

ART. VII.—*Analysis of a Lithion-Mica from Zinnwald in Bohemia.* By C. G. GMELIN, Professor of Chemistry in the University of Tübingen. In a Letter to Dr BREWSTER.

DEAR SIR,

I HAVE the honour to send you the result of the analysis of a Lithion-Mica, along with a few laminæ, with the request that you may examine their optical structure. When I had found that the mica from Chursdorf was a lithion-mica, I searched in vain for others of the same nature in my small collection of minerals. Soon after I met with a beautifully crystallized mica from Zinnwald in Bohemia, which I immediately reckoned to be lithion-mica. While I was engaged with its analysis, I received the 5th number of your Journal, where I found that several species of lithion-micas had been already discovered by Messrs Turner and Haidinger. The lithion-mica from Zinnwald, which I have analysed, is accompanied by tungstate of lead. I have obtained the following result:

Silica, - - -	46.233
Alumine, - - -	14.141
Oxide of iron, - -	17.973
Oxide of manganese, - -	4.573
Potash, - - -	4.900
Lithion, - - -	4.206
Fluoric acid, - -	3.729
Water and loss, - -	4.245
	100.000

This mica loses by ignition not more than 0.83 per cent., and even if this loss is taken for pure water without fluoric acid, there still remains a loss of 3.4 per cent., which, in fact, is very considerable. I have been convinced, by direct experiment, that when this mica is fused in a platina crucible, by far the greatest part, if not all the fluoric acid, remains behind; for, when the fused mass is covered by carbonate of soda, and again exposed to heat, there is obtained by analysis a quantity of fluoric acid, which is probably not inferior to that obtained from the mica before it has been previously fused. The considerable loss may be, I think, accounted for by the volatilization of the alkaline matter, which is expelled by barytes during the intense heat required for the decomposition of the mineral. This inconvenience might be, I suppose, prevented by the use of oxide of lead instead of carbonate of barytes.

The fluoric acid is evidently to be considered as an essential ingredient of mica, and lithion-micas appear to be constantly possessed of a large quantity of this acid; and there seems to exist an insensible passage in that respect from the micas to the talcs, which also deserve to be examined with greater accuracy. I should have wished to try the easily fusible micas from St Gothard before the blow-pipe, but those which I have had an opportunity to examine fused with difficulty, and did not possess the characters of lithion-micas. It does not appear to be an easy task, to separate mechanically those portions of the lithion-mica from Chursdorf, that prove to be different from the rest in their optical structure; and I have not at present an apparatus fitted for that purpose. If I should find an opportunity, I shall take the liberty of sending to you a sufficient quantity, that you may execute this separation, and I should be happy to make a careful analysis of both portions.

I am engaged at present with a comparative inquiry into the volcanic products, and those of what was formerly called the floetz trap formation. It is well known, that muriatic acid has been long since discovered in basalts. This acid seems to be much diffused in these formations. I have, for instance, found it in the prehnite from Dumbarton, and in a great many other minerals of a similar origin. I thought that it might also be an ingredient of Tesselite, but I could not discover a sensible quantity of it. It may also be a constituent part of some meteorolites, which in many respects have a resemblance to the products of the floetz trap formation; but I have now no opportunity to verify this hypothesis.

I am,
Dear Sir,
With high esteem, yours, &c.
C. G. GMELIN.

TÜBINGEN, 31*st Dec.* 1825.

ART. VIII.—*On the Law of the Compression of Air, and of Gases capable of being Liquefied by Pressure.* By H. C. OERSTED, Professor of Natural Philosophy in the University of Copenhagen. Communicated by the Author.

THE law of Mariotte,* according to which the volumes of a mass of air are reciprocal to the pressures which they suffer, has not yet been established by accurate experiments, unless in the case of very weak pressures. With regard to high pressures, it may still be doubted whether or not they follow the same ratio. Several distinguished philosophers have taken for granted the accuracy of this law, for all the pressures to which a mass of air can be subjected, while others, such as James Bernouilli and Euler, suppose that the volumes decrease in a much less progression; whereas, in the small number of experiments that have been made under considerable pressures, the volumes decrease in a much higher progression than the pressure. This result, indeed, has been obtained by Sulzer † and by Dr Robison, as will appear from the following tables:

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* This law was first deduced from the experiments of the celebrated Boyle, by his friend Richard Townley, but as it is so well known under the name of Mariotte, who discovered it nearly at the same time, and by his own experiments, I have made use of this name, already consecrated by time.

† See the Memoirs of the Academy of Berlin.

Experiments of Sulzer, the most complete Series.		Experiments of Robison with dry air.	
Densities.	Elasticities.	Densities.	Elasticities.
1,000	1,000	1,000	1,000
1,091	1,076	2,000	1,957
1,200	1,183	3,000	2,848
1,333	1,303	4,000	3,737
1,500	1,472	5,500	4,930
1,714	1,659	6,000	5,342
2,000	1,900	7,620	6,790
2,400	2,241		
3,000	2,793		
4,000	3,631		
6,000	5,297		
8,000	6,835		

Captain Schwendsen and I having proposed to investigate the theory of the air gun, found it necessary to examine, as a fundamental principle, the extent of the law of Mariotte. The apparatus commonly employed to establish this law, consists of a bent tube ABCD, Fig. 13, Plate V. of which DE contains the air, and the other ABCE mercury, which serves to inclose and to compress the air. This apparatus has several inconveniences. It is difficult to divide accurately the portion DE into parts of equal capacity, and this portion is dilated by the interior pressure so as to expose the apparatus to the risk of being broken when the pressure becomes considerable. In order to guard against that accident, tubes of a small diameter have been used, but they occasion friction sufficiently great to produce a sensible influence on the results.

In order to avoid these inconveniences, we had recourse to an apparatus constructed according to the same principle which I employed in my apparatus for the compression of water. A vertical section of this apparatus is represented in Fig. 14, where ABCD is a strong glass cylinder with a brass cover AC; EF is a divided glass tube (supported by an iron frame *l m n o*) the lower part of which is an iron vessel, containing a little mercury, which closes the tube EF before its immersion in the mercury which is found at the bottom of the cylinder; IK is the superior limit of the mercury; GH represents part of a very strong glass tube glued into a hollow piece *i i*, which has a screw on its outer surface to screw into the opening in the cover AC. In this cover there is another hole *p*, which is shut by a screw *p* E. TV is a wooden stand, surmounted by a pillar RST, which serves as a support for the tube GH. The two supplementary figures, Fig. 15 and 16, represent the frame *l m n o*, and the transverse section of the lower part of the apparatus.

In order to make the experiment, the lid AC is unscrewed, and the tube EF, containing air well dried, is put into its place. The lid AC is then put on, and well closed up. The tube GH is also put in its place, and, by means of a funnel placed in the aperture *p*, the cylinder is filled with water. The pressure excited by this water is measured by the height of the mercury in the tube GH. The apparatus is then closed up by the screw, which goes into the aperture *p*, and when mercury is poured into the tube GH, this fluid rises also in the tube EF, and compresses the air which is contained in it. The difference between the levels of the mercury in EF, and in GH, gives us the compressing power, and as the tubes have equal divisions, this difference of the levels is found by a simple subtraction. Although the tube EF of our apparatus is everywhere of a calibre nearly equal, yet we have determined exactly the capacities corresponding to the divisions by weighing the portions of mercury in each.

The divisions on the tube GH reach only a few inches below the cylinder. The other distances were measured by a scale.

In order to have the tube GH sufficiently long for great pressures, we united, by iron screws, several tubes of glass, each 7 feet in length. The experiment was always made in a stair of the house, which contains the physical cabinet of the university, no apartment being sufficiently high to permit the necessary elongation of the tube GH.

With this apparatus we have made several experiments, the results of which are conformable to the law of Mariotte; but they have not all been attended with the same success, for it is very difficult to make all the joints and screws sufficiently impenetrable to mercury acting with high pressures.

It is only in one of the experiments that we reached to a pressure of eight atmospheres, and we shall now give the results of it. The air in the tube EF was well dried by muriate of lime. The capacity of the tube was measured by mercury, and it contained 1054.8 grammes of it, at the temperature of 20° centigrade. The pressure of the atmosphere on the day of the experiment was 0.7578 metres. The following table shows the ratio which we found between the compression of the air, and the pressure of the mercury:

Densities.	Compressing Force.	Differences.	Differences Divided by the Pressures.
1,000	1,000	0,0000	0,0000
1,1052	1,1051	+0,0001	+0,0001
1,1676	1,1693	−0,0017	−0,0015
1,2736	1,2706	+0,0030	+0,0024
1,4744	1,4694	+0,0050	+0,0035
1,587	1,581	+0,006	+0,004
1,812	1,806	+0,006	+0,003
2,112	2,079	+0,033	+0,016
2,529	2,520	+0,009	+0,004
3,168	3,147	+0,021	+0,007
3,616	3,599	+0,017	+0,005
4,209	4,185	+0,024	+0,006
5,057	5,010	+0,047	+0,009
5,603	5,572	+0,031	+0,005
6,288	6,287	+0,001	+0,000
8,175	7,082	+0,093	+0,013
8,030	8,014	+0,016	+0,002

The first column of this table gives the numbers obtained by dividing the primitive volume by the volume reduced by the compressing forces, *i. e.* the densities. The second column gives the compressing forces in numbers, of which unity is the pressure of a column of mercury of 0.7578 metres, equal to the pressure of the atmosphere on the day of the experiment. The third shows the differences between the compressions and the compressing forces, and the fourth shows the ratios of these differences to the compressions.

It is very difficult in these experiments to determine exactly the volume of air inclosed, since the inferior limit is a curved surface, whose form is often modified by the friction between the mercury and the glass. In all these experiments we have endeavoured to divide, by the eye, the concave part into two parts of equal volume, but the results show that we have attributed too little of this volume to the inclosed air. Without this error the differences would have been smaller. In other respects, they are as small as could be expected in experiments where a vernier could not be used.

In the last observation, for example, where the observed length of the column of air was 56.4 millimetres, the length which would have entirely agreed with the law of Mariotte, is 56.287, which differs only 0.113 millimetres from observation, an error which is unavoidable in such observations. In the last experiment but one, the observed length of the column of air was 63.17 millimetres, whereas the number which would have satisfied the law of Mariotte, is 63.99. This difference amounts to 0.82 millimetres, but, being between two other observations whose deviations are very small, it cannot affect the general law.

In order to examine the compression of air by great forces, we made use of air-guns. Our sovereign, whose enlightened magnanimity has so often contributed to the progress of science, put at our disposal all the apparatus which was necessary for this inquiry. The reservoir of air in this kind of arm is the *culasse*, which ought to be very strong; we at first measured the capacities of these by weighing them when empty, and when filled with water.

It was then easy to calculate the quantity of air which such a reservoir contained. That which we most frequently used contained 0.891 grammes of air when the barometer was at 0.76. We were thus capable of determining, by the balance, the degree of compression which we had attained in our experiments. This method was found sufficiently exact, as the balance which we commonly used was sensible to a centigramme. We succeeded in introducing into this reservoir as much as 101.2 grammes of air, a quantity equivalent to the pressure of 110.5 atmospheres. We have also, in these experiments, taken into consideration the dilatation which the interior pressure ought to produce in the reservoir. This dilatation was determined by weighing in water the reservoir when empty, and when filled with air; and in the calculations, it was supposed that the dilatations which it experienced were proportional to the quantities of air introduced into it.

If the reservoir had not been dilated, when 101.2 grammes of air were forced into it, the density of the air would have been 113.5 times that of the atmosphere; but, when calculated, by applying the dilatation of the reservoir, it amounted only to 110.5. In Fig. 17 we have shown the method in which we made the experiments on the expansive force of air compressed in such a reservoir. AB represents the reservoir, that is the *culasse* of an air-gun, CD is a plate with a pillar CE, FH is a piece of iron, whose upper part receives the axis round which the lever FG turns. This lever is balanced by the mass F. At I the lever carries a tooth or pin with which it presses upon the valve M. A slide N with the scale L of a balance serves to determine the force necessary to open the valve. As this is kept in its place by a spring, we at first examined what was the force required to open it when the air inclosed had the same density as the atmospheric air. When this was done, we charged the reservoir as much as possible, and after having determined the resistance which the introduced air gave to the valve, we discharged the reservoir by degrees, always determining by the balance the quantity of air which remained, and by the apparatus in Fig. 17, its expansive power.

This class of experiments, however, is not susceptible of any rigour, because the valve does not always apply itself in the same manner. When the valve is covered with leather, in order to make it shut better, the inequality is very great, and it is on that account that we have made a series of experiments with a valve of steel, which was well ground into the aperture, but we have not been able by this means to obtain sufficiently great pressures.

The first table shows the results obtained by a valve covered with leather, and the other the results obtained by a ground steel valve.

Experiments made with a Culasse, whose Valve was covered with Leather.

Weights of air inclosed, in grammes.	Densities, that of the atmosphere being 1.	Pressures on the valve in grammes.	Pressures divided by the densities.
1	1,122	812	725
2	2,273	1809	806
3	3,364	2552	758
4	4,484	3693	823
5	5,604	4395	784
6	6,723	5750	855
7	7,842	6693	853
8	8,960	6797	758
9	10,077	7711	764
10	11,193	8166	729
10	11,193	8434	753
10	11,193	8480	757
10	11,193	8445	754
10	11,193	8437	753

Experiments made with a Culasse, whose Valve was without Leather.

Weights of air inclosed, in grammes.	Densities that of the atmosphere being 1.	Pressures on the valve, in grammes.	Pressures divided by the densities.
1,	1,122	1269	1131
2,	2,243	2368	1055
3,	3,364	3388	1007
4,	4,484	4751	1059
5,	5,604	5750	1026
5,	5,604	5620	1002
5,05	5,657	5790	1023
5,05	5,657	5800	1025
5,	5,604	5730	1022
6,	6,732	6871	1021
7,	7,842	8113	1034
8,	8,960	9344	1043
9,	10,077	10375	1029
10,	11,193	11440	1022
10,2	11,417	11725	1027
15,	16,76	16766	1000
15,1	16,87	17243	1022
20,	22,326	22988	1029
25,6	28,543	29253	1025
30,	33,393	34197	1024
35,2	39,13	40232	1026
40,1	44,52	45633	1025
45,	49,894	51641	1035
50,	55,362	57467	1038
55,	60,816	63102	1037
60,	66,254	67798	1023

In these tables, the first column shows the weight of air introduced into the reservoir; the second shows the condensation; the third the force required to open the valve, diminished by the force required to open it before the charge; and the fourth gives the pressure of the atmosphere obtained by dividing this force by the condensation.

In the first table, the mean number is 797; the deviations from it vary on both sides. In the second table, we have, by rejecting the first number as too discrepant, 1027 as the mean, and it is evident that most of the numbers are not far removed from it. These experiments, therefore, imperfect as they are by their very nature, concur in proving that the compressions produced by very great forces, are regulated by the same law as those which are feeble. But, in order to decide if the compressions of any gas whatever follows the same law, we have had recourse to gases capable of being liquefied by a few atmospheres. The sulphurous acid gas, which, according to M. Faraday, is liquefied by a pressure of two atmospheres, appeared to us very fit for this class of experiments.

Two equal tubes, the one filled with sulphurous acid very dry, and the other with atmospheric air, were placed in a small mercurial bath, and introduced into an apparatus, where these aeriform bodies could be exposed to a suitable pressure; the result was, that they suffered a diminution of their volume always equal, till the sulphurous acid gas began to convert itself into a liquid. The following is the detail of the experiment.

In Fig. 18, AAAA is a cylinder of glass very strong, and of the same kind as that which I used to show the compression of water. This cylinder has a brass cover surmounted with a cylinder BBBB, in which moves the piston C, pushed by the screw DD; EE, EE are two equal and divided tubes, whose lower ends are immersed in an iron dish FF, which is fixed to the end of a strip of glass GGGG, which, at the same time, serves to keep the two tubes in a vertical position. The cylinder AAAA is filled with mercury to HH. The experiment is begun by filling the two tubes with the aeriform materials, placing them in the dish FF, and fixing them on the strip of glass GGGG. When this is done, the apparatus is introduced into the cylinder AAAA, where the dish FF is plunged in the mercury, which is below the line HH: The cylinder is filled with water, and the body BBBB of the pump is put in and filled with water. The piston DD is finally put in, and is made to act upon the inclosed water. This water communicates its pressure to the mercury, which, in its turn, transmits it to the two aeriform materials contained in the tube.

The following are the results of the experiments with two tubes, one of which contains atmospherical air, and the other sulphurous acid gas, the temperature being 21¼° centigrade.

Sulphurous Acid Gas.	Atmospherical Air.	Condensation of the Sulphurous Acid.	Condensation of the Atmospherical Air.	Differences.
131,2	128,5	1,	1,	
128,	125,33	1,0261	1,0259	+0,0002
122,4	120	1,0754	1,0768	÷0,0014
117,33	115	1,1229	1,1215	+0,0014
112,	110	1,1750	1,1729	+0,0021
106,875	105	1,2302	1,2297	+0,0005
101,5	100	1,2937	1,2942	÷0,0005
96,3	95	1,3634	1,3644	÷0,0010
91,25	90	1,4396	1,4403	÷0,0007
86,	85	1,5278	1,5257	+0,0021
80,75	80	1,6228	1,6228	0,0000
75,5	75	1,7329	1,7311	+0,0018
70,6	70	1,8542	1,8539	+0,0003
65,6	65	1,9971	1,9974	÷0,0003
64,5	64	2,0310	2,0307	+0,0003
63,4	63	2,0649	2,0638	+0,0011
62,4	62	2,0976	2,0982	+0,0006
61,3	61	2,1342	2,1336	+0,0006
60,3	60	2,1705	2,1702	+0,0003
59,25	59	2,2101	2,2082	+0,0019
58,2	58	2,2475	2,2474	+0,0001
57,16	57	2,2879	2,2874	+0,0005
56,	56	2,3356	2,3289	+0,0067
54,875	55	2,3835	2,3720	+0,0115
53,875	54	2,4279	2,4166	+0,0113
52,8	53	2,4798	2,4619	+0,0169
51,75	52	2,5317	2,5109	+0,0268
50,6	51	2,5831	2,5610	+0,0221
49,6	50	2,6488	2,6171	+0,0317
48,6	49	2,7008	2,6674	+0,0334
47,6	48	2,7595	2,7240	+0,0355
46,6	47	2,8207	2,7819	+0,0388
45,5	46	2,8886	2,8423	+0,0463
44,4	45	2,9556	2,9057	+0,0499
43,33	44	3,0240	2,9717	+0,0523
42,4	43	3,0974	3,0407	+0,0567
41,16	42	3,1733	3,1130	+0,0603
39,33	41	3,3186	3,1889	+0,1297

From this table, it appears that the differences are very inconsiderable, and vary on one side and another, till the pressure amounts to 2.3 atmospheres, when they become greater, and go on increasing. At a pressure of 3.2689, a little above that represented in the table, the humidity becomes visible, and beyond this the contraction takes place rapidly. Before this term, there is, perhaps, a feeble liquefaction at the contact of the gases with the sides of the cylinder, and at the surface of the mercury; for the contact of a heterogeneous body seems to favour the transition of the body from one state of aggregation to another, as I have shown in a memoir on the experiments of Winterl, printed in the *Journal of Gehlen* for 1806, vol. i. p. 276—289.

In some experiments we have found that the water penetrated between the mercury and the sides of the tube. We have since corrected this inconvenience by cementing to the open extremity of each tube a brass ring, which amalgamates with the mercury, and thus prevents the water from escaping.

We have also compressed *Cyanogen* by the same means, and we have found that the liquefaction of this gas begins when the air is compressed to $\frac{1}{3\frac{1}{2}}$ of its volume, the thermometer being at 23° centigrade, and the barometer at 0.759 metres.

It would be easy to multiply these experiments, but those which we have given are sufficient to prove that the compression of air and of gases is proportional to the compressing force, however great that force may be, provided they preserve their gaseous state, and have lost the caloric developed by their compression. These researches, therefore, have only served to confirm the opinions of the most distinguished philosophers of our times upon this subject; but, as there were still others who entertained an opposite opinion, we have not considered the publication of our experiments as altogether useless.

The compression of fluids is, as far as we have discovered, subject to the same law of being proportional to the compressing forces. We may, therefore, suppose, that gases, reduced to the state of liquids, begin again to follow the same law which they obeyed in their gaseous state. It is also probable, that liquids, after being converted into solids, are subject to this law. If that shall be confirmed by ulterior experiments, we may conclude that it is only in the transition of a body from one state of aggregation to another, that this law is not regulated by the compressions.

COPENHAGEN, 9*th September* 1825.

ART. IX.—*Route to India, by Egypt and the Red Sea.* By CAPTAIN PRINGLE, Royal Engineers. Communicated by the Author.

THE contradictory statements which I received respecting the above route, induced me to note down the inquiries which I made up on the subject; and their result will, perhaps, be useful to such officers as may have an intention of proceeding by Egypt and the Red Sea to India.

The season in which vessels sail from the Red Sea to India is confined to the short space of about two months, extending from the first of July to the first week in September; and this is done, that they may have the benefit of the south-west monsoon in the Indian seas, and of the steady weather which is then prevalent. It will be requisite, therefore, to regulate all the previous proceedings of the journey, in order to suit the above season.

It will be necessary, then, to arrive at Mocha either before or within that period. It might be possible, indeed, even after that time, to get round the southern shore of Arabia to Muscat, from which place there are vessels sailing to Bombay at all seasons; but such a voyage would be attended with difficulty and danger. In coming from ports higher up the Red Sea, all vessels, I believe, touch at Mocha; at least all that are proceeding to British India, as the Company have their resident there. The vessels employed in this trade are chiefly Arabs. A few of them are square rigged, but the greater part are Buglas, similar to the Indian Donie, which is a sloop, or large boat, with an unwieldy sail. Many of them, however, have airy poop-cabins.

The Buglas are almost the only vessels used in communicating betwixt the different ports of the Red Sea. The

Arab vessels, particularly the Buglas, seldom venture to stand directly across from Kosseir to Jidda; but, in making that voyage, they go as far north as the Ras Mahomet, or entrance into the bay of Suez, and never lose sight of land; indeed, they keep generally in a channel between the coral reefs and the shore, and come every night to an anchor, or to moorings on the coral banks. For the sake of some trifling traffic, they also make delays at the different small ports on the coast. All this renders the voyage extremely tedious. These vessels, however, pass during the whole year from Suez, or Kosseir, to Jidda, and from Jidda to Hodeida and Mocha.

The time required for the voyage down the Red Sea in these vessels will be about fifty days; allowing twenty days from Suez, or Kosseir, to Jidda, and twenty from Jidda to Mocha, and a delay of about a week at each port. The latest period, therefore, of leaving Egypt, in order to catch the last vessels which sail for India from Mocha, will be about the 15th of July; and for the first vessels about the 23d of May. A few years ago this part of the route could be performed in about half the time, there being then a trade carried on in British Indian vessels direct from Suez to Bombay. These vessels made their course down the centre of the sea, where all is clear and open, the coral reefs appearing to extend but a little way from shore; but the Pacha of Egypt, who was a partner with the English merchants, put a stop to the trade, because it fell short of his expectations.

The coral reefs lie parallel to a great part of the Arabian shore; and the Arabs probably sail this way, because they have smooth water; but the navigation is intricate, and can only be pursued by day-light, and with a fair wind.

The winds in the Red Sea do not partake of the regular monsoon. In the southern portion of the sea, however, southerly winds are prevalent from October to May, and northerly winds from May to October.

A company's cruizer, when not needed on more important service, is sent every year into the Red Sea, and she usually leaves Bombay in December. But the chance of meeting with her cannot be taken into calculation. In 1824, only one English vessel had come into the Red Sea. She brought a cargo from Bengal to Jidda, and was to take coffee from Mocha. There were several large vessels from Surat, and other parts of India, but not commanded by English masters.

The chance of finding vessels at Kosseir and Suez, is, I believe, nearly equal at present. The Pacha has two or three brigs employed in transporting grain from Kosseir to Jidda, for the use of his army in Arabia, and these brigs are commanded by Greeks. There are also several Buglas employed in the same service, so that the delay at Kosseir in waiting for a passage is not likely to exceed a week. The obtaining a passage in one of those vessels should be mentioned in the firman or passport which is given at Cairo, in order that it may be presented to the Turkish governor at Kosseir. By embarking at Suez, the traveller will miss the sight of all Upper Egypt.

All Mahomedan vessels trading in the Red Sea are obliged to call at Jidda, which is the port of Mecca, in order to pay a tribute to the shrine of Mahomet. Jidda is the principal port of the Red Sea, and its lofty buildings give it the appearance of a large place. Its principal support depends upon the pilgrims who arrive there, annually, from all Mahomedan countries, on their way to Mecca; and as these men are generally crowded into the native vessels, they add greatly to the discomfort of the European passengers. The European, therefore, in making his bargain, should limit the number of these pilgrims, or exclude them entirely; as the price he pays for his passage is sufficiently ample to entitle him to do so.

In the voyage down the Red Sea, however, many annoyances, and much incivility will be experienced, besides a constant attempt at imposition, and a want of faith as to agreements, particularly in so far as regards delay at the different ports. It is customary, indeed, to have a written agreement made out in presence of the Turkish governor at Kosseir, Jidda, &c.; but any petty excuse will be allowed as an evasion.

The people throughout Arabia are bigotted Musulmans, and the boys will point, and even throw stones at a person in a Frank dress. This may be passed unnoticed; but the men also will sometimes show insolence, in which case it is necessary to be decided, and to make them know at once that you are prepared, and willing to use your arms. Pistols, therefore, should be always carried in a waist belt, when a person goes to any distance from his people. At Jidda, the company have a native agent, Hassan Aga, who gives lodgings, &c., to Europeans during their stay here; and at Mocha, the presence of the resident insures some degree of respect and protection; but, otherwise, little advantage will be derived from their assistance.

As the Pacha of Egypt, however, is extending his conquests on both sides of the Red Sea, and is only prevented from taking Mocha by the fear of offending us, it is not improbable that the European traveller, in a short time, will pass down the Red Sea with as much security as he passes at present through Egypt. The army which Mahomet Ali has in Arabia, amounts to about 10,000 men. With these he has garrisoned Mecca and the ports; and last year he took the field with 7000 men against the tribes east of Comfidah, on the frontiers of Sana, or Yemen, from which he had just returned with partial success when we were at Mocha. These tribes were said to be the remains of the Wachabees. So long as this army is maintained in Arabia, the intercourse will be considerable with Egypt, and the security of travelling much greater.

The traveller himself must lay in provisions for the voyage, as these Arab vessels merely supply wood and water. Wine, spirits, tea, and any other luxury, must be laid in for the whole voyage from Cairo to India; particularly the two first, as they are articles prohibited in Mahometan countries. The servant who attends him must be able to cook victuals; and he should also be able to speak Arabic, which will prevent the necessity of having a dragoman. One such servant, with a native one to assist, would be sufficient for two travellers. The sailors, however, particularly those on the Nile, are willing, in general, to give assistance. All sorts of provisions are very plentiful in Egypt; they are less so at the ports in the Red Sea; but fowls, sheep, bread, coffee, &c., can be procured at all times. The water at the ports on the Red Sea is brackish, and that at Kosseir is also sulphurous.

On the voyage, we were two in number, and each of us had a servant. We hired the stern cabin, and the following were the prices paid for our passage during the voyage: From Kosseir to Jidda, twenty-five dollars each; from Jidda to Hodeida thirty-five; from Hodeida to Mocha five; and from Mocha to Bombay ninety; but these prices greatly exceed what would have been paid by natives.

With the exception of a few palm trees round the villages and towns, the shores of the Red Sea are mere deserts, which extend to the mountains about thirty or forty miles distant. If any vegetation shows itself on this flat, it consists of stunted acacias and other shrubs of the desert. The shores, therefore, offer nothing interesting; but the mountains are high, and have a fine serrated outline.

In passing along the inhospitable shores of the Red Sea, the only object is to make progress; but it is otherwise in passing through Egypt, a country which gives the great interest in the whole route. The time, therefore, to be passed in it will vary, according to the pursuits and views of the traveller. But in Egypt, also, there is a season to be attended to; that in which the plague usually prevails. This disease is generally expected to break out in Alexandria about the end of February; and in Cairo a few weeks later. Some years escape altogether, and in others it does not rage with such violence as to require much precaution. It is always considered as having ceased about the end of June.

The usual mode of travelling in Egypt, is to hire a boat or kanja. These boats are about seventy feet long. They carry two large sails, and have a crew of seven or eight men, who track the boat when the wind is not favourable. In the spring, however, the prevailing wind blows up the river, and at that time the current is not strong. The crew are completely under the orders of their employers; and any complaint made to a Turkish authority of their disobedience would get them severely punished. But the traveller, as is generally done, may punish them himself.

The kanjas have a cabin in the stern, similar to that of a gondola; and, though low, it is sufficiently large for two persons. The servants cook the victuals in the forepart of the boat. The hire of the boat and crew is from twenty to thirty Spanish dollars a month.

The antiquities of Alexandria, the position of our army, the site of the action with the French in 1801, may be seen in three or four days. Mr Lee, our consul resident at Alexandria, is extremely hospitable and kind in lending every assistance. In Alexandria there is an hotel kept by a Maltese, and a *table d'hôte.*

It will take a week to sail by the new canal into the Nile and ascend to Cairo; but if Rosetta be visited a couple of days more will be required.

At Cairo there is a very good hotel kept by a Frenchman, a *table d'hôte*, &c. The expence there will be about a dollar a day. At Cairo there is also an excellent Cicerone, a Scotsman named Osman, dragoman to the consulate, who is extremely useful, not only in visiting the antiquities, &c. but in procuring the boats and supplies. Ten days will be well occupied in seeing Cairo, and in making arrangements for the journey.

Cairo is the last place where wine can be procured, and here, as the expence of transport-carriage across the desert is very trifling, it is well to take a good supply. The packages should be such as will fit the side of a camel; about four dozen. Besides a sufficient quantity of powder and shot for use, a few canisters of fine powder should be taken as presents for any Cashif or governor who may be civil. These supplies may be procured in Egypt, but better and much cheaper in Malta, or at the port where you embark from Europe.

The desert betwixt Cairo and Suez is passed in two days. To ascend the Nile to Ghinneh will require about twenty days, allowing a day or half a day to visit each of the principal antiquities on the route. The temples, &c. are generally at a short distance in the desert; but donkeys can always be procured. To ascend from Ghinneh in order to see Thebes will require about a week more; and to visit Assouan or

Syenē, the first cataract, another fortnight. It is possible to travel more expeditiously on canals; but in that case, besides the journey being more fatiguing, some of the antiquities would be missed, as they lie on both sides of the river.

The best season to travel in Egypt is winter, or the early part of spring. Towards April the weather becomes very hot. At Ghinneh, the thermometer had risen in the end of March to 104° of Fahrenheit in the shade; but as the nights are comparatively cool, little inconvenience is felt, and there is none of that sultry oppression, which is experienced in India at a lower temperature. A few weeks previous to the above state of the thermometer, it had been as low as 46°; the dress, therefore, must be such as can easily be adapted to such changes. In Egypt there is no use in adopting the Turkish dress, the European one being a better protection. But in the Red Sea, it may be as well to make your servant wear the Arab dress, or at least to have one for marketing, &c.

There is excellent shooting on the Nile and its banks; the game consisting of quails, snipes, wild ducks, geese, crocodiles, &c.

At Ghinneh, there is an Arab merchant, named Hassan Omar, who acts as an agent for English travellers, and will make arrangements for camels to pass the desert with. He and Osman, at Cairo, are recompensed by a present, or a few dollars. The desert between Ghinneh and Kosseir, is passed with ease in a few days; and each camel employed on this route costs about a dollar. A field mattress, laid across the camel's saddle, forms an easy enough seat, and is conveniently ready to lie down upon at any short halt. A tent is not at all requisite in an atmosphere where it never rains. There are two wells on the road, but the water is a little brackish. Shrubs and camels' dung for fuel are found in sufficient quantity to cook what is necessary. The traveller should provide himself with live fowls, as in some winds butcher-meat becomes putrid in a few hours.

Six weeks may be considered as the shortest period for travelling from Alexandria to Kosseir, if it is meant to take a cursory view of the antiquities of Egypt; but the whole journey betwixt these two places, may be performed in a fortnight.

The works which have been written on Egypt are so numerous, that is difficult, if not presumptuous, to say which should be selected as a guide. For this purpose, Denon or Hamilton are generally recommended; and, for the ancient history of Egypt, Herodotus and Strabo. Volney treats of it during the reign of the Mamalukes, and describes the various sects and nations composing its population. Norden, Neibuhr, Bruce, Burckhardt, have also written upon it; and the last, from having professed Mahomedanism, learned a great deal of the customs, rites, and other ceremonies of the natives. There are several very late travels: Legh, 1812, Light, 1815, Captains Mangle and Irby, Belzoni, Henniker. The last has given a concise journal of the antiquities, &c.

Travelling in Egypt is safe and easy. At present, there is no occasion for a Janizary, as such a person, so far from being of use, would be a mere annoyance. It is necessary, however, to be armed with pistols and a fowling-piece, &c. and to be prepared for danger, particularly should any part of the country be in a state of insurrection, as such a circumstance renders the protection of the government precarious, and often useless, even at a considerable distance from the scene of tumult. The Turks always are completely armed; consequently, arms are looked upon as a part of dress, and insure respect to every person who is entitled to wear them.

The Turks, in general, not excluding the soldiers, were always most willing and ready to oblige, or to be of service; and, during the insurrection, this friendly disposition of theirs was frequently of some importance. In return for their civilities, they merely asked for a little powder for priming, for which purpose, a couple of charges was sufficient, or requested us to look at their wounded, and give medicine. They fancy, indeed, that every Frank has some skill in physic; and, on this account, a few common medicines and ointments should form a part of the stock laid in.

It has been in contemplation to establish steam-vessels on the above route. The red sea seems to be particularly favourable for their employment; and fuel, consisting of wood and charcoal, might very probably be obtained in sufficient quantity, and at a moderate charge. There are also pits of petroleum on the coast between Kosseir and Suez at Gabel Ezand; and, as the petroleum is said to be in great abundance, it would, very probably, when burnt with wood, produce a strong combustion. The length of the red Sea is about 1200 miles. Mocha or Aden would be the best parts to depart from for India. The distance from these to Bombay is about 2000 miles; but the islands of Socotra, which are about one-third of the way, might be made a depot for fuel.

But, in the Indian seas, it would probably still be necessary to attend to the S. W. monsoon, which, in June and July, blows very strong, and carries with it a heavy sea. In August and September, however, a steam-vessel might make good way, as the wind is then comparatively light, and the water smooth. During the N. E. monsoon, which is prevalent from October to May, and which is said to blow with considerable violence from December to March, it would probably be better for steam-vessels not to attempt the passage.

One plan proposed was to cross the desert from Suez to Thineh, on the coast of the Mediterranean; but, in this way, the Nile and Egypt would be entirely missed. If, on the other hand, the Nile were taken, is is quite favourable for steam-boats; only that, from the number of the sand-banks, and their so frequently shifting, the boats must be constructed so as to draw little water.

There appears, then, to be no difficulty of establishing the above route, if the land passage, or that through Egypt, remain open to us, and of this there can be no doubt, so long as Mahomet Ali governs Egypt. Should his successor, however, refuse permission, or should Egypt return to its state of former anarchy, it might be a question how far it would be proper for us to take possession of the country, for the Turks hold it only by force of arms, and are a quite distinct race from its native population. The natives are principally Arabs, and are a fine athletic people, capable of rendering the country a very productive colony, valuable even independently of the connection it would establish between our eastern and European possessions.

So much for the Trans-European part of the route. The principal ports from which vessels sail for Alexandria, are Malta, Marseilles, Leghorn, Genoa, Naples, and Corfu; and of these, the best probably is Malta. It gives not only a good opportunity for fitting out, and laying in, a proper assortment of supplies, but for obtaining a servant, Maltese being a dialect of Arabic sufficiently near to be understood by Arabs. It would be of great use, however, if the servant, besides Arabic, also understood Turkish. The hire of a good servant, will be from twelve to twenty dollars a month. Each traveller may take about one hundred pounds in Spanish dollars or German crowns, from Malta, as the exchange is much higher in Egypt, and a part of this sum may be converted in Egypt into Turkish gold, though Spanish or German silver will do very well for the expences of the Red Sea. Bills on Bombay can be cashed at Mocha. The whole expence from Malta to Bombay will be about one hundred and fifty pounds; but it is far from being advisable to carry more money than is absolutely wanted, and that which is carried should be concealed and divided as much as possible.

COLUMBO, CEYLON, *May* 9, 1825.

ART. X.—*Observations and Experiments tending to show that the Sense of Taste is not a separate one.* By a Correspondent.*

I THINK there is no such sense as taste, distinct from the other known senses. It has been always well known, and is generally admitted, I believe, that we do not taste when we have our noses stopped, or our breath held, and it is also found, that a particular complaint, or illness, will sometimes take off both the power of smelling and tasting, and yet not hinder the

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* We shall be glad to hear again from the author of this article.—ED.

other senses. It is also often observed, and I have always found it so myself, that there is a likeness between the smell of a thing and the taste of the same, or of another thing, and, *vice versa*, which there is not between the appearance and sound of a thing, the sound and feel, the smell and colour, &c. And this sort of likeness is also quite of a different nature from that which we speak of as existing between the appearance of a four-cornered figure to the eye and the feel of the same figure; to perceptions which resemble one another in conveying, though by different senses, the idea of the number four. And it is still more distinct from that association, produced by experience, which we mean to denote when we say "such a thing looks like a soft thing,"—"such a person looks like a good-humoured person,"—"such a thing sounds like a solid,"—or, "like a broken thing,"—by which we mean, not that there is any likeness between the perceptions in themselves, for instance, between a certain noise and the appearance or feel of a crack in a glass, &c. but that the noise is like another noise which we had before found to be usually or always connected with the appearance or feel of a crack in a glass. The likeness between the perceptions of smell and taste, on the contrary, seems to every body, I believe, to be that of perfect identity, as to the perception itself, and distinguishable, if it is distinguishable, only by being perceived by a different organ, and under different circumstances, in the one case, from what it is in the other. I have also often found, that when I have been surrounded by a very strong odour in the air, and have had, at the same time, my mouth open, I have seemed to taste as well as to smell it; and I have been sometimes led to think, from this circumstance, that tastes in the mouth might be seasoned, as it were, by the smell of something placed near us while eating, just as they are by sauces which we taste in the ordinary way, though in a less degree probably. It is also worthy of remark, that those who treat of the senses find no difficulty, in the case of the others, in pointing out what are the proper organs of each; but when they come to the taste, they seem puzzled, and often differ from one another: Sometimes the tongue, sometimes the palate, are stated to be the seat of it; sometimes both, or both with the addition of the lips. This difficulty of ascertaining precisely the seat of this sense seems very remarkable in the case of a sense which, as we commonly suppose, operates in actual contact; unlike the sense of sight, &c. which acts at a distance. Besides, though we commonly consider the sense of tasting as one exercised by some part of the mouth, and as capable of being exercised only on a substance immediately in contact with the organ of tasting; and, on the other hand, consider that of smelling as exercised by the nose, and on a substance at a distance; or rather, to speak more accurately, on air, and particles contained in that air, though not discernible by any of the other senses, and brought by that air into contact with the organ of smelling; yet when, after eating, air returns from the stomach, we seem to taste the taste of the thing which had been eaten, (of onions, for instance, or turnips,) as completely as we can be said to taste any thing; and people sometimes describe this as an operation of tasting, or, "having the taste remain;" yet it is air only that is presented to the organ in this case. Some things of strong scent, perhaps, are tasted after having been swallowed, even independently of this, merely by their adhesion to the upper and unclosed part of the gullet, as onions.

These facts, though I had noticed them, I had never put together, or much considered, when I found it observed in an article in the *Edinburgh Review*, in 1821, I think, that there are some things which we smell, while we are tasting or eating them, by means of the internal aperture which leads from the back of the mouth into the nose, and through which also we breathe when our mouth is shut; and that this internal smell constitutes what we mean by the term flavour, when we use it as opposed to taste; which latter term, in this writer's opinion, relates only to a perception which is confined to the mouth.

It appeared to me that the author of that article was so far right, but should have gone farther; and that not only the quality called by him flavour is a quality perceived by the smell only, but that there is not even any such distinction at all, as he supposes, between taste and flavour; for that every thing which we call taste is in fact this internal smell; or else is merely a feel in the mouth; an operation of the sense of feeling; and that any peculiarity it may have is owing only to the peculiar kind or degree of sensibility, which the tongue,* and other adjacent parts have; in respect to the sense of feeling, compared to most other parts; just as the inside of the eyelid, a sore place, the sole of the foot, the inside of the stomach, the epiglottis and lungs, the naked nerve of a tooth, the sides, where tickling is administered, &c. have very peculiar degrees and kinds of sensibility in respect of feeling, compared to one another, or to other parts; so that one of those parts feels very acutely certain sensations which another of them, or which the ordinary skin of the body, scarce regards at all: So aching is very different from itching, and the sense of hunger in the stomach from that of cold in the fingers; and yet those different sensations are not therefore considered as being distinct senses; because the difference between them is far less, and of another kind, than that between one sense and another, as seeing and hearing, hearing and feeling, &c. I mean to say, that, on reading this article, I did not recollect, nor can I since find, any instance of the distinction set up by this reviewer: it struck me, that, having adopted his way of accounting for flavour, I had nothing left for what he would call taste; no instance of what is commonly called taste, but what would be destroyed by stopping the nose, and thus extinguishing the smell; or else would be properly referred to the sense of feeling only.

I then proceeded to try experiments. The unpleasant tastes of castor oil, and of magnesia, are the principal instances which the reviewer selects of what he would call real tastes, and not flavours; that is, he thinks, stopping the nose would not relieve the sense of them at all. This I can positively deny: I have taken castor oil, and, by persevering in keeping the

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* This peculiar feel of certain esculent substances, perceived in the tongue, is sometimes perceived by the teeth too, as the acid and astringent property of lemon or Seville orange juice; but nobody ever considered the teeth as organs of taste.

nose shut for an hour or more, been quite free from the very disgusting taste ordinarily experienced from it. And, as to magnesia, though part of the disagreeableness of it is the clammy feel, yet I have found, in this case also, that, with the nose stopped, that inconvenience was by no means great; owing to its not being then accompanied by the mawkish sickly taste which magnesia has, and which, immediately on removing the pressure on the nose, began to be perceived. I observed the same thing as to sugar, which is another instance given by the reviewer: he thinks you can taste it as well with the nose stopped. This is not the fact. All that remains, when you stop the nose, is the sort of languid feel, of dissolving as it were, which it produces in the mouth, and which has some resemblance to the feel which one has in the same parts when rapidly warmed after they have been exposed to hard frost, and also to the feeling of languor in the nerves which is connected with a liability to toothache, and often felt near the time of the actual pain.

I then considered, that, if my supposition was true, the reason why we do not taste when the nose is stopped, or the breath retained, must be, that in that state, though the faculty of smelling is not at all diminished by it, there is wanting a current of air, to carry the air which is the vehicle or seat of smell, from the mouth into the nose. For, though it is true, that where there is a large space of free air, a smell may diffuse itself, and even strongly, though there is no perceivable current or motion in the air; yet even there it would always strike the sense much more strongly if borne on a current of air, setting towards the organ of smelling; and, besides, in a large space of air, when undisturbed from without, there is probably more motion than there is in a small one when equally undisturbed from without. Then, if this supposition be true, it would follow, that we might expect to find that we should taste as little while the breath is drawing in through the nose, as while there is no breath at all, either drawing in or out, since no current, from the place when the substance to be tasted is, would then set towards the organ of smell; and even less if possible, since the current will rather set the contrary way; and accordingly I found that it was so. Put into the mouth, while the nose is stopped, a little lavender water, and move the tongue about to the palate, &c. as you do when tasting any thing; you will have no taste, though you will feel a heat on the tongue, such as you do in the stomach after swallowing spirits; but if asked whether it might not be brandy, gin, peppermint, noyau, that you had in your mouth, you could not tell. Now breathe out through the mouth as much as you can, still holding the nose, and at the moment when you have breathed out to the utmost, set the nose free; an inspiration will follow, which, if you pay attention, you may make to continue some time, during which, even though you keep smacking in your mouth as before, you will not taste the lavender water; but the instant the breath turns and begins to pass out, the taste will come upon you. My reason for stopping the nose in this case, before I begin, instead of afterwards, is, because you will the easier remark the moment at which the taste first comes upon you, if you have not tasted the thing at all before; for it will make greater impression. Besides, by this means you may, by shutting your eyes and letting another person put into your mouth a liquor or substance which you have tasted in your life before, but which they have now chosen without telling you what it is, be quite sure that you did not taste it before the breath began to rush outwards through the nose; since, as in this case, you will not have had the least knowlege beforehand what it is you have in your mouth, it will be impossible for you to imagine that you tasted it when in fact you did not; and it is the confusion arising from imagination, or association arising from previous knowledge, that we are most to guard against in this matter. But it should be something whose feel in the mouth is not decidedly different from that of all other things, else you will know it by that; an aqueous fluid is therefore convenient. I chose lavender water, because it happened to be at hand, but it is rather a good subject for the experiment, because it has a decided taste, and also a feel, which it has in common with many other liquors (spirits) from which it yet decidedly differs in taste. I tried it next with sal volatile; but it answers with every thing I have tried; and I also observed, that, in common eating, I do not taste any thing but while the breath is going out: and I suppose I should have observed that before now, if it was more easy and natural, than it is, to take notice spontaneously, without endeavouring at it, when the breath is coming in and when it is going out; but in fact we are seldom led to remark at what moment the change from inspiration to expiration, or *vice versa*, is taking place.

I next tried the experiment with zinc and silver on the tongue; the process usually referred to in lectures on galvanism. I considered, that if that sensation should prove to be, while the tongue is between the metals, what one would commonly call a taste, and not merely a feel, it would destroy my supposition; because it seems clear, that the tongue alone, and not the nose, could be the organ of this sensation which is produced by the galvanic action transmitted through it: unless, indeed, we could suppose some vapour to be generated: but that it would equally, or even more, destroy another supposition, which, I believe, is generally received among observing persons, upon the common notion of the taste, viz. that no taste can happen without touching the palate or roof of the mouth; since here the tongue is to be kept confined. I saw in "Conversations on Chemistry," and I suppose it is so in other similar books, that the sensation produced by this experiment is called "a taste accompanied with heat;" but I did not mind the name; because, as we are commonly told that our tongue is the peculiar seat of taste, any peculiar sensation, of which the tongue was the exclusive seat, might very naturally come to be called so; and I believe the peculiar sensation produced by these metals in this way, is a sensation exclusively confined to the tongue; in truth, it is not easy to find any other place where this galvanic experiment can be tried; since the metals must be applied on two sides, and near; unless we were to skin one of our fingers for the purpose; for the skin prevents the action; at least, I did not find it succeeded when tried on part of the moist inner surface of the lip doubled together, or on the two sides of the gums.

When tried on the tongue, with a half-crown piece and a plate of zinc, I think the sensation while the tongue is between the two metals, is not a taste, only a sort of feel. When I tried it with a silver spoon, (which I presume is purer silver than a crown piece) and zinc, a strong and nasty taste took place immediately on removing the metals, and leaving the tongue at liberty to touch the palate. But then there was a smell too, exactly like the taste; it was on the spoon, not on the zinc, I think. It was also like the smell of a spoon with which an egg has been eaten, and the spoon was tarnished as it is by that; whether owing to albumen in the saliva, or in the nerve, I do not know. This is so full a proof of my supposition, that I need not, but for curiosity, go further.

When I try it with a crown piece and zinc, the tingling in the tongue greatly abates, on removing the metals, and no taste, that I can perceive on smacking, succeeds.

What is called, a brassy taste, which is referred, I believe, to this same galvanic principle, is certainly connected with a strong smell. Brass, and even copper alone, at least copper money, we know has, when rubbed, a good deal of smell. I still, therefore, see no reason to doubt the truth of my opinion, that, when we have any thing in the mouth, every perception of it which we should ordinarily call tasting, and not feeling, is, in fact, a smell perceived in the nose only, and conveyed thither by the air when passing through the internal aperture.

In the case where the taste is perceived as soon as the breath turns to go out, I considered that what is breathed out had been in those experiments before breathed in, from or through the mouth; so that the air, which went out through the nose, had come, originally at least, from the forepart of the mouth, if it did not do so immediately. And, if it were not for this consideration, the fact would appear not to be agreeable to the theory which I am maintaining; since merely breathing out air through the mouth, or even through the nose, does not, in one operation, carry air from the fore-part of the mouth through the nose; and, therefore, if the substance tasted is, as I supposed it generally to be while it is chewing and moved about by the tongue, I say, if it is in that part of the mouth which is forwarder than the passage up into the nose, it would not, but for the consideration just mentioned, follow that the substance would be tasted while the breath was going out.

I therefore tried this experiment: I tried to place myself in such a condition, as that the air breathed out should not have been before breathed in; that is, I applied the substance to the tongue, during the course of a long expiration, as soon as possible after the beginning of the expiration, but so as to make quite sure that it was not before the beginning of it. There was no stopping of the nose in any part of this experiment. Now, according to what I have just said, the substance ought not in this case to be tasted at first, even though the breath be going out, but must wait till the second expiration, after an intermediate inspiration, except so far as smell may pass into the nose from without; but even that would not be during the first inspiration, but during the inspiration following, and must, as appears from the former experiments, take place only in a very trifling degree. I now tried it with lavender water; a substance in one respect inconvenient, because it diffuses its smell so much, that it is likely that some should be drawn in by the nose from without during the breathing in, and thus make the trial not quite fair as to what is to happen during the second expiration. But it is easy to prevent this sufficiently, by spreading the hand between the nose and the mouth. I found, that if I smacked it about in the mouth, as you do when you wish to perceive the taste of a thing fully, I tasted it even during the first expiration; and I conclude, that, during that process, at least with a thin fluid like this, some of it is passed down the mouth, farther back than the passage to the nose.

When I did it without smacking, only laying it on the tongue, and keeping the mouth wide open, it did not taste during the first expiration, but only felt warm; in the inspiration, a very little scent indeed passed in from without, next to none, but I had no taste in the mouth even then, only a feel of warmth still; and then, when the breath went outwards the second time, I had the ordinary perception which we call taste. I tried it also with ginger, which does not diffuse its smell so much, and the result was just the same; no taste perceived, but only the hot feel to the tongue, till the second breathing out. If it is tried with a solid thing, which you chew, it is rather difficult to avoid checking the breath, and turning the current, while you chew: however, I found the same result in this case too.

Some people may object, that the most striking smells, at least of pleasant ones, viz. the smells of flowers, have little or no corresponding taste belonging to them. And, *vice versa*, that some excellent tastes are not accompanied by smells. In the latter case, I believe it will not be found that they are even powerful tastes, though they may be exquisite ones.

We must remember, that when we taste a thing in the mouth we warm it, and also melt or dissolve it, if it was solid before, both which processes are known to be, in general, means of drawing out the scent of bodies. It is not, therefore, inconsistent with my supposition, that salt of lemon, for instance, should be tasted when in the mouth, and yet have no smell when dry in the bottle. It is not the same thing which we compare in the two instances; but dry salt in the one, and a warm solution of it in the other. We also, in eating and chewing, triturate, as it is called, that is, reduce to small particles, and also bruise and rub, I mean against the palate, the substance eaten; and that process, we know, is a great elicitor of some sorts of smells, as we find when we bruise rosemary leaves, and such like, in the hands, in order to smell them better; and, indeed, sometimes a leaf will have a strong smell belonging to it, and yet it will not be at all perceived by smelling the leaf, but only by rubbing it in the fingers. Some smells, on the contrary, are not brought out by rubbing, as the fragrant smell of a rose-flower, but rather are destroyed by it, because it brings out other smells which stifle the fragrant one; and so it seems to be no refutation of the opinion which I am proposing, but merely what might be expected, that if we were to chew a rose-petal, we should not perceive, by the taste, so much of the sweet smell as we had perceived, by the smell, before we put it into the mouth.

Further, 1. We must recollect how large a surface it is that the smell, when powerful, comes from, in many cases, compared to the small portion which we can chew at once:— a whole nosegay of violets; a grove of oranges; a bed of camomile, &c. 2. In some flowers, the scent appears to come from one part only, while in others this circumstance cannot be perceived; in a honeysuckle, we can squeeze out a sort of honey, which tastes of the smell of the flower, as I may say. This makes it likely that it is so, in fact, in the case of all flowers, and such like things, though we cannot ascertain it in all; and if so, the chewing the whole, including the inodorous part, will be likely to confound the smell. 3. I am inclined to think, that as some smells, as I have already mentioned, are more given out by means of heat, others, on the contrary, are less so, and that this is the case with flowers: in different sorts of wine, I think we find it to be the case. 4. In the case of those flower-smells, which are powerful "in the air, where they come and go," as Bacon expresses it, we must recollect that there is a cloud of fragrance, as one may say, hovering and collected near them, which, therefore, must greatly exceed what could be at any one time elicited directly from the flowers; it is on that account partly, that we smell them more at sunset, because the air then becomes still, and the scent "lies," as they say in hunting, that is, it is not blown away. And in the case of such flowers, as "the steam of rich distilled perfume" is more delightful, in degree, than the smell of the flowers when near us, as Bacon remarks, and even a little different from it in the quality of the scent, it is no wonder it should be more delightful than their taste, and different from it. In the same manner, we find, that we cannot completely judge of the smell of a dead rose-petal, by the strong smell issuing from a drawerful of them when opened. 5. Another important difference is, that if you smell with the nose, the whole quantity of odour, contained in that draught of air, strikes straight upon the organ of sense; but if you had taken that quantity into the mouth, it could not (as already observed) have reached the organ of smell, till it had first been drawn into the lungs, and so mixed with a much larger body of air, which it would there have met with; so that, when the same quantity of air was again returned outwards, through the nose, it would bear with it a much less proportion of odour. Unless, indeed, in some few cases, after many breathings, the whole air in the lungs might become impregnated with the odour to the same degree, *i. e.* in the same proportion to the volume, as the air inhaled had been impregnated with it; as I find, in inhaling with the mouth from the mouth of a lavender water-bottle, and immediately stopping my mouth and breathing through the nose, that I have much less sense of the smell, than when I inhale through the nose: but yet, when I have drawn the scented air in through the mouth, and breathed it out through the nose with stopped mouth, I say, when I have done this successively several times, I find the sense of smell, which is perceived in the breathing out, get much stronger. 6. We acquire a faculty, when we want to perceive an external smell strongly, of drawing in breath quick through the nose some times, sniffing, as it is called, which presents more of the air, and olfactory particles, in a given time, to the organ, than would otherwise reach it. Nothing of this kind is ever done with regard to the internal smell or taste; I do not know whether we could have acquired the power in the latter case, as well as in the former, but, in fact, we have not. It would have to be exerted in the contrary direction, as appears from what I have said already; and would, even it were performed, produce less effect, from what I have just observed in (5.)

7. Lastly, we must bear in mind the effect of association. We are used to receive some sorts of smells more from without, and others more from within, *i. e.* by what we call taste; and in liking, or disliking, each or both, we are guided in part by the system of associations, belonging to that way of perceiving, through which we are at the time perceiving the sensation in question. We exercise the internal smell, or the taste, principally while we are feeding on what is our needful food; always (except in the case of physic, or of betel and tobacco) in the feeding on what is not absolutely hostile or repulsive to our digestive organs. Our scale of likings and dislikings, then, as to their sense or mode of perception, is tinged throughout with this sort of association, derived from what is agreeable to the digestive organs. It is tinged with another, perhaps even more important, viz. touch, the feel to the mouth; neither of which have any thing to do with perfumes; on the contrary, the sense of external smell, applied

to such things as we do not eat, is associated with the idea of the complete absence of all these circumstances; and where pleasant, its pleasure is increased, where painful, its pain is materially diminished, by this very absence, by its independent and semi-incorporeal nature, as I may say. Now, it happens very often indeed, that when, from association, the pleasure or pain, which we derive from a particular perception, is materially altered, we no longer recognize the perception as being the same in itself: so that a smell, which as perfume stood high in our preference, may, when taken in as a taste, be thought less agreeable, and thus not readily recognized to be the same perception, and *vice versa.*

Contrary associations produce more diversities in smells than in any thing, I believe. I have known a person, who was passing one of those scavenger's heaps, which lie near some of the roads in the outskirts of London, but who had not directed his eyes that way, remark, that there was a great smell of musk. In this case, of course, whether such person was pleased or not with the smell, would depend entirely on whether he was undeceived or not as to what was the real cause of it. I had never before the least idea that the smell of musk was identical with the smell in question, which to me, who perceived whence it came, was quite offensive. That which had hindered me from before remarking that they were alike, must principally have been, that I always had been used to find the one pleasant, and the other disagreeable.

ART. XI.—*Account of Dr Clark and Captain Sherwill's Ascent of Mont Blanc, in August* 1825.

SOME time ago, Dr Edmund Clark had formed a plan of ascending Mont Blanc; but, as he had no other motive for this journey but that of curiosity, he resolved to wait for the most favourable weather, and to rely on the judgment of the most experienced persons at Chamouni.

Dr Clark had sought in vain at Geneva for a companion; but, on the day preceding that fixed for the ascent, Captain

Markham Sherwill of Fontainbleau proposed to accompany him in the expedition.

On Monday the 25th of August, about 7 o'clock in the morning, our travellers set out from Chamouni, accompanied by seven guides, viz. Joseph Maria Coutet, who had already been *three* times at the summit of Mont Blanc; Simeon Devuasson, Pierre Tairraz junior, both of whom had once been on the summit, and Julian Devuasson; Pierre Joseph Simond; Simeon Tournier, the youngest of the guides, was twenty-six years old, and the oldest thirty-eight.

Having arrived at Pierre Pointue, they quitted their mules, and as soon as they reached the moraine of the glacier, they spent a short time in breakfasting. Before they set out, Dr Clark counted the pulses of several of the guides, and he found that their acceleration varied from four to thirty pulsations in a minute. This acceleration did not appear to have any proportion, either direct or inverse, to the muscular strength of the individuals.

When they had reached the Grand Plateau, the rays of the sun were so scorching, that Dr Clark was obliged to take off his spencer. He experienced in his face the most painful smarting. He was very thirsty, and he frequently refreshed himself by eating snow and some grains of raisins. His respiration was not changed, but it was loaded. Captain Sherwill experienced much nausea and oppression. Having sat down on the ice to take some refreshment, they eat very little. Simeon complained of a pain in his head. When they reached the Petits Mulets, the wind became strong and very cold; at last, at five minutes past three o'clock, they reached the summit of Mont Blanc.

The barometer was at 15 inches 9 lines, and $\frac{6}{10}$ths. At St Bernard, at the same time, it stood at 21 inches, 1 line, $\frac{7}{10}$ths; and at Geneva, at 27 inches, 0 lines, and $\frac{13}{16}$ths. The thermometer exposed to the sun stood at half a degree below zero, whereas, at Chamouni, in the shade, it reached 14°. At two o'clock in the afternoon, the thermometer rose at St Bernard to 10° below zero, and, in the Botanic Garden at Geneva, to 19°.

Dr Clark experienced a difficulty of breathing, even when he ceased to move. He experienced in his breast a sensation similar to that which precedes *emophtisie*, a disease to which he had been subject in his youth. He did not spit blood, however, on the summit of Mont Blanc. One of the guides having accidentally received a stroke in the nose, lost a little blood, which appeared of a much blacker colour than usual. Dr Clark, as well as Captain Sherwill, had a severe headache, and their faces were pale and contracted. The Captain described a singular sensation which he experienced near the summit. He felt as if his body possessed an extraordinary degree of elasticity and lightness, and as if his feet scarcely touched the ground. The guides were in general very much fatigued, and complained of headaches. Our travellers returned to the Grands Mulets, where they slept, and next morning they returned in safety to the valley.—*Bibl. Univers. November* 1825, p. 245.

Art. XII.—*Farther Observations on the History of Mr Babbage's Experiments on the Production of Magnetism by Rotation.*

In the last number of this Journal we laid before our readers a popular summary of the remarkable discoveries which have been recently made in this country and in France, on the production of magnetism by rotation. One of the objects of this paper was to assign to each philosopher concerned, the share which he had in these discoveries, and we had the good fortune to receive from a distinguished correspondent an interesting communication on that subject, which formed the ground-work of our popular summary. We regret, however, to find that our information was not so minute as could have been wished, and that the opinions and experiments of Mr Babbage were not so amply detailed as their importance demands. We hasten, therefore, to supply this defect, which neither we nor our correspondent had before the means of avoiding.

About the month of November 1824, Mr Barlow's experiment, in which he produced a deviation of the magnetic needle by the influence of iron balls in rotation, became the subject of conversation at the Royal Society. Upon hearing this result, Mr Babbage, on the authority of magnetical experiments of a totally different kind, stated that he should have expected it, and that the effect depended essentially on the *time* that iron and steel took to receive and give up magnetism. This opinion was not received at the time as possessing much plausibility, but, on the following day, Mr Herschel and himself tried Mr Barlow's experiment with the wheel of one of Mr Babbage's turning lathes, and they found the deviations to accord with Mr Babbage's expectations, and his explanation to be satisfactory. It is of course manifest, that any mass of iron becoming magnetic by induction, will, if moved rapidly round, not immediately lose its axis of polarisation, but this axis will continue to exist with diminished force for a short time, and thus, during rotation, the virtual axis of magnetism will be deviated a little from its direction while at rest.

At this stage of the inquiry, a report reached London in the spring of 1825, that M. Arago had produced rotation in a needle by making a plate of copper revolve under it, and that other metals, and even glass, wood, and other substances, produced the same effect. It was also reported, that when the plates were cut by slits from the centre, no effects were produced.* It immediately occurred to Mr Babbage, that these effects depended on the influence of time, but the statement respecting the effect of cutting seemed to present great difficulties. His explanation, however, was, that the substances tried by Arago were all slightly susceptible of magnetism (as Coulomb had proved of the metals before,) that they acquired magnetism more rapidly than they parted with it when once acquired, and, consequently, that if a plate revolve under a needle, the difference of the attractions on the two sides will cause the needle to advance in the direction of the plate.

At this time Mr Herschel proposed to Mr Babbage to enter upon a course of experiments on this subject; and the results which they obtained have been published in the *Philosophical Transactions.*

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* The latter part of this report was not quite correct.

Even at this period it was stated by Mr Babbage, that in all probability similar results might be produced by electricity, if an insulated and electrified metallic needle were suspended over a revolving plate of any substance. This experiment he did not then make; but at the commencement of January 1826, while discussing the subject with some friends, he restated his belief, that electricity must produce the same effect; and finding that they were not so much convinced of this as he himself was, he went home to make the experiment. The apparatus which he intended to use, was a piece of sheet brass of the form ○——○ suspended by silver wire from glass, and electrified by contact with excited sealing-wax, and placed above a disc of glass or metal. When glass was used, Mr Babbage mentioned his expectation, that a very slow revolution of the glass would produce one in the electric needle; while, in the case of the metal, he thought that it might require great velocity, or, perhaps, more than he could give it, and that this would vary, partly according to their relative powers of conducting electricity.

He performed these experiments, and obtained the results which he had predicted. When the glass disc was very slowly turned by the hand, it caused an immediate and very decisive revolution in the electrified needle, while copper discs required a much greater velocity. These experiments were repeated at various times in the presence of several scientific friends, who were satisfied as to the truth of the fact, as well as of its explanation. Mr Babbage has now put up an apparatus for more careful experiments, and in order to measure the different conducting powers of various substances. The results of these experiments will soon be communicated to the Royal Society. He suspects that some of the effects ascribed to the magnetism of non-metallic substances may have been produced by electricity; but he is not yet able to speak with certainty on this point.

From the preceding historical sketch of Mr Babbage's labours, we think it cannot be doubted, that he has the sole and undoubted merit of having been the first to give that explanation of the recent experiments of Messrs Barlow, Christie, and Arago, which is founded on the consideration of the time that bodies take to receive or part with magnetism, or any other similar quality.

ART. XIII.—*Description of the Great Stone Bridge of Seventeen Arches erected over the Garonne at Bourdeaux.* In a Letter to the EDITOR, from a Correspondent.

MY DEAR SIR,

I avail myself of an opportunity of sending you a short account of the erection of the bridge now nearly completed here. I had the pleasure of going over the whole of the works yesterday with MM. Des Champs, and Billaudel, the engineers in charge of the undertaking. It is truly magnificent and displays the resources of able men employed in overcoming what had so long been deemed insurmountable difficulties. The interior of the bridge, *i. e.*, the space between the road-way of the inner surface of the arches, is all open work, and is capable of lodging several regiments of soldiers. This mode of finishing the work cannot have diminished the expence, but it certainly, in a great degree, lessens the load on the piers, which were originally intended for carrying a light bridge of iron. M. Des Champs is preparing a work, containing the history and particulars of the erection. The plates (which are ready) are so numerous and detailed, that they will form a very useful work for all engineers in similar situations.

So early as 1772, M. Le Trudaine conceived the project of uniting Bourdeaux and Libourne by two bridges, and by a new road, which should establish a direct communication between the capital of the kingdom and the capital of Guienne. This scheme was submitted to the inspector-general of roads and bridges; but M. De Voglie, after examining the locality, returned with the persuasion, that there were insurmountable obstacles to the foundation of a stone-bridge over the Garonne. This scheme, however, was brought forward in 1808, but Napoleon thought that a bridge of wood was all that was necessary for the passage of his soldiers. This bridge was begun in 1810. Its length was to have been 530 metres, or 1640 English feet, and its expence was estimated at 5,000,000 of francs.

In the year 1811, upon the report of M. Des Champs, M. Mole, director-general of roads and bridges, adopted the proposal of modifying the original plan, and of substituting in place of it nineteen centres, or arches of carpentry, supported by twenty stone piers; the first pier was founded during the campaign of 1811, and in 1812, the foundation stone of the second pier was laid.

The scourges of war, however, pressed heavily upon France, the public treasury was exhausted, and all public works were permitted to languish. Upon the return of Louis XVIII. in 1814, only six piers had been undertaken towards the banks of the river; three of these scarcely reached the height of low water, and the other three were imperfectly founded. His majesty immediately ordered this enterprise to be continued, and from that moment it advanced with a steady pace.

In consequence of the difficulty of procuring all the wood necessary for the original execution of this plan of 1811, and for the periodical renovation of the wooden centres, it was decreed in 1815, that the arches should be constructed of iron; but this plan was afterwards abandoned, and on the 17th March 1819, it was determined upon by M. Becquey, director-general of roads and bridges, that the whole bridge should be built of masonry; that it should consist of hewn stone and bricks; and that every pier, previous to the commencement of the arches, should be loaded with 4,000,000 of kilogrammes, or about 4000 tons.

These changes did not occasion any delay in the works; a loan of 2,000,000 of francs was sanctioned by the law of the 10th April 1818, and a joint stock company was organized for completing it. This was the first project submitted to the chambers for a monument of public utility, and it produced a favourable influence on the developement of the spirit of association in every part of France.

The bridge of Bourdeaux consists of *seventeen* arches of masonry, of hewn stone and bricks, resting on sixteen stone-piers, and two stone abutments. The *seven* arches in the middle are of equal dimensions, and are eighty-seven feet in diameter. The opening of the first and the last arches is sixty-eight feet, and the rest are of intermediate dimensions. The vaults have the form of arcs of a circle, whose rise or height is equal to a third part of their cord. The thickness of the pier is thirteen feet nine inches. The tympanum or interval between two arches is adorned with the royal cipher, encircled with a crown of oak, and engraven on a ground of bricks. Above the arches is a fine bold cornice, and two pavilions, adorned with porticoes and columns of the Doric order, are built at each extremity of the bridge.

The parapet is five feet; the width of each footpath eight feet two inches; the width of the road thirty-two feet four inches, and the whole width of the bridge forty-eight feet eight inches. A slight declivity, commencing at the fifth arch on each side, and descending towards the banks, facilitates the union of the road-way with quays, and allows the rain-water to flow off. The injury, however, produced by rains, will be more certainly prevented by an ingenious arrangement, of which no other building presents an example. The imposing mass of contiguous vaults, already mentioned, and in appearance so heavy, is bound together interiorly by a multitude of galleries, similar to the apartments of cloisters, which communicate with each other, from one end of the bridge to the other. By means of these vaults, the engineer can, at any time, examine the condition of the arches below the road-way, and it will be easy to keep them up and repair them without interrupting the passage of carriages. There exists even under each foot-path of the road-way a continuous gallery, in the form of an aqueduct, by which the springs from the hills, on the right bank of the Garonne, may be conveyed and distributed through the city.

In order to give an idea of the extent of this bridge, the following table has been drawn up, showing its magnitude in comparison with some of the principal bridges in Europe. *

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* Full drawings and descriptions of the bridges of Tours, La Guillotiere, and Dresden, will be found in Mr Telford's article on Bridge in the *Edinburgh Encyclopædia*.

Names of Bridges.	Length between Abutments	Width between Parapets.		No. of Arches.	Diameter of Arches.		Thickness of Piers.	
	Eng. Feet.	*Feet*	*In.*		*Feet*	*In.*	*Feet*	*In.*
Bourdeaux over Garonne,	1597	48	8	17	86	11	13	9
Waterloo over Thames,	1237	42	0	9	118	0	20	0
Tours over the Loire,	1424	47	10	15	80	0	16	0
Guillotiere over Rhone,	1870	24	11	18	very unequal.		unequal.	
Dresden over the Elbe,	1447	34	3	18	54	9	32	10

Great as this bridge is in point of magnitude, yet it is neither by the number nor by the size of its arches that it recommends itself to the notice of the professional engineer.

The depth of the river, the rapidity of its currents, and particularly the instability of its bed, were the real difficulties which called forth the talents of the engineer; and in these respects, the bridge of Bourdeaux will not suffer by a comparison with any other work of the same kind.

The Garonne has a depth of twenty, twenty-five, and in some places of about thirty-five feet, and twice every day the flux and reflux of the sea raise its waters sixteen and even twenty feet high; and its currents, in both directions, have often a velocity of more than ten feet in a second. This river flows over a sandy and muddy bottom, which is easily displaced, and which collects in banks in different parts of its course.

In order to found such a building upon a soil of such consistency, 250 piles of fir-wood were driven in as the foundation of each pier. After they had penetrated the ground from twenty-six to thirty-three feet, they were all cut over on a level, about thirteen feet below the low water of the river. A large boat, or floating caisson, with a flat bottom, and of a pyramidal form, received the first row of stones of the pier; and when this was, as it were, thrown down in its place, the workmen descended in diving-bells, and made the caisson rest on the piles destined to bear it. A general pavement, consisting of loose stones, covered the bed of the river in the direction of the arches. These stones enveloped and agglutinated by the mud which collects between them, form a bed impenetrable to the corrosive action of the waters, and insure the permanence of the bridge.

BOURDEAUX, 14*th December* 1825.

ART. XIV.—*Account of the Shock of an Earthquake felt at Sea by the Honourable East India Company's Ship Winchelsea.* In a Letter to the EDITOR, from Capt. LACHLAN, 17th Regiment.

MY DEAR SIR,

Having observed in the last *Edinburgh Journal of Science*, an article containing some short notices of earthquakes at sea, and among them a slight reference to one experienced on board the Honourable East India Company's ship Winchelsea, in 1823, I have thought that some further particulars regarding the latter instance from one who was a passenger in that ship, would not be unacceptable to you; and I, at the same time, take the opportunity of directing your attention to two errors which have crept into the short notice alluded to, viz. that the earthquake took place on the 9th instead of the 10th February as there given, though from its having occurred, *post meridiem*, it would, *nautically* speaking, be reckoned the 10th; and that, instead of being in Lat. 52° N., we were little more than 1° N. of the line.

At ten minutes past one, P. M., all on board* were thrown into considerable alarm and agitation by an earthquake, the shock of which lasted for more than a minute. I happened, with several other officers, to be upon the poop at the time, and was, I believe, one of the first to observe—and not without alarm—a strong tremulous or quivering motion, shaking the whole frame of the ship, for which, being unable to account, I naturally referred to others, but they seemed as much at a loss as myself; some only thinking it might be

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* The fine old ship, Winchelsea, Captain W. Adamson, 1330 tons burthen, brought home the 17th regiment of foot, besides two detachments of king's and company's soldiers, and had on board at the time about 550 souls.

owing to the rolling of a large butt upon the gun-deck; while to others it seemed as if caused by the veering out of cable; while others again, more seriously alarmed, said they feared we touched the ground. On the last idea being mentioned, I naturally ran to the ship's side; but observing no alteration in the appearance of the water, I was then, for the first time, persuaded that it was an earthquake; and by this time the motion had ceased. I then went below to the captain's cabin, and begged to be allowed to look at the barometer, but there appeared to have been no particular alteration in the mercury at the time. There had, however, I learned, been a previous unusual rise and subsequent fall of about $\frac{1}{10}$th of an inch; and it may be added, that, since noon of yesterday, there had been a fall of about $\frac{4}{10}$ths altogether, the height then being 30.5 inches, whereas that noted to-day was only 30.1. In the thermometer there had been no particular change, ranging about 83° as usual, but the air felt very sultry. On adverting to the idea that we had touched upon a bank, Captain Adamson said that this was out of the question; and that, if such had been the case, he must have seen it, as he had been looking down attentively at the sea from the stern windows nearly the whole time. And, no doubt, considering the clearness of the water, that would have been the case.

The shock seemed to me to come *aft*; and such also was the feeling of many of the men who were below in the orlop-deck, where the motion appeared to have been felt more severely, some of the soldiers having been seized with a momentary sickness during its continuance.

So unusual a phenomenon, of course, furnished abundant conversation during the rest of the day, not a little increased by one or two of our companions stoutly maintaining that the motion was caused by our scraping either a sand or coral bank.

According to Captain Adamson's observations and charts, we were in latitude 1° 21′ north, and longitude 85° 35′ east, at the time of the shock, from which point the nearest part of the coast of Ceylon bore N. W. 6° 15′, or 375 miles, and Acheen Head E. N. E., distant 10½ degrees, or 630 miles, but Pulo Nias Island lay somewhat nearer due east.

It will be extremely interesting hereafter to know what other vessels have felt the same shock, and whether it has been experienced any where on land. Independent of earthquakes not being common in Ceylon, I am inclined to think, from the direction which the motion *seemed* to take, combined with the frequent occurrence of such convulsions among the eastern islands, that we shall hereafter hear of something remarkable having happened in Sumatra, or somewhere in that direction.

To the above, I may add the following general note respecting the day:

Sunday, 9th.—Light changeable airs, but chiefly from the southward during the day, and nearly calm at night, with the ship rolling a good deal. Course various, owing to the head wind obliging us to tack.—Meridian latitude 1° 25′ north, longitude 85° 35′ east.

And it may perhaps be as well to state also, that the after part of the 8th was so cloudy and threatening, as to induce us to take in studding-sails and reef top-sails, and that it was probably about this time that the barometer fell from 30.5 to 30.1. Before this the wind had been generally from the north-eastward; but it then shifted round to the southward, and continued fluctuating for three or four days between S.W. and S.E., with sultry weather, and thermometer from 83° to 85° at noon; but the barometer regained a steady average altitude of 30.5 on the 11th.

The above are all the particulars which I am now enabled to give you respecting the earthquake felt on board the Winchelsea; but, as you appear desirous of accumulating further notices respecting similar phenomena, perhaps the annexed accounts of two other earthquakes at sea, strongly corroborative of *our* feelings, and showing that the puzzling nature of the sensations thereby produced have not been confined to us alone, will not be uninteresting or unacceptable to you. To me they proved highly interesting, from happening to be met with while at sea, a very short time after our alarming visitation.

I may add, in conclusion, that though I watched the public prints pretty closely, for some time after our return to

England, in hopes of noticing some accounts of corresponding convulsions in the eastern seas or islands, I was never so fortunate as to meet with any. One is, therefore, inclined to suppose, that the shocks witnessed by us must have either been altogether submarine, and of confined extent, or of so very slight a nature when felt on shore, as not to have attracted any attention. I remain, My Dear Sir,

Yours very truly,

R. LACHLAN.

EDINBURGH CASTLE, 13*th Feb.* 1826.

ART. XV.—*Notice of Two Earthquakes felt at Sea.*

IN addition to the preceding interesting account of the shock experienced by the Winchelsea East Indiaman, Captain Lachlan has favoured us with the following notices of similar phenomena. *

1. When off Lisbon (about 1770) we had a foul wind, blowing hard all night and the next forenoon, when it suddenly dropped to a calm, leaving a heavy cross popling swell.

The people were all at dinner, when a general alarm spread quickly throughout the ship, above and below, occasioned by a violent tremulous motion of the ship, as if like to shake it to pieces. The guns and carriages actually rattled on the decks; and in our more deliberate thoughts afterwards, we could compare the agitation of the ship to nothing but that of a vessel driven violently by a very strong current or tide over a hard gravelly bottom, which she raked all the way.

The consternation in every countenance was stronger than language can describe; for no one could divine the cause, though all expected immediate destruction. A rumbling noise accompanied the agitation, arising gradually but speedily from the bottom upwards. It lasted between two and three minutes, subsided and left us as if nothing had happened.

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* Extracted from Hariott's *Struggles through Life.*

The first thing ordered was to sound the well—all was right there. The next was to try for soundings, but none were found with more than two hundred fathoms of line. During this the gunner was called on the quarter-deck, and examined as to the powder-magazine, and when any one was last there. He declared that no person whatever had been there that day. The first lieutenant was ordered to go down with the gunner and examine the magazine, and all below, and I was ordered to attend them. We found every thing as it should be.

In the course of this search, the gunner, who was an old man, swore that he knew what it was, and affirmed it to be an earthquake. This account, added to his being an Irishman, made us both heartily laugh, although our errand was not of a very laughable nature.

In making his report to the captain, the lieutenant told him what the gunner said of its being an earthquake, which created another laugh on deck. However, the old gunner was called aft, and directed to explain himself. He said he was on board a merchant-ship lying at anchor in the port at the time of the great earthquake at Lisbon in 1755, and from the effect it had on the vessel, he concluded this to have proceeded from a similar cause. There was no denying the justness of this remark. Yet not an officer on board could be persuaded it was possible, and, from arguing upon it, we deemed it impossible, from the immense body and weight of water, more than two hundred fathoms deep, that any thing afloat on the surface could be so violently and strangely affected by the concussion of the earth beneath.

2. On the 6th of January, the ship Dispatch * experienced the following effects, evidently resulting from an earthquake, and the account is copied from Captain Brown's Journal.

At five, A. M., having a moderate steady breeze at E. S. E. and cloudy weather, steering at N. N. E., at the rate of five miles and a half per hour, a long swell from the S. E., felt a motion, as if the ship was running over the ground, or some other solid substance; and, at the time, for the space of

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* Extracted from one of the *Asiatic Annual Registers.*

from five to seven minutes, heard a confused grinding, tremulous noise, affecting the ship in every part. It crazed, and the ship was instantly hoved too, and we sounded with ninety fathoms of line up and down, but no ground. By this time it was perfectly day-light, the sea not in the least confused, nor could we perceive the smallest appearance of any thing which had occasioned it. The ship was not felt to strike once. She kept perfectly upright, held her way through the water, and answered her helm; nor does she make any water in consequence of the shock received. These circumstances make us at a loss to account for it in any other manner than attribute it to some violent convulsion of nature. Draught of water forward eight feet, and aft ten feet six inches. Lat. 7°, 58′ S. Long., reduced from an observation of the sun and moon on the 1st instant, 87°, 39 E.

ART. XVI.—*Abstract of a Memoir on the Birds in the Environs of Geneva*, by L. A. NECKER. With Observations, by a Correspondent. *

THIS interesting memoir was drawn up with the view of forming an Ornithological Calendar, to show the different periods of the year when the migratory birds of the canton of Geneva appeared and disappeared. The facts related are, M. Necker states, the result of his own continued observation for upwards of twenty years; and to these have been added, others communicated by scientific friends, and information derived from sportsmen, and from fowlers by profession. This curious subject, though illustrated in a great measure by the incidental notices of travellers, and the relations contained in the works of ornithological writers, wants the continued observations of scientific men fully to explain the economy of nature in this wonderful particular. From swallows being sometimes found torpid after the usual period of their migration, it was believed by many naturalists, that, in

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* See *Mémoires de la Société de Physique et d'Hist. Nat. de Geneve*, Tom. ii. p. 29.

place of winging their flight to more genial climates, they remained torpid in holes, or sunk in clusters to the bottom of lakes—that instances had occurred, where birds thus situated, were revived from their torpid sleep by the application of gentle heat—and the improbability of the continued flight of birds over such an amazing extent of space, was held as giving weight to the theory which asserted their hyemal torpidity. Other naturalists, from the periodical disappearance of many of the feathered tribes,—the fact of their being frequently met with in flocks in a half-exhausted state at sea—and even observed at times corresponding with their disappearance in Europe on the continent of Africa—with more justice concluded, that our annual visitors, led by unerring instinct, come thither for the great purpose of propagating their species in safety, and return, undirected by compass, across the ocean, by the same instinctive impulse, to more genial climes, when the approach of winter threatens to deprive them of their usual food.

' What M. Necker has done in regard to the birds which frequent the neighbourhood of Geneva, has been ably performed by Mr William Markwick for those which visit England. In a paper read before the Linnean Society of London on the 3d of February 1789, and which was published in the first volume of their *Transactions*, Mr Markwick has given the results of his personal observation on the appearance and disappearance of birds for a period of sixteen years, viz. from 1768 to 1783, and has embodied these results in a tabular form, somewhat similar to the Ornithological Calendar of M. Necker. Mr Markwick was induced to make his observations public, from the idea that many authors who have written on the subject, did so, not from their own observation, but from the vague accounts, and imperfect observation of others. Catfield, the place where these observations were made, is situated near Battle, in Sussex, about five miles from the sea, in a country finely diversified with hill and dale; and though there is no large river near it, yet there is much oozy, springy ground, and many woods in the neighbourhood. Were similar observations made in the different countries of Europe, the islands of the Mediterranean, and on the nearest points of the African shores, for simultaneous years, the periodical migrations of birds would be satisfactorily ascertained; many curious facts would be elicited regarding the temperature of different regions, with which these migrations are in some measure connected; and not only would the route of the birds which come from the Arctic ocean, in the end of autumn, and beginning of winter, to seek shelter in our comparatively temperate climate, be easily traced, but the flight of those which visit us in spring and autumn for the purpose of incubation, would be with certainty known.

There are few places, M. Necker observes, more favourable to the study of ornithology than Geneva. Besides the great variety of species, proper to the climate, which are found in the plains and valleys, the Lake of Geneva is frequented by a multitude of aquatic birds—its borders by others—and the neighbouring mountains, rising to the height of 2000 toises, give a series of climates, similar to what is found on the globe between 46° N. Lat. and the pole. Thus, in the space of a few leagues round Geneva, are found most of the species which are dispersed at immense distances from each other through the rest of Europe.

Among the birds found near Geneva, some are stationary; others migrate in autumn to more southerly climates, and return in the spring for the purpose of incubation; and there are others, again, which arrive from the Arctic sea in autumn, and remain till the following spring calls them to their destined habitation in the north. Besides these different species, which may be said to be indigenous to Switzerland, M. Necker remarks, that there are found, as by chance, some individuals of species which inhabit countries very different, and led thither by causes which are but imperfectly known. They arrive isolated, meagre, and starving; and their appearance forms one of the most curious facts in natural history.

The memoir of M. Necker is divided into five sections, the first of which treats of the stationary birds of the low grounds in the neighbourhood, such as the sparrow,—the yellow hammer,—linnets,—the blackbird, &c. These are joined about the end of February, or the beginning of March, by flocks of woodcocks, (*Scolopax rusticola*,) which arrive in the forests at the foot of the mountains, probably from Italy, Spain, or the south of France. They stop here but till the snows on the higher grounds are dissipated, and quit the low grounds in April to build their nests in colder and more elevated regions. During the night they feed in the open and humid meadows, and return by the dawn of day to the protection of the woods. The fowlers, aware of this, intercept them in the evening and morning twilight, and kill them in numbers. Wild pigeons also arrive at the same period, on their flight to the north, or to the mountains.

Towards the middle of March, flocks of starlings and larks come from the south; and some days after, about the 25th of March, the house-swallow (*Hirundo rustica*) appears, at first in small numbers, but afterwards in large troops, which spread themselves over the neighbouring country. Many remain, while others continue their flight towards the north. The arrival of this bird is hailed with joy by the husbandman, as announcing the commencement of the most interesting of the seasons, and the return of heat. It sometimes happens, however, that, after the arrival of these swallows, unexpected cold kills the insects on which they feed, and then, as witnessed in 1812, these unfortunate birds assembled in numbers upon the shores of the lake, the Arve, and the Rhone, in the hope of discovering food. Many fell into the water, or, placed on the shore, allowed themselves to be taken by the hand; others flew about the houses seeking insects on the walls; and many were found dead from hunger in the streets and highways. It may be noticed here, that this remark of M. Necker, regarding swallows falling into the water, when exhausted, and in search of food, goes far to explain the circumstance, so often related, of their being found in winter at the bottom of lakes and ditches. It is very probable, that those individuals which have not taken flight with the main body in their annual migration, deprived of their usual supply by premature cold, may have been seeking their food on the surface of the water, and have dropped exhausted into the lakes, or sheltered themselves in crevices of walls from which they were to depart no more.

The house-swallow (*H. urbica*) arrives about fifteen days after the first; and the beginning of April is marked by the arrival of the linnet. The cuckoo *(Cuculus canorus)* appears about the tenth; and towards the middle of this month a new detachment of birds arrives, which have passed the winter in countries more southerly—the shrike—the hoopoe, and the wryneck. About the 20th of April, the melodious song of the nightingale *(Motacilla Luscinia)* is heard; and, about the same time, a few nocturnal birds make their appearance, among which, besides some species of owls, the goatsucker *(Caprimulgus Europæus)* is found. The quail *(Tetrao coturnix)* and the rail *(Rallus crex)* arrive from Africa about the end of April, and beginning of May. The kite *(Falco Milvus)*—the fly-catcher, and the golden oriole *(Oriolus galbula)* finish the catalogue of birds which spend the spring and summer in the plains around Geneva.

M. Necker goes on, in this manner, to note the arrival and departure after incubation of all the birds which are found in the low grounds, mixed with notices of their habits, descriptions of the rarer species, and accounts of the methods pursued by the fowlers for taking them. We regret that the length of the Memoir prevents us giving more than a slight outline of the different sections.

The *Second Section* is devoted to those birds which are found in the higher grounds and mountains; and here a list of birds is given, varying in their species according to the altitude. The crossbill *(Loxia curvirostra)* inhabits the fir woods,—the *Tetrao lagopus*, and *Fringilla nivalis*, are found on the snow at the foot of the glaciers—and the *Falco fulvus*, and *Falco albicilla* of Temminck are found at still higher elevations.

The *Third Section* treats of birds which frequent marshy grounds, and the shores of lakes and rivers, such as the heron, plover, stork, and bittern. The lapwing and plover begin to arrive about the 20th of February—the snipe appears about the beginning of March—the grey heron and the stork about the middle of that month. About the 20th of March, the *Tringa pugnax* appears; and about the end of the same month the *Hirundo riparia* arrives, to take possession of the elevated and rocky cliffs on the banks of the Rhone and Arve, where it excavates its nest, or takes possession of a hole already formed. This is the only species of swallow, according to Mr Charles Bonaparte, an accomplished ornithologist, which is common to Europe and to North America. The identity of the European and American specimens he ascertained by careful comparison. *

Water Birds form the subject of the *Fourth Section.* The lake of Geneva, towards the close of winter, is inhabited by a crowd of ducks of various species, which have passed the cold season on the lake. On the approach of spring, numerous tribes of palmipedes hasten to regain the seas and marshes of the north, which they had been obliged to quit in autumn; and, at the same period, birds of a similar kind, and others of different species, are observed, which had passed the winter in lakes or marshes more southerly, or on the shores of the Mediterranean.

About the 10th of March, the *Anas acuta*, *fuligula* and *ferina* prepare to depart. Towards the 25th, the *Anas clangula*, and *A. boschas* have almost entirely disappeared. Then two species of teal, *(A. querquedula* and *crecca,)* the coot, *(Fulica atra,)* and the *Gallinula chloropus* make their appearance, the two last of which shelter themselves among the reeds. About the end of April, or beginning of May, the lake is covered by multitudes of little palmipedes, which, always on the wing, dart upon the smaller fishes, or aquatic insects. These are the *Sterna hirundo* and *nigra*. These little birds, far from being alarmed by the noise of a gun, fly in crowds round the body of their murdered companion, as if they wished to carry it away. Gulls are also abundant on the lake; and it was at one time believed that they formed a number of different species. But since observers have discriminated the variations of plumage caused by age, sex, and the climate, the number of species which frequent the lake of Geneva regularly has been reduced to two—the *Larus canus*, and *ridibundus*, the last of which is seen for the greater part of the year.

It is chiefly, however, on the approach of winter, that the lake

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* *Journal of the Academy of Natural Sciences* of Philadelphia, Vol. IV. p. 258.

is covered with palmipedes of different species; and while the land is deserted by its winged inhabitants, the waters are animated by the arrival of numberless birds from the north, who come to seek their food in a lake which the most severe winter never freezes. Ducks of various species form a large proportion of the annual visitors; and the taking of these afford to the fowler a considerable portion of his employment. While the marshy grounds are not frozen over, these leave the lake in numbers to feed there during night; and the people accustomed to take them, post themselves at break of day by the margin of the lake, or on the borders of the marshes, to intercept them on their return. But when the frost is severe, the ducks do not quit the lake. They assemble in crowds, seem jealous of the approach of enemies, and the moment a boat approaches in their direction, take flight to another situation. This excessive caution renders ordinary boats of no use in their capture.

The ingenuity of some young men belonging to a village in the neighbourhood of the lake, has, however, overcome this difficulty, by the construction of a canoe, or little boat, with which they can approach the flocks of wild ducks without alarming them. This boat is from six to seven feet long, and the sides little more than five or six inches in height, with a flat bottom. A hole pierced in the centre of the bottom, and inclosed by a strong and elevated border, to prevent the water from entering the vessel, permits the passage of a little oar, constructed in the form of a duck's foot; and a long-barreled gun is fixed to the prow of the boat. The fowler extends himself on his belly along the bottom, and gives motion by his hand to the duck-foot oar. The little boat, thus impelled by an oar which is not seen, is directed towards the birds, who, perceiving nothing but a floating chest, are not alarmed, and the fowler adjusts his aim when within the proper distance. This frail bark can only be used in very calm weather.

The *fifth* and last section of M. Necker's memoir is devoted to those birds which are only occasional visitors,—the inhabitants of distant countries, separated by accidental causes from the rest of their species, and driven by similar causes from their usual haunts. The Chatterer *(Bombycivora garrula,* Tem.*)* is one of these. Two instances of their appearance occurred at Geneva in January 1807, and January 1814. At this last period they were very abundant, and passed the winter in the neighbourhood. They all disappeared in March. In 1807, these birds extended over a great part of western Europe, and were seen around Edinburgh in the beginning of that year. The *Emberiza calcarata,* an inhabitant of the northern regions, was taken in a snare with larks in September 1816; the *Falco lagopus* was killed near Copet in January 1812; the *F. rufipes* in May 1816; the *Strix bubo* in October 1818, and 1822; the Roller *(Coracias garrula)* in September 1805, and 1819; the Bustard in August 1813; the Egret and the Avocette in May 1821; and the Ibis, *(Ibis falcinellus,* Tem.*)* one of the species adored by the Egyptians, and preserved among their mummies, was killed in June 1810 on the border of the lake. Many other rare birds are mentioned as occasionally seen in the neighbourhood of Geneva; but our limits prevent us from giving even their names. Referring to the Memoir for the complete list, we conclude by noticing that the *Phalaropus hyperboreus* and the *Sterna Caspia* were procured by M. Necker; and the Flamingo, the Bee-eater, the Spoonbill, the stormy Petrel, and the Ortolan *(Emberiza hortulana)* were taken and preserved by the late Professor Jurine.

Respecting the causes of the occasional appearance of birds in countries remote from their native abodes, M. Necker suggests, that a temporary want of subsistence may have led some to seek their food in places beyond their usual range—that storms may have unwillingly driven others far from their accustomed dwellings—or the pursuit of rapacious birds may have terrified others from their native territories. And, lastly, in some cases, it may be supposed, in accounting for the appearance of birds, not otherwise to be accounted for, that they may have escaped from captivity, and been thus thrown on shores very distant from their own.

An anomalous occurrence of this nature has lately taken place in our own neighbourhood; for we learn, that a specimen of the migratory pigeon of North America, *(Columba* *migratoria,)* the first which has occurred in this country, was shot in Fifeshire in January last, and presented to the University Museum by the Rev. Dr Fleming.

The number of species of birds found in the canton of Geneva, and neighbouring mountains, amount to 242, of which 185 are, properly speaking, indigenous, and 57 are accidental. Of the 185 indigenous species, 95 belong to the low grounds, (of which 32 are stationary all the year, and 63 are birds of passage;) 31 species belong to the mountains;—37 are marsh and shore birds, (of which three are stationary, and 34 birds of passage;)—and, lastly, 22 inhabit the lake, one species only being stationary, the others birds of passage.

Of the 57 species of accidental visitors, 20 belong to the plain, 16 are marsh and shore birds, and 21 water birds.

At the conclusion of the Memoir, M. Necker gives his Ornithological Calendar, in which, like the similar list of Mr Markwick, he gives the dates of the earliest arrival and departure of all the migratory birds which he has mentioned as frequenting the neigbourhood of Geneva. These two calendars are interesting, as affording the means of comparing the arrival and departure of migratory birds in two portions of Europe at a distance from each other; and had they been for corresponding years, the results would have been more satisfactory. From a slight glance at both, the progress of migration does not seem to be so rapid and continuous as many conceive it; but to proceed by stages, as it were, as the animals from the southward find subsistence on their route. There seems no reason, indeed, for supposing it to be otherwise; but still it would be interesting to know, from a series of such observations, the time taken by birds of the most rapid flight, to traverse such an extent of surface; and to have the means of investigating the causes which stop some species at determined geographical positions, while others, as the swallow, are found scattered in every country of northern Europe. The earliest arrival of the swallow *(Hirundo rustica)* is marked in the Genevan Calendar on the 18th of March 1806—the latest period 10th April 1816; while, in Mr Markwick's table, the earliest arrival of the same bird is April 7, 1788, and the latest April 27, 1771. The swallow leaves the neighbourhood of Geneva from the 10th to the 23d of October; and, in England, they disappear between the 15th of October, and the 18th of November. The earliest appearance of the cuckoo near Geneva is noted on the 29th of March 1809—and its earliest appearance in England, April 22, 1769.

One of the most curious particulars connected with the annual migrations of birds, is the circumstance of individuals returning for a series of years to the same nestling-places. Spallanzani having tied a thread of red silk round the leg of a swallow, which built its nest in his window, saw for three seasons the same stranger annually appear; and similar instances are on record concerning many other species of migratory birds. This wonderful direction of instinct, which divides the innumerable flocks of birds in their progress northward, and leads particular families to seek the protection of the same roof, or the same chimney-top which formerly sheltered them, affords a subject not the least worthy of contemplation, among the thousand instances of wisdom and beneficence which arrest the student of Nature at every step of his progress. S.

ART. XVII.—*Account of the Discovery of an Inhabited Island in the Pacific.* By CAPTAIN EEG of the Pollux Sloop of War, in the Service of his Majesty the King of the Netherlands. In a Letter to Dr BREWSTER from G. MOLL, Professor of Natural Philosophy in the University of Utrecht.

MY DEAR SIR,

TWO vessels in the service of his Majesty, the King of the Netherlands, have lately crossed the Pacific. After leaving Washington's Island, it was deemed expedient to keep in the seventh parallel of south latitude, sailing to the westward, being the track in which Captain Eeg, commanding the Pollux sloop of war, thought some islands might probably be discovered. The coral islands in those seas being generally small and low, it was reckoned prudent to proceed at night under easy sail, and thus to leave de Peyster's and Sherson's Islands one degree to the north and south. On the 14th July 1825, at 5^h A. M., after a very hazy and rainy night, it was presumed that land was to be seen a-head, but very indistinctly; and shortly after the breakers were distinctly heard. The vessel was brought to, and the signal made for the Maria Reygersberch frigate to do the same. After sunrise, they discovered a very low island, bearing W. by S., two miles distant (miles of 60 to a degree.) The land appeared well stocked with cocoa and other trees. About noon, they had the north point of the island, S. 60° E. The longitude of this island and its latitude being ascertained, with as much accuracy as circumstances would allow, and no other island being found in the same position in any of the charts on board, this was deemed a new discovery. The nearest land was de Peyster's group, but it was 50′ different in latitude. Though the sky was very clear, no other islands were seen at the same time. The name of Nederlandich Island was given to this new land. Its north point is in lat. 7° 10′ S., and the centre of it in long. 177° 33′ 16″ E. from Greenwich; the variation of the magnetic needle being 7° to the east. The longitude was determined by three chronometers. One of these, made by Thomson, was reckoned the most accurate; its rate had been ascertained seventeen days before at Nukahiwa, and its differences from the other two were very regular. A few days before coming in sight with the island, the longitude was ascertained by lunar observations, agreeing remarkably well with the chronometers. This island has a form resembling a horse shoe; its extent is about eight miles. In the west side is an indentation, closed by low reefs, and terminating in a lagoon. The natives, some of whom were armed with long sticks, were very numerous, sitting or running along the shore, as the vessel sailed along. An armed boat was dispatched towards the shore. The island appeared iron-bound; for, at a boat's length from shore, the depth was six fathoms, and rough coral ground. A ship's length from shore there was fifteen fathoms depth. At the N. W. point they found a coral reef, projecting far in the sea, and on which there was a heavy surf. It was supposed that these were the breakers heard previous to the discovery of the island. The land had a pleasing aspect, and appeared fertile. The number of natives assembled on shore was estimated at about 300. They were of a dark copper hue, tall and well-made. Few were less than six feet Rhinland measure, or 6.166 English. The women were also very stout. Some of the people were *tatooed*, but not so much as at Nukahiwa. They were naked, except some covering made of leaves. A few others had some cloth of cocoa bark wrapped round the waist. The heads of some were adorned with feathers. Their conduct appeared very fierce and wild, and they contrived to steal whatever they thought within their reach. The boat-hooks soon disappeared, and they even attempted to tear the oars from the hands of the boat's crew. An old man, with a white beard, and of respectable appearance, carrying a green bough in his hand, was at their head. He continually kept singing some monotonous song, in a melancholy tune. They bartered some cocoa-nuts, and some of their tools, against some old handkerchiefs and empty bottles; and it appeared that their language had some resemblance with that spoken at Nukahiwa. When the boat again put to sea, they tried the effect of firing a few musket shots in the air, but the natives did not show symptoms of fear, and thus appeared unconscious of the effects of European arms. No canoes were seen in the possession of these people, nor did they attempt to approach the ships, although the weather was excellent, and the sea very calm. The commanders of the two vessels regretted very much that their large complement, and the small quantity of water, obliged them to make every possible dispatch. They accordingly pursued ther journey to Sourabaya in Java, where they found other work at hand than the discovery of new countries.

I am, Dear Sir,

With very great esteem,

Your humble servant,

G. Moll.

Utrecht, 9*th Feb.* 1826.

ART. XVIII.—*Notice respecting the Working and Polishing of Granite in India.* In a Letter to the EDITOR, from ALEXANDER KENNEDY, M. D. F. R. S. E.

DEAR SIR,

YOU will probably recollect, that when the "Notices regarding the Working and Polishing of Granite, by the Natives of India," appeared in the *Edinburgh Philosophical Journal*, No. viii. p. 349, you then inquired whether any colouring material was mixed with the lac and corundum, and which would account for the black colour acquired by the granite in the process of polishing. I could then only say, that though I had frequently seen the process performed, and had also witnessed the preparation of the ingredients, I had never seen any colouring material mixed with them. I nevertheless set on foot an inquiry, by writing to a friend, who I knew could easily ascertain the point from the native workmen. It happened to be a subject with which he was himself well acquainted, and, in his reply, after mentioning that the granite is first brought to a smooth surface by being rubbed in the manner usual with masons, with part of its own substance and water, he adds, that, in the process of polishing, which was the object of my inquiries, "no colouring material is used."

I perfectly recollect, that, when the whole of this process was performed under my own eye, the granite, after having been smoothed with its own substance, retained its own colour and appearance, having then acquired no part of the black colour which it afterwards got under the lac and corundum, and as to the origin of which we are still as much in the dark as formerly.

There seems good reason for believing, that the polish which the stone thus acquires endures for ages. It is this material which is so often seen used as black monumental slabs, &c. in the Mussulman burying-grounds in India, and of which also the pilasters, cornices, and other ornaments of the mausolea, erected over their princes and great men, are always formed. It also affords a most suitable material for the *toorbut* erected over the body under the centre of the dome of these magnificent structures, and which is generally covered with inscriptions from the Koran.

I had requested my friend to send me a specimen of the polished granite, which he has only been prevented from doing by want of a suitable opportunity.

EDINBURGH, 15*th February* 1826.

ART. XIX.—*Observations on the Superiority of Achromatic Telescopes with Fluid Object-Glasses, as Constructed by* Dr BLAIR.

ALTHOUGH it cannot be doubted that the Achromatic Telescope, from its first invention to its latest modifications, is a British invention, to which no foreigner has made the slightest addition, yet no attempt of any magnitude, and with any reasonable prospect of success, has been made in Great Britain for perfecting this noble instrument. Contented with supplying the European market with this article of their manufacture, our opticians have blindly followed the ancient routine; and neither our government, nor our public institutions, have originated or encouraged any attempt at improvement. The opticians of France and of Germany, on the contrary, have been busily employed, not only in rivalling the English in their methods of working lenses, but, with the aid of public bodies, and of the government itself, they have devoted themselves to the more important object of perfecting the glass of which the lenses are composed. The success which they have obtained in these respects has exceeded even their own expectations; and the telescopes of M. Fraunhofer of Munich, and of M. Lerebours of Paris,* have been brought to such perfection, as to threaten England with the loss of one of the staple articles of her manufacture.

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* The opinions of Mr Herschel and Mr South on these telescopes will be given in a subsequent article. See page 309.

The attention of men of science has at last been roused to this subject; and the Royal Society of London has appointed a committee for making experiments on the best method of manufacturing flint-glass for achromatic telescopes. Government have released the committee from the restrictions of the Excise laws, and an experimental glass-house has been erected for the purpose. We cannot doubt but that these experiments will be attended with success; but a considerable time must elapse before our artists regain that advantageous position which they have lost.

Amid all these exertions to improve the achromatic telescope, it has often struck us with surprise, that no attempt has been made to introduce and to improve the *achromatic telescopes with fluid object-glasses,* invented and actually constructed by our countryman Dr Blair. The doctor himself took out a patent for this valuable improvement, but practical difficulties were experienced in the manufacture of them for sale, which prevented the patentee from ever deriving any pecuniary advantage from his indefatigable and successful labours. This, therefore, was, in a peculiar manner, a case where the patronage of government was required, and where it ought to have been given. From the want of such encouragement, this invention has entirely fallen into oblivion, and is now in the same state in which it was in the year 1789, when it was first submitted to the public!

" The only philosopher, as we have elsewhere remarked,* that we know of who actually looked through the telescopes of Dr Blair, was Dr Robison, who always spoke of them in terms of the highest praise. He informs us, indeed, that Dr Blair had a telescope not exceeding *fifteen* inches in length, with a compound object-glass, *which equalled in all respects,* if it did not surpass, the best of Dollond's, *forty-two inches* long. The effect of this telescope, when applied to the examination of double stars, was, we understand, particularly fine; and it is deeply to be regretted that Dr Blair was not encouraged, by some public aid, to carry on the manufacture of such valuable instruments. For ordinary purposes, telescopes of this

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* *Edinburgh Encyclopædia,* Art. OPTICS, vol. xv. p. 484.

kind may be considered as too delicate and complex; but, admitting in its full force the objection to them, drawn from the change which either does or may take place in the fluid media, their use in public observatories, and, particularly, their application to fine graduated instruments, were objects of primary importance to the progress of astronomy, even if the lens required to be renewed every two or three years."

Since these observations were printed, we find that, at a meeting of the Royal Society of Edinburgh, held on the 7th December 1789, Dr Blair exhibited one of his telescopes to the members who were present, and showed them its performance when directed to double stars. Professor Playfair was one of those members, and the following minute is inserted in his hand-writing in the account of the proceedings of that evening:

"Dr Robert Blair, Professor of Astronomy in the University of Edinburgh, produced before the society an achromatic telescope of a new construction, in which the convex lenses are of common glass, and the errors which arise from the different refrangibility of light, and from the spherical figures of the lenses, are corrected by the interposition of transparent fluids. The focal distance of the object-glass of this telescope is *twelve* inches, the aperture is *two* inches, and the powers belonging to it are two double eye-glasses, with one of which it magnifies *seventy-five* times, and with the other *ninety-five* times.

"There are also four double convex lenses, whose focal distance are one-fifth, one-tenth, one-twentieth, and one-thirtieth of an inch, and whose powers are of consequence, sixty, one hundred and twenty, ten hundred and forty, and three hundred and sixty times. The fixed stars appear through this telescope with round well defined disks; sometimes surrounded with imperfect rings,* but free from radiation and glare. Some double stars that happened to be in sight, were shown through the instrument to the members present. The power of *two hundred and forty* is found to perform best in separating the close double stars."

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* These rings are mentioned by Professor Amici, as produced by the best achromatic telescopes, and also by reflectors, when directed to luminous points. See page 309 of this Number.

With these evidences in favour of the vast superiority of Dr Blair's telescopes to all other achromatic instruments, we earnestly hope that the Royal Society of London, or the Board of Longitude, will take some measures for reviving their manufacture. As night-glasses, they would be invaluable, and, if generally used at sea, they might save to the country many a vessel, and to society many a valuable life.

The Society for the Encouragement of the Useful Arts in Scotland, has offered an honorary medal for the best achromatic telescope with fluid object-glasses, and we trust their example will be followed by other public scientific institutions.

EDINBURGH, *February* 21*st* 1826. D. B.

ART. XX.—*On Epistilbite, a New Mineral Species of the Zeolite Family*. By DR GUSTAVUS ROSE, Berlin, F.R.S. Edin. Communicated by the Author.

As the fundamental form of the species, we may consider a rhombic octahedron, the three axes of which, $a : b : c$, Fig. 20, Plate V, are in the ratio of $\surd\, 2.022 : \surd\, 11.886 : 1$.

The crystals most generally observed, are very obtuse rhombic prisms *M*, Fig. 21, terminated by two planes *s*, which are set on the acute edges, and having the more obtuse solid angles of combination replaced by the rhombic planes *t*. From this rhombic form of the planes it appears, that the three prisms *M*, *s*, and *t*, may be obtained by laying planes on the edges of a single scalene four-sided pyramid, the same which has been assumed as the fundamental form of the species, though its faces have not yet been observed in nature. There are also crystals, in which the faces *t* are large enough to intersect each other, and to produce an edge, which then forms another termination of the crystals. In these, the faces *s* replace the acute solid angles of combination, and likewise possess the figure of rhombs, as in Fig. 22. Sometimes, also, the edges between *s* and *M* are replaced by the narrow faces marked *u*; two of them produce parallel edges of combination with *t*.

The formulæ of these faces, after the method of Professor Weiss, expressing the ratio of their axes, are—

$$M = [a : b : \infty\, c].$$
$$r = [\infty\, a : b : \infty\, c].$$
$$t = [a : \infty\, b : c].$$
$$s = [\infty\, a : b : c].$$
$$u = [a : \tfrac{1}{2}\, b : c].$$

The following are the measures of the angles:

M on $M = 135^\circ\ 10'$.
M on $r = 112^\circ\ 25'$.
M on $t = 122^\circ\ 9'$.
t on $t = 109^\circ\ 46'$.
t on $u = 154^\circ\ 51'$.
t on $s = 141^\circ\ 47'$.
s on $s = 147^\circ\ 40'$.

Simple crystals are rare; generally the epistilbite is found in twins, resembling, in some respect, those of carbonate of lead, and joined parallel to one of the faces of the prism *M*, as represented in Fig. 23, of which Fig. 24 is a horizontal projection. The faces of the horizontal prism *s*, in both the individuals, form an angle, which is salient at the edge *x*, and re-entering at the edge *x′*. The truncations of the acute lateral edges of the prism *M* form an angle of 135° 10′, equal to the angle of the prism itself.

The crystals are implanted on a mass of the same species, consisting of granular particles, in the cavities of amygdaloidal rocks, and are found in Iceland, and the Faroe Islands, along with heulandite.

The cleavage of epistilbite is highly perfect, and easily obtained parallel to the face *r*, which replaces the acute lateral edge of the prism *M*. In other directions there is uneven fracture. The faces *M* are shining, but uneven, and do not admit of measurement by means of the reflective goniometer; the faces *s* are dull, *t* and *r* are both smooth and shining. The lustre of *M* and *t* is vitreous, and that of *r* is pearly and bright; the colour of the crystals is white, their transparency sometimes perfect; often they are only translucent on the edges.

Its hardness is = 4.5, between fluor and apatite; the specific gravity I found to be = 2.249 in several small crystals; = 2.250 in a single larger specimen; both of them at a temperature of 10° R.

Before the blowpipe, the indications given by epistilbite are the same as in stilbite and heulandite. In the mattrass, it intumesces considerably, and gives off water. On charcoal, it froths up, and forms a vesicular enamel, but cannot be melted into a globule. Borax dissolves a great quantity of it, and forms a clear globule. It is likewise soluble in sal of phosphorus, with the exception of a silica skeleton. With solution of cobalt the enamel becomes blue.

The epistilbite is soluble in concentrated muriatic acid, with the exception of a fine granular residue of silica. After ignition it is insoluble.

The chemical composition, obtained by analysis, is as folfollows —

Silica,	58.59	containing oxygen	30.44	12
Alumina,	17.52		8.18	3
Lime,	7.56		2.12	1
Soda,	1.78		0.45	
Water,	14.48		12.87	5

The corresponding mineralogical formula is $\left.\frac{N}{S}\right\}S^3 + 3\,AS^3 + 5\,Aq.$

Observations.

Several years ago I observed and measured the crystals of epistilbite in the Royal Collection of Berlin. Even before this period, Professor Weiss had placed by themselves, as a new variety of foliated zeolite, some specimens of it, which, however, were not very distinct. The variety which I first examined, occurs in small but simple crystals, along with larger crystals of heulandite. Afterwards, in 1824, I recognized this species in Paris, where Count Bournon likewise had considered it as something new. He allowed me to institute some measurements with these crystals, which I found to agree exactly with those I had obtained before. I feel particular pleasure, in having this opportunity of publicly expressing my gratitude to Count Bournon, for the extreme liberality with which he permitted me not only to look over the cabinet under his direction, but also to examine and measure more minutely the crystals which it contains.

The crystals of epistilbite very much resemble those of stilbite, and of heulandite, with which probably they have often been confounded. In allusion to this resemblance, the name of *epistilbite* has been formed. Like the crystals of these two species, they possess a single cleavage, with a strong pearly lustre, while, on the mostly uneven crystalline faces in other directions, their lustre is vitreous. They differ from them by a greater specific gravity, which, in heulandite, I found = 2.211 at a temperature of 6° R., in stilbite, and between 2.145 and 2.176 at a temperature of 8° R. Also their hardness is a little greater, for, in both heulandite and stilbite, it is yet below that of fluor-spar. The most considerable differences, however, are those in their regular forms; the angles of epistilbite and stilbite, though within one system of crystallization, are incompatible, while in epistilbite and heulandite, even the system of crystallization is different. For the sake of an easier comparison, I have added a figure of heulandite, Fig. 25, and one of stilbite, Fig. 26, a little modified, but agreeing in position with those of Professor Mohs. The crystals of epistilbite are farther remarkable for the frequency of their occurrence in twin-crystals, which have not yet been described in either of the other species. Of stilbite, Mr Allan showed me a cruciform twin in his cabinet, which he had himself brought home from Faroe; but this is one of the rarest specimens ever observed.

Also the chemical composition of stilbite and heulandite, according to Hisinger and Walmstedt, are different, the formulæ being respectively $CS^3 + 3\ AS^3 + 6$ Aq, and $CS^3 + 4\ AS^3 + 6$ Aq. The analyses are—

	Stilbite.	Heulandite.
Silica, - - - -	58.00	59.95
Alumina, - - -	16.10	16.87
Lime, - - - -	9.20	7.19
Water, - - -	16.40	15.10

The analysis of epistilbite was an easy one. The mineral is partly dissolved in muriatic acid, giving as a residue a fine-grained powder of silica. From the remaining liquid, the alumina was precipitated by caustic ammonia, and the lime by oxalate of ammonia. The alumina, redissolved in muriatic acid, gave a small additional quantity of silica. The oxalate of lime was ignited, then carbonate of ammonia added to it, and again dried, to transform it into carbonate of lime, which was weighed. The remaining fluid was evaporated, the residue redissolved in water, by which another small quantity of silica was separated, and the solution allowed to crystallize. Very distinct cubes formed, which appeared to be crystals of muriate of soda, as they did not deliquesce, nor did they produce a precipitate, either when dissolved in alcohol, and added to a solution of muriate of platinum in alcohol, or when dissolved in water, and added to a solution of tartaric acid in water.

The quantity of water given above is the mean of two experiments, which gave separately 14.72, and 14.25.

From another analysis of the epistilbite, I obtained the following result:—

Silica, - -	60.28	containing oxygen	31.31
Alumina, - - -	17.36		8.11
Lime, - - -	8.32		2.34
Loss, calculated as Water, -	12.52		11.34

There is less water, and more silica in it, than the quantity required by the formula. This was caused by the circumstance, that, in order to render the mineral more easily acted upon by muriatic acid, I had ground it down to an impalpable powder, which was suspended in water, and then allowed to subside, by which means only the most minute particles are separated. In drying it on the stove, the heat became a little too great, so as to drive off a small quantity of the water, and to render part of the mineral insoluble, which therefore increased the apparent quantity of the silica. But I have mentioned this analysis, because I have conducted it with as much exactness as I could command; and, because, at least the relative quantity of alumina, lime, and soda, is correctly determined.

I have comprised the soda and the lime under one head in the formula $\left.\begin{matrix}O\\ \overline{N}\end{matrix}\right\} S^3 + 3\,AS^3 + 5\,Aq$, though these two substances do not appear to be isomorphous. The form of anhydrite, $\ddot{C}a\ddot{S}^2$, is different from that of anhydrous sulphate of soda, $\ddot{N}\ddot{S}^2$ as described by Haidinger. The crystals of meionite also, and those of nepheline, cannot be reduced to the same fundamental form, though the chemical composition of the former, according to the analyses of Leopold Gmelin and Stromeyer may be expressed by the formula $CS + 3AS$, and that of the latter, according to the analysis of Arfvedson, by the formula $NS + 3AS$. But it is probable, particularly from the analyses of the mesotypes by Fuchs, that soda, containing a certain quantity of water, may be isomorphous with lime, in the same manner in which ammonia, with two atoms of water, is isomorphous with potash, as has been shown by Mitscherlich. In this case, it would be necessary to add some of the water to the soda, in order to have it isomorphous with lime, and the number 5, which is not a common one among this kind of formulæ, would then be likewise modified. In the meantime, it will be prudent to express the formula as above, because the quantities of oxygen, contained in each, soda and lime, taken separately, are in no simple ratio to the oxygen in the other ingredients, though, particularly in the second analysis, the oxygen of the soda, and that of the lime, are very nearly in the ratio of one to six.

ART. XXI.—*On the Horary Variations of the Barometer.*

By BARON ALEXANDER DE HUMBOLDT.[*]

IN the year 1682,[†] M. M. Varin des Hayes, and De Glos, remarked, that, at Goree, the barometer was generally lower

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[*] This paper is a brief abstract of the elaborate dissertation on this subject, published in the *Relation Historique.—Livrais. 5*, Folio, p. 270—313.

[†] We must again repeat here what we have said in No. iv. p. 336, that, in 1666, Dr Beale, an Englishman, observed, "that very often, both in winter and summer, the mercury stood higher in the cold mornings and evenings than in the warmer mid-day."—ED.

when the thermometer was highest, and generally higher in the night than the day, by from two to four lines; and that this instrument suffered a greater change from the morning till the evening, than from the evening till the morning.

It was in 1722 that the phenomenon of the hourly variations was observed, for the first time, and with great exactness, by a Dutch philosopher, whose name has not descended to our times. In the *Journal Litteraire de la Haye*, it is said, in a letter from Surinam, "The mercury rises in this part of Dutch Guiana every day regularly, from 9^h in the morning till half-past 11^h, after which it descends till 2 or 3 o'clock in the afternoon, and afterwards it returns to its first height. It suffers nearly the same variations at the same hours of the night. The variation is only one-half or three-fourths of a line, or, at most, a whole line. It would be desirable that the philosophers of Europe would make their conjectures on this subject."* The observations which I have made seventy-seven years later on the same coast of Surinam, on the banks of the Orinoco, have confirmed, with the exception of the hour of *maximum* in the morning, the accuracy of the first determination of the periods.

From 1740 to 1750, Father Boudier observed the barometer at Chandernagore in India. He found that the greatest elevation of the mercury took place every day about nine or ten o'clock in the morning, and the least elevation towards three or four o'clock in the evening; and he remarks, that, during the great number of years that the barometer was marked at Chandernagore, there were only eight or ten days in which this uniform motion of the mercury was not observed.

The academicians sent to Quito in 1735, observed also the horary variations of the barometer, and they found that it reached its maximum at nine in the morning, and its minimum at three in the afternoon, the mean difference at Quito being $1\frac{1}{4}$ of a line.

In 1751, M. Thibault de Chauvelon reduced into tables the

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* We trust that M. Arago will now have the candour to divest his countryman, M. Godin, of the honour which he had erroneously conferred upon him, of having been the first to observe the horary variations of the barometer.—Ed.

horary variations of the barometer, which he had observed at the Antilles. In a work published in 1761, he observes, "that, a short time after his arrival in Martinique, he perceived that the barometer rose gradually during the whole morning, and that, after it had been some time in motion, it began to descend till sunset. After having been some time stationary, it rose at the approach of night, till ten in the evening. The most considerable revolutions in the atmosphere do not alter this periodical march of the barometer, which coincides with that of the horary variations of the magnetic needle. In the middle of the most copious rains, of winds and of storms, the mercury rises and descends, if it is its time to rise or descend, as if all was tranquil in the air. The same variations take place at Senegal."

Since the year 1761, Doctor Mutis has observed the atmospherical tides at St^{a} Fe de Bogota during forty years. He determined, with precision, the epoch of the *minimum* which precedes sunrise; but, unfortunately, his observations, which he concealed with too much care during his life, have not been published since his death. M. Mutis in New Granada, Alzate and Gama in Mexico, were the first who examined the hourly variations on the back of the Cordilleras at 1200 and 1400 toises above the level of the sea.

Neither the observations of Thibault de Chauvelon in 1751, nor the small number of those published by Alzate in 1769, corresponded to the tropical hours, that is, to the epochs when the barometer arrives at the convex and concave summits of the curve of its daily variations. It was in the voyage of La Perouse, that MM. Lamanon and Mongez made, in 1785, every hour the first continuous observations, during three days and three nights, when they were in the middle of the Atlantic Ocean, between the parallels of 1° north latitude, and 1° south latitude.

The work of Lamanon is anterior, by eight years, to that undertaken at Calcutta by Messrs Trail, Farquhar, Pierce, and Balfour; but, as their results were inserted in the fourth volume of the *Asiatic Researches*, published at Calcutta in 1795, while the voyage of La Perouse did not appear till 1797, the Indian observations acquired more celebrity in Europe. They were, indeed, the only ones from which, at my departure for America, I had obtained a knowledge of the regularity of the horary movements of the barometer.[*] Doctor Mosely, in his *Treatise on Tropical Diseases*, published in 1792, observes, that the barometer has two daily movements, one of ascent, and the other of descent, rising when the sun approaches the zenith or nadir, and falling when he recedes from these points. Dr Balfour also observed the barometrical changes for every half hour, during a whole lunation, in the year 1794.

I commenced the series of my observations on the variations of the weight of the atmosphere, along with M. Bonpland, on the 18th July 1799, two days after our arrival at Cumana, and I continued them for five years with the greatest care, from 12° of south lat., to 23° of north lat., in the plains and on the table lands, whose height is equal to the peak of Teneriffe. Since the time of my voyage to the Equator, this phenomenon has occupied almost all travellers and natural philosophers, who have been provided with instruments fitted for making these observations.

As our limits will not permit us to follow our author through the details of his elaborate dissertation, we shall now present our readers with two of the latest and most accurate sets of observation on the horary changes of the barometer made within the tropics, the first by Captain Freycinet in 1820, and the second by M. Duperry in 1823.

1. *M. Freycinet's Observations at Rio de Janciro in* 1820

Hours of Observation.	Height of the Barometer in 100dths of a Millimetre. m m.	Hours of Observation.	Height of the Barometer in 100dths of a Millimetre. m m.
11^{h} P. M.	Max. 766.71	11^{h} A. M.	766.65
12	766.77	12	765.96
1 A. M.	766.59	1 P. M.	765.76
2	766.15	2	Min. 766.04
3	Min. 765.65	3	764.28
4	765.67	4	764.49
5	765.78	5	764.43
6	766.00	6	765.33
7	766.35	7	764.69
8	766.49	8	766.38
9	766.91	9	766.55
10	Max. 766.96	10	Max.

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[*] See this *Journal*, No. iv. p. 336.

In this table, the heights are reduced to 32° Fahr., but, in order to correct them for capillarity, and the error of level, we must add 0.922 of a millimetre.

2. *M. Duperry's Observations at the Port of Payta, in* 5° 5′ *of South Lat. in* 1823.

		Barometer.	Centigrade Thermometer.
Mar. 12,	6^{h} A. M.	762.20	25.0
	7	762.40	25.3
	8	762.40	25.9
	8½	762.70	26.7
	8¾	762.80	26.7
	9	762.70	27.2
	10	762.50	26.8
	11	762.10	26.9
	12	761.50	28.2
	2 P. M.	759.80	28.7
	3	759.20	29.1
	4	759.20	28.8
	5¾	759.20	27.6
	6	759.30	27.7
	9	761.40	26.9
	10	762.30	26.7
	10¾	762.30	26.3
	11	762.40	26.2
	11¾	762.20	26.1
	12	762.30	26.0
Mar. 13,	1 A. M.	761.30	25.8
	2	761.10	25.5
	2¾	760.70	25.3
	3	760.80	25.3
	4	761.20	25.3
	5	761.50	25.6
	9¼	762.30	27.0
	10	762.20	26.8
	12	761.20	29.5
	2¾ P. M.	759.80	30.9
	4	759.80	30.5
	5	760.00	30.4
	10	761.60	27.3
	11	762.50	27.4
	12	762.80	26.4

Although M. Van Swinden announced, in 1776, the existence of horary variations in the north of Europe, and fixed the *maximum* and *minimum* at $+ 1\frac{1}{2}^{h}$;—6^{h}; $+ 10^{h}$;—22^{h} astronomical time, yet we owe the first precise observations to M. Ramond. "I have obtained," says this excellent observer, "results very analogous to those which M. Humboldt has brought from the Equator, but the hours of the variation differ according to the season. For winter, the *tropical hours* (the hours at which the motion returns upon itself) are 9^{h} A. M., 3^{h} P. M., and 9^{h} P. M. In summer, the fall appears to begin from 8^{h} A. M., and to continue till 4^{h} P. M., and does not recommence till 10^{h} P. M."

In consequence of the singular regularity of the barometrical variations at Bogota, MM. Boussingault and Rivero have detected a *monthly variation* in the oscillations of the mercury, the mean monthly height being greater in June and July, and smaller in December and January, when the earth is nearest the sun. In the following table, the mean heights are reduced to the zero of temperature.

Monthly Mean Heights of the Barometer at Bogota, Lat. 4° 55 50.

Results of One Year.	Barometer in Parts of a Metre.	Mean of the Oscillations in Millimetres.	Mean Temp. of 9^h, and 4^h Centigrade.
	m		
January,	0.56045	2.31	15.7
February,	0.56048	2.31	15.9
March,	0.56061	2.39	15.3
April,	0.56113	2.34	15.2
May,	0.56075	2.45	15.4
June,	0.56124	1.86	15.1
July,	0.56134	1.50	14.2
August,	0.56111	2.22	16.6
September,	0.56094	2.59	16.2
October,	0.56071	2.77	15.3
November,	0.56045	2.44	15.1
December,	0.56013	2.40	15.0

The results contained in this table are confirmed by the observations of M. Caldos in 1807 ; and it appears also from fourteen years observations of Herrenschneider, at Strasburg, that the monthly means are higher in September, and lower in April. The following are Herrenschneider's observations, reduced to 15° centigrade.

Result of 14 Years.	Mean Height of the Barometer in Lines.
January,	333.128
February,	333.452
March,	332.905
April,	332.449
May,	332.516
June,	333.416
July,	333.168
August,	333.352
September,	333.635
October,	332.981
November,	332.866
December,	332.700

From seven years observations made at Clermont, M. Ramond has ascertained that the barometer is highest in January and June, and lowest in April and November.

The next subject of M. Humboldt's inquiry, is to ascertain if these horary variations have any connection with the lunar motions. M. Toaldo had long ago averred, that, in Italy, the barometer was much higher in the quadratures than in the syzigies, and in apogee than in the perigee; but the results of the observations of MM. Boussingault and Rivero made at Bogota on the subject, by no means confirm the opinion of Toaldo. They were made in the last five months of 1823, and the first seven months of 1824, and the following are the results:

	New Moon Metres.	First Quarter Metres.	Full Moon Metres.	Second Quarter Metres.
Mean Height of the Barometer.	0.56216	0.56161	0.56198	0.56222

In a letter from M. Boussingault to Baron Humboldt, dated Bogota, February 9, 1825, he says, "I dare not deny that there is any lunar influence on the mean weight of the mercury; but I believe that this influence, if it does exist, is scarcely perceptible, because it is lost among the other causes of the horary variations."

We shall now conclude this article with Baron Humboldt's very interesting summary of the laws, or the general relations of this class of atmospherical phenomena.

1. The horary variations of the barometer are felt in all parts of the earth, in the torrid, as well as in the temperate and frigid zones; at the level of the sea, and at heights above 200 toises. The two atmospherical tides are not generally of equal duration. In comparing results of unequal accuracy, and obtained by thirty different observers, between 25° of S. lat., and 55° of north lat., we find, for the epochs of maximum and minimum deviations of two hours. By excluding five results only, the *maximum* in the morning falls between $8\frac{1}{2}^h$ and $10\frac{1}{2}^h$, the *minimum* in the afternoon between 3^h and 5^h; the *maximum* in the evening between 9^h and 11^h, and the *minimum* in the morning between 3^h and 5^h. As the most correct type, we may adopt for the equatorial zone,

$+21^{h}\frac{1}{2}$; -4^{h}, $+10\frac{1}{2}^{h}$; -16^{h}, and for the temperate zone, $+20\frac{1}{2}^{h}$; $-3\frac{1}{2}$; $+9\frac{1}{2}$; -17^{h}, astronomical time reckoned from noon.

2. In the temperate zone, the epochs of the maximum of the morning, and the minimum of the evening, are nearer, by 1^{h} or 2^{h}, the sun's passage of the meridian in winter than in summer; but the type of the summer resembles more the type between the tropics. Observations on the morning minimum are still much wanted.

3. In the torrid zone, the times of *maxima* and *minima* are the same at the level of the sea, and on the table lands 1300 or 1400 toises high. We are assured that this isochronism does not show itself in some parts of the temperate zone, and that, at the summit of the great St Bernard, the barometer *falls at the hours when it rises at Geneva.*

4. The variations everywhere become slower near the concave and convex summits of the curve which represents them; and in some places the mercury seems to remain stationary, during a time varying from 15′ to 2^{h}.

5. In general, under the torrid zone, between the equator and the parallels of 15° north and south, the strongest winds, storms and earthquakes, and the most sudden changes of temperature and humidity, neither interrupt nor modify the regularity of the horary variations. Whereas, in some parts of equatorial Asia, as in India, where the monsoons blow with violence, the season of the rains masks entirely the type of the horary variations; and, at the same time, when these variations are insensible in the interior of the continent, on the coasts, and in straits, they show themselves, without any alteration, in the open sea, under the same parallels.

6. Between the tropics, a day and a night are sufficient to determine the times of *maxima* and *minima*, and the duration of the small atmospherical tides. In the temperate zone, in 44° and 48° of lat., the phenomena show themselves in all seasons with much distinctness, in the means of from fifteen to twenty days observations.

7. The unequal extent of the diurnal variations produces, in the torrid zone, at the same hours, in different months, differences of barometrical height, more or less considerable.

The extent of the oscillations decreases, in proportion as the latitude, and the annual deviations due to accidental perturbations, increase. In the *maxima* of the evening, the mercury is generally a little lower than in the *maxima* of the morning. If we confine ourselves to observations that are precise, and sufficiently numerous to give means worthy of confidence, we find, that the extent of the oscillations under the torrid zone, between the equator and the parallel of 10°, in the tide of 9^h A. M. to 4^h P. M., is, in the plains, from 2.6^{mm} to 3.3^{mm}; on the plain of Bogota 1365 toises high, 2.3^{mm}; towards the extremity of the southern torrid zone, in the plains 2 millimetres. In the whole year, the diurnal variations vary at Bogota from 0.63^{mm} to 3.64^{mm}, and the means of the monthly oscillations vary from 1.5^{mm} to 2.7^{mm}. The extent of the oscillations in the morning tides from 9^h to 4^h, and in the evening from 4^h to 11^h, are generally, under the tropics, in the ratio of 5 : 4 or 5 : 3. The mean barometric heights of the days vary between 0° and 10° of latitude, in the plains, 3.8^{mm}, and on the plain of Bogota 3 millimetres; a difference of level, therefore, of 1600 toises, has a very slight influence on the mean of the daily oscillations, and on the extremes of these oscillations. The mean heights at noon, between the tropics, are constantly some tenths of a millimetre higher than the general mean of the day, deduced from the *maximum* of 9^h A. M., and the *minimum* of 4^h P. M. In advancing from the equator to the poles, we find the differences of the barometrical heights at 9^h A. M. and 4^h P. M., between 0° and 20° of lat., from 2.5^{mm} to 3.0^{mm}; between 28° and 30° of lat. to 1.5^{mm}; in 43° and 45° of lat. to 1.0^{mm}; in 48°, 49° 0.8^{mm}, and in 55° of lat. to 0.2^{mm}.

8. The barometrical means of the months differ from each other under the tropics from 1.2^{mm} to 1.5^{mm}; at Havannah, Macao, and Rio Janeiro, near the tropics of Cancer and Capricorn, from 7 to 8 millimetres, as in the temperate zone. The extreme deviations of the year are, at the same hours, near the equator, from 4 to 4½ millimetres. They rise sometimes at the extremity of the equinoctial zone, near the tropic of Capricorn, to 21^{mm}, and near the tropic of Cancer to 25 and 30 millimetres. In the temperate regions of Europe, the limits

of the extreme monthly oscillations are, in the ascending motion, one-half nearer each other than under the tropic of Cancer. In the limits of the ascending oscillations, this difference between the two zones is much less sensible. The interruption of the horary oscillations presents, near the tropic of Cancer (in the Gulf of Mexico) a prognostic of the proximity of tempests, of their force and their duration. The monthly means of the barometric heights diminish regularly, from July to December and January, on the plain of Bogota, and even in the southern hemisphere, on the coast of Rio Janeiro. At the extremity of the northern equinoctial zone, the return of the north winds raises the means of December and January above those of July and August.

9. Under the tropics, as in the temperate zone, in comparing the extreme deviations of the barometer, month by month, we find the limits of the ascending oscillations two or three times nearer than the limits of the descending oscillations.

10. The observations hitherto collected do not indicate any sensible influence of the moon on the oscillations of the atmosphere. These oscillations appear to be owing to the sun, who acts not by his mass, viz. by attraction, but as a star, radiating heat. If, in modifying the temperature, the Solar rays produce periodical changes in the atmosphere, it remains to be explained why the two barometric maxima coincide almost with the warmest and the coldest epochs of the day and the night.

The following table will afford a general view of all the horary results:

General View of the Horary Variations in different parts of the Globe, and at Different Heights above the Sea.

	Names of Observers.	Minima after Midnight.	Maxima in the Morning.	Maxima Afternoon.	Maxima in the Evening.	Mean extent of the Oscillations in Millimetres.	PLACES OF OBSERVATION.
EQUATOR.	Lamanon and Mongez.	— 4^{b}	+ 10^{h}	— 4^{h}	+ 10^{h}	....	Atlantic Equatorial Ocean.
	Humboldt and Bonpland.	— 4½	+ 9¼	— 4½	+ 11	mm 2.55	Equatorial America, from 23° N. lat., 2° S. lat., and between 0.71500 toises high.
	Duperry.	— 3	+ 9	— 3½	+ 11¼	3.40	Payta, coast of Peru, S. lat. 5° 6′.
	Boussingault and Rivero.	....	+ 9½	— 3½	+ 10	2.44	La Guayra N. lat. 10° 36′.
		— 4	+ 9	— 4	+ 10	2.29	Bogota, N. lat., 4° 35′, height 1366 toises.
NORTH AND SOUTH TORRID ZONES.	Horsburgh.	— 4	+ 8½	— 4	+ 11	....	Indian and African seas, N. lat. 10°, S. lat. 25°.
	Langsdorff and Horner.	— 3½	+ 9¾	— 4	+ 10½	....	Pacific Equatorial ocean.
	Sabine.	— 5	+ 9½	— 3¾	+ 10	....	Sierra Leone, N. lat. 8° 30′.
	Kater.	— 5	+ 10½	— 4	+ 10½	....	Plain of Mysore N. lat. 14° 11′, height 400 toises, rainy season.
	Simonoff.	— 3½	+ 9½	— 3½	+ 9¾	....	Pacific Ocean, from N. lat. 24° 30′, to S. lat. 25° 0′.
	Richelet.	— 5	+ 9	— 5	+ 10	....	Macao, N. lat. 22° 12′.
	Balfour.	— 6	+ 9¼	— 6	+ 10	....	Calcutta, N. lat. 22° 34′.
	Dorta, Freycinet, Eschwegge.	— 3	+ 9¼	— 4	+ 11	2.34	Equinoctial Brasil, at Rio Janeiro, S. lat. 22° 54′, and the Missions of the Coralos Indians.
TROPIC.	Hamilton.	....	....	....	....	....	Plain of Kathmandu.
	Leopold de Buch.	....	+ 10	— 4	+ 11	1.10	Las Palmos, N. lat 28° 8′
	Coutelle.	— 5	+ 10	— 5	+ 10¼	1.75	Cairo, N. lat. 30° 3′.
	Marqué Victor.	Sum. Win.	+ 8½ + 10	— 5½ — 2½	+ 11	1.20	Toulouse, N. lat. 43° 34′, five years.
TEMPERATE ZONE.	Billiet.	Sum. Win.	+ 7½ + 10	— 3 — 2	....	1.00	Chamberry, N. lat. 45° 34′, 137 toises.
	Ramond.	Sum. Win.	+ 8 + 9	— 4 — 3	+ 10 + 9	0.94	Clermont Ferrand, N. lat. 45° 46′, 210 toises.
	Herrenschneider.	— 5	+ 8½	— 3½	+ 9½	0.80	Strasburg, N. lat. 45° 46′, six years.
	Arago.	....	+ 9	— 3	....	0.70	Paris, N. lat. 48° 50′, nine years.
	Nell de Breautté.	....	+ 9	— 3	....	0.36	La Chapelle, N. lat. 49° 55′.
	Sommer and Bessel.	....	+ 8½	— 2½	+ 10	0.20	Konigsberg, N. lat. 54° 52′, eight years.

ART. XXII.—*Notice regarding Professor Mitscherlich's Observations on the Dimorphism of Hydrous Sulphate of Zinc, and Hydrous Sulphate of Magnesia.* By WILLIAM HAIDINGER, Esq. F. R. S. E. Communicated by the Author.

DURING my stay at Freiberg, I had prepared solutions of sulphate of zinc, and of sulphate of magnesia, to examine and measure crystals newly obtained of the hydrous salts. When the solution of the sulphate of zinc was quite concentrated, and the temperature of the stove rather high, on which I had placed the solutions for producing a slow diminution of heat, I likewise obtained crystals. These crystals, however, bore no resemblance to the ordinary ones produced at lower temperatures, but their forms belonged to the hemi-prismatic system, somewhat like borax, and their degrees of transparency were very low. The sulphate of magnesia, which, on account of the isomorphism of magnium and zinc, I examined under the same circumstances, gave the same result. These facts, isolated as they were, I mentioned to Professor Mitscherlich while at Edinburgh, in 1824. He found that sulphate of nickel, whose second form, a pyramidal one, had been described before, did not yield a hemi-prismatic species, when exposed in the same manner to a higher temperature. Some time afterwards, when he was examining the changes produced by heat in the double refraction of crystallized bodies, he observed that it remained unaltered in the hydrous sulphate of magnesia, till at once the whole crystal, which was heated in oil, became opaque. On being broken, it showed the structure of a pseudomorphous crystal, consisting of a number of individuals, beginning at the surface, and meeting in the inside of the original crystal. Professor Mitscherlich repeated the experiment under various modifications, from which it appeared, that this change always ensued at a temperature of about 42° R. (126° Fahr.) both in the sulphate of magnesia, and the sulphate of zinc. When the crystal is exposed in a glass tube to the heat of the spirit-lamp, its decomposition takes place without the loss of water, except, perhaps, what has been mechanically included between the lamellæ; proving that it is essentially the same mixture which forms both species, whose difference merely depends on the arrangement of their particles. Hence, Mitscherlich infers, that a movement of the particles within a solid body may take place, by which they are otherwise symmetrically arranged, and form a new species, which, in the above mentioned salts, alone exists above a temperature of 42° R. (126° Fahr.) Did our temperature never go below that, we would not know the ordinary prismatic salts at all, or, at least, they would be as difficultly obtained, as the six-sided low prisms of hydrous chloride of sodium, which but few chemists have had occasion to observe. After the change, no more cleavage is visible, and though the compound mass of crystals is yet coherent, it yields to a gentle pressure, and crumbles into pieces. Changes produced in a somewhat analogous manner, have been observed in several dimorphous bodies. According to Mitscherlich, the sulphur obtained by fusion in hemi-prismatic crystals, is quite transparent, but after a day or two it becomes opaque. It is well known, that Arragonite, when exposed to a higher temperature, will at once fly into powder, while calcareous spar, heated along with it side by side, remains unchanged, and even retains its transparency. It is highly probable, that, in the first instance, prismatic sulphur, in the second, rhombohedral lime-haloide are formed.

BERLIN, *February* 12*th* 1826.

ART. XXIII.—*Observations on the Geography of the Burrampooter and the Sanpoo Rivers.* By Captain R. LACHLAN, 17th Regiment. In a Letter to the EDITOR.

MY DEAR SIR,

ACCEPT of my best thanks for the perusal of the Sketch Map and printed Extract, descriptive of Lieutenant Burlton's Researches in Assam, regarding the source of the Burrampooter, which I return herewith.* Knowing as you do, that, in conse-

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* This Lithographic Map, for which I have been indebted to an esteemed correspondent in India, is entitled, " Sketch *of the Country bordering*

quence of strong doubts raised during a short voyage up the Burrampooter, and confirmed by subsequent diligent inquiries, I had, several years ago, ventured to call in question the accuracy of the generally received geography of that river, as identified with the Sanpoo of Tibet, and that I had, even the year before last, submitted a Memoir on the subject to the Asiatic Society of London, in which I arrived, by simple reasoning upon all that I had heard read and seen, at nearly the same conclusion respecting the real source of that river, as Lieutenant Burlton has done from actual survey and investigation near its fountain head,—you may easily imagine how much gratified I must feel at perceiving my hypothesis so generally confirmed; and I shall of course wait the arrival of further advices from India with much anxiety and interest.

As you seem solicitous about the fate of this great geographical question, it would have afforded me much pleasure to have had it in my power to give you a perusal of the Memoir alluded to; but, unfortunately, owing to bad health, and being much hurried at the time it was given in, I had not leisure to get a second fair copy made of it, and I was even obliged to allow a very rough draft, instead of a fair copy, of a Sketch Map of Assam, &c. constructed to elucidate it, to

on the Burrampooter," and is dated from the Surveyor General's Office, Calcutta, June 4, 1825. It is drawn on a scale of eight British miles to an inch, and represents very distinctly the various anastomosing feeders which flow into the Burrampooter near its source. The Booree Dheing river, and several of the streams which flow into it, and have their origin a little to the south of Brama-khoond, anastomose with one another in a most remarkable manner, so as to flow into the Burrampooter at two places, first near its source about Leddeea, by a branch called New Dheing river, and then, a little above Rungpoor, by the Boree Dheing river. In this way there is formed an island 70 miles long by 30, called Mowamareeah, in which the town of Rungagora is situated.

About two years ago, Captain Lachlan explained to me his theory of the origin of the Burrampooter and Sanpoo rivers, in which, contrary to the opinions of the best geographers, he maintained that these were two separate rivers. This theory appeared to me so ingenious, and so well-founded, that I had no doubt it would be established by the researches likely to be made during the Burman war. It was, therefore, peculiarly gratifying to me to send to Captain Lachlan the above map, which confirms the principal point of his theory.—Editor.

go in with it, without retaining any copy of that document at all. This I regret the more, as a single glance at that map, and its appended notes, imperfect and conjectural as were most of the materials, and rude as was its construction, would have given you at once a full insight into all the features of what I call my "*Theory;*" whereas your Sketch, being confined to the *upper* part of Assam, and, therefore, showing none of the leading feeders of the Burrampooter during its course through that country, can be of little assistance, except in nearly exhibiting the real source of the river. I say *nearly*, because I perceive that neither that map, nor the printed extract, point out expressly the actual situation of the Burrampooter's sources. This, however, it would appear, had subsequently been established beyond a doubt, as I very lately observed in one of the London newspapers a paragraph, stating that *Lieutenant Burlton had discovered the source of the Burrampooter river to be in a snowy range of mountains in lat.* 28° *N. and Long.* 96° 10′ E.; 1000 *miles distant from* [i. e. less remote than] *the place where it was before supposed to have had its rise!*—

As matters have turned out, I cannot help regretting that my notes on the subject were not given to the public through the medium of some other channel than the Asiatic Society of London, as, independent of the chance of their never seeing the light, the delay which has already occurred has altogether defeated the principal object I had in view, namely, the hope of their speedily attracting the attention of some of our countrymen on service in Assam, and giving an additional spur to their investigations so near the very scene of the disputed geographical question. But, unfortunately, not even the slightest notice of the subject of the Memoir, has ever found its way into any of the public prints, further than that a *Paper connected* with the geography of the Burrampooter had been read at the Society's Rooms. This, however, cannot now be helped.

That you may have some general idea how far I have been right in my investigations respecting the Burrampooter's origin, I have much pleasure in stating, without attempting to go into any of the lengthened details given in the Memoir, that perhaps the whole of my theory may be described as confined to the four following points.

1*st,* I consider the Burrampooter of Assam and Bengal to be quite distinct from the river of Tibet, known in our maps by the name of Burrampooter and Sanpoo, and to have its rise from Brahmakoond, among the mountains to the E. N. E. of Assam, nearly in the same situation as laid down by Lieutenant Burlton ;—and that point I have taken the liberty of marking on your Sketch with a red pencil cross.

2*d,* I am induced to suppose that Major Rennel was led to mistake for the Sanpoo bending N. towards Tibet, either the northern Assamese branch of the Burrampooter, called the Sobunsirree or Khobunkhirree, or that named the Dhekrung, one or the other of which, or perhaps the Somderree, I am inclined to think, may have their origin in the great lake *Jamdro-palte*; but I consider the Burrampooter to be chiefly indebted for the great magnitude of its channel in Bengal to the copious supplies it receives from the many considerable rivers which pour their waters into it within a very short distance of each other on the N. E. frontier of that province, assisted by the extraordinary abundance and protracted duration of the rains in that quarter; before being recruited by which the Burrampooter, compared with the Ganges, can be considered little more than a mountain torrent!—

3*d,* The Sanpoo of Tibet I consider to be altogether distinct from the Burrampooter, though apparently known to the Nepalese by the same name, and I suppose it to take a southerly course from Tibet into the Ava territory, some distance to the eastward of the sources of the Burrampooter, and ultimately become the great Burmese river, the Irrawaddy. While,

4*th,* I consider the chief source of the Kienduan or minor western arm of the Irrawaddy, to lie among the mountains in the immediate vicinity of Brahmakoond, and to flow from them in a southerly direction under the different appellations of Sanpoo or Shanpoo, Borolooit, Boodalooit, and Burmalooit, until it progressively changes to Kienduan, and falls into the Irrawaddy under that name; and that it was this diversity of name, united with the puzzling mythological origins often assigned to rivers by the natives of India, that led European geographers to infer the existence of a connection between the Burrampooter and Sanpoo of Tibet, as well as of an anastomosis between the Burrampooter and the Ava river.

How far all these opinions will stand the test of further actual survey and local investigation, is yet to be determined; and I cannot reasonably expect a confirmation of the whole; but enough has already been favourably decided to have proved very gratifying to me, and to have fully repaid me for any little time and trouble devoted to so interesting an inquiry.

I need scarcely add, that I was mainly assisted in my inquiries, while in India, by my worthy and intelligent friend, Mr D. Scott, who has furnished so many interesting and valuable morceaux of research from the N.E. frontier of Bengal.

Should you wish for any further details, I shall have great pleasure in furnishing you with them as far as in my power. In the meantime, I trust that the readiness with which I make the present communication will be accepted as an earnest of the willingness with which I shall attend to your future wishes; being, my Dear Sir,

Yours very sincerely,

R. LACHLAN.

EDINBURGH CASTLE, *Feb.* 20, 1826.

ART. XXIV.—*On a Property of Light, exhibited in the Examination of small Luminous Points by Telescopes.* * By PROFESSOR AMICI of Modena.

THE property of light, which I propose now to explain, and which I observed some time ago, enables us to distinguish the discs of the satellites of Jupiter, which have a sensible diameter from those of the fixed stars, whose diameter is inappreciable by our eyes.

In observing the stars with my telescopes, to which I have

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* This notice is an abstract of part of Professor Amici's *Memoir on the Observation of Jupiter's Satellites in the Day-time.*

adapted a divided object-glass micrometer, I have remarked, when the magnifying power was sufficient to make the phenomenon perceptible, that, if I doubled the image, by separating the semi-lenses, the luminous discs became elongated, and assumed an oval form. The small diameter of the ellipse thus formed is equal to the diameter of the primitive disc. This elongation always takes place, provided that the telescope is well centered in a direction perpendicular to the section of the lens of the micrometer, and it is for this reason that the distance between two stars is in no way diminished. This elongation takes place only for the fixed stars, whose diameter is inappreciable by the eye, and even when the magnifying power is from 100 to 1000 times. With respect to objects of an appreciable diameter, as the planets would be, they are not subject to this luminous expansion, which alters their form; or, at least, I have not been able to observe it in them. I have noticed several times, that the discs of the satellites of Jupiter, though smaller in appearance than those of the fixed stars, preserve themselves perfectly circular, and have their contours well defined, even when their images are doubled. This furnishes us with an easy criterion for distinguishing between a real disc and an apparent one, and, consequently, for distinguishing, at first sight, a new planet from a fixed star; for, if the planet has not a disc extremely small, if we separate the lenses of the micrometer, this disc will preserve its form, while the image will lengthen itself, if the star is a fixed one. *

In seeking for the cause of this phenomenon, I found that the elongation of the images could not arise from any property of the semi-lenses, because the effect takes place even when they are removed, and shows itself with Newtonian telescopes,

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* Sir William Herschel has published, in the *Philosophical Transactions* for 1805, several experiments, for the purpose of establishing the limits of the visibility of small objects in telescopes. He finds, that the rays reflected by the central portion of the great mirror tend to augment the false discs, while those reflected from the circumference tends to diminish them. The different effects, therefore, of the internal and external rays, reflected at the surface of a mirror ten feet in focal length, is a criterion for distinguishing a false from a real disc, provided that their diameter exceeds *one-fourth* of a second.—Amici.

when half the aperture is shut up by a semicircle of card, in which case the image resembles that formed by a semi-lens. If the card is turned round, so as always to cover one-half of the mirror, the elongation, in the image of the star, will always take place in a direction perpendicular to the line which separates the open from the covered half of the speculum.

It is easy to ascertain that this effect does not depend on the aberration of the light in the mirror, since, in this case, it would take place in the direction of the diameter of the semicircle of card, and of the section of the semi-lens.

In order to be still farther satisfied that the elongation of the images did not proceed from the aberration of sphericity, I placed, at the end of a refracting telescope, a rectangular aperture, one of whose sides was quadruple of the other, and I put it symmetrically around the axis of the tube. Had any aberration been sensible, it would have shown itself by dilating the discs of the stars in the direction of the greater side of the rectangle; but this did not happen. The image of the star was accompanied with two long luminous tails, which, in turning round the card, kept always perpendicular to the greatest side of the rectangle.

This phenomenon, therefore, appears to me to be caused by the light inflected by the sides of the diaphragm, and this explanation is confirmed by another fact, which I have observed in using Newtonian telescopes. If, when the telescope is pointed to a star, the eye-glass is brought nearer the mirror than distinct vision requires, we perceive, in the margin of the luminous circle, which has the form of the mirror, a very narrow band of brilliant light, which shows itself even round the shadow of the small mirror, and of the arm which carries it. The same thing takes place, if the eye-glass is drawn out beyond the place of distinct vision. I cannot, therefore, attribute this phenomenon to any other cause than the inflection of light by the sides of the small mirror, and its support, and by the mounting of the large mirror.

If we examine attentively the formation of the image of a star, while bringing the eye-glass from the point of indistinct to that of distinct vision, we shall see that the false disc of the star proceeds, in a great measure, and almost entirely, from those luminous bands which I have mentioned. If a method is not found for remedying this defect, it will become an obstacle to the unlimited magnifying power of telescopes, which would be obtained, if we could form mirrors so as to give an image as distinct as the object itself. These telescopes, indeed, would always err from want of light.

Phenomena, analogous to those which I have described, take place also in achromatic telescopes; and the phenomenon of false discs is in this case still more remarkable. The image of a luminous point is now accompanied with a series of concentric rings, * which are easily discovered by bringing the eye-glass alternately within and without the place of distinct vision. The cause of those appearances appears to be the same in the two telescopes, but, in the achromatic ones, there is a certain arrangement which favours the production of these rays. Experience has taught me to form double object-glasses, so that I can make either one ring, or a greater number of rings, appear, by moving the eye-glass on each side of the place of distinct vision.

ART. XXV.—*Observations on the Relative Performances of Achromatic and Reflecting Telescopes.* By Mr HERSCHEL, Mr SMITH, and PROFESSOR AMICI.

HAVING already had occasion to make our readers acquainted with the improvements which have been made on the continent upon achromatic telescopes, we are glad to have an opportunity of laying before them an account of the fine achromatic telescope of M. Lerebours, together with the opinions of three eminent astronomers, respecting the relative performances of refracting and reflecting telescopes. The remarks of Mr South and Mr Herschel were addressed to Professor Shumacher, and published in his *Astronomische Nachrichten*, and those of Professor Amici appeared in the *Correspondence Astronomique* of Baron Zach.

The diameter, says Mr South, of the object-glass of the

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* See page 284 of this Number.

achromatic telescope, constructed by M. Lerebours, now in the Royal Observatory of Paris, is rather better than 9.2 inches English, uncovered by the cell, but of which 8.4 inches only are in actual use. Its focal length is *eleven feet.*

The magnifying powers with which I used it on the night of the 15th of March last, are 136, 153, 224, 240, 420, and 560. With all, except 560, (which, by some forgetfulness, was not applied,) Venus was *extremely well* defined during a *dark* night; of course, Jupiter and Saturn were *well* shown. The two stars of Castor, of γ Leonis, of ζ Orionis, were exhibited with 240, 420, and 560, as round as possible, ω Leonis * presented by its side a light-blue star with 420, which could not be overlooked by the most careless observer, and with 560 both stars were *admirably* defined.

I need not inform you, that a telescope, having an object-glass of the diameter above mentioned, which, with these powers, will neatly define the limb of the planet Venus, and will give to the discs of the double stars here named images absolutely round, deserves to be well spoken of. Indeed, I have no hesitation in saying, that this telescope is the best achromatic I ever pointed to the Heavens; *nor will I withhold my regret, or even the mortification I feel in asserting, that England, when I visited it in May last, could not produce an achromatic any thing like it.* The stand upon which it is mounted is not provided with any means of giving to the telescope equatorial motion.

Whilst, however, I say thus much, I am far from entertaining the sentiments of Mr Fraunhofer, as to the decided superiority of refractors over reflectors, nor can I accompany Mr Struve in his idea, that the Dorpat telescope " may perhaps rank with the most celebrated of all reflecting telescopes, namely, Herschel's." It is true, I have not had the enviable qualification of having seen the former; still I think the Paris telescope furnishes me with data upon which to form something like a rational conjecture.

Its object-glass actually in use is in proportion to Mr Struve's, (if all of *it* be effective,) as seventy to ninety-two nearly, a difference not very hard to be allowed for.

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* According to Professor Amici, the two stars are distant 0″.5.—Ed.

I have seen the nebulæ in Orion; the planets Jupiter and Saturn, with the Paris telescope; and with their appearances in Mr Herschel's twenty feet reflector, I am perfectly familiar, and the comparison is many times in favour of the latter.

The power of the twenty feet reflector at Slough is well authenticated; and if the indefatigable astronomer of Dorpat will turn his probably matchless achromatic upon some of the faint nebulæ in the constellation Virgo, or upon some others, not easily resolvable into stars, he will soon satisfy himself, that his ideas of its space penetrating power are much overrated.

The star ζ Bootis was seen "close double" by Mr Pond at Lisbon, perhaps twenty years ago,* and, as I believe, with a Newtonian reflector of six inches aperture, and the circumstances mentioned in a letter written by him to Dr Wollaston. The instrument with which I first observed it, in 1810, "close double," was a reflector of the worst possible construction, viz., a Gregorian reflector of six inches aperture, and thirty inches focal length, but a very perfect instrument, made for me by Mr Watson in the year 1809, and which is now in the possession of my friend Mr Perkins."

After speaking of the merits of the telescope of M. Lerebours, Mr Herschel proceeds as follows:

"My object in writing this, is to obviate an erroneous impression that may arise in the minds of those who read Mr Fraunhofer's Memoir, as to the great inferiority of reflecting telescopes in point of optical power to achromatics in general, and more especially to those constructed with such delicacy as his own doubtless are. Those who have witnessed the performance of M. Amici's beautiful Newtonian reflector will not readily admit this inferiority, but will feel disposed to wish that some attempt might be made to accommodate such admirable instruments to the more exact purposes of astronomy, an object which appears to have been too easily lost sight of.

"Mr Fraunhofer's expressions, when speaking of the loss of light by metallic reflection, are, I think, too strong. He observes, that 'the most perfect metallic mirror reflects *only*

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* See *Scientific Intelligence*, ASTRONOMY, § 1.—ED.

a small part of the incident light, and that the greater part is absorbed;' and that, in consequence, the intensity of the light entering the eye of the observer, is always very small." A metallic mirror, however, reflects 0.673 of the incident light, or more than two-thirds, and absorbs less than one-third of the whole. M. Fraunhofer appears rather to have in view the Newtonian construction, where *two* metallic mirrors are used, and where the whole effective quantity of light is only 0.452 of the incident rays. * No one who has been half blinded by the entrance of Sirius, or of α Lyræ, into one of my father's twenty feet reflectors, will say that the intensity of its light is small, nor, to take a less extreme case, will any one who uses one of M. Amici's Newtonian reflectors of twelve inches aperture, (a perfectly convenient and manageable size, and of which he has constructed several,) be disposed to complain of its want of light. The ordinary reflector used by my father in his reviews of the Heavens, was a Newtonian, *seven* feet focus, and barely *six inches* in aperture; and, consequently, equal, *cæteris paribus*, to an achromatic of $4\frac{1}{4}$ (4.254) English, or 3.999 Paris inches, and therefore by no means proper to be put in competition with M. Fraunhofer's *chef d'œuvres* of seven and nine inches; yet it will be recollected, that, with this telescope, and with a magnifying power of 460, ω *Leonis* was discovered to be double, and distinctly separated, and its angle of position measured.

In order to demonstrate the superiority of refracting over reflecting telescopes, M. Fraunhofer has selected the star ζ *Bootis*, which my father has described as a double star of the sixth class, (No. 104,) in his second catalogue of double stars, but without mentioning the division of the large star into two, as a double star of the first class. It might, however, be very easily overlooked in a review in indifferent weather. It is, at least, as difficult to resolve as η *Coronæ*, more so than σ, either of which, with any telescope, be its goodness what it may, requires a favourable atmosphere for its separation. From this omission, however, Mr. Fraunhofer concludes, that the power of the telescope was insufficient to

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* The experiments on which this result is founded, are detailed in the *Article* OPTICS in the *Edinburgh Encyclopædia*, vol. xv., p. 625, 626.—ED.

resolve it, and must, therefore, have been inferior to that of an achromatic in the hands of Mr Bessel, with which it was recognized by that eminent astronomer as double. It will be seen, in reference to the Memoir on double stars by Mr South and myself, that this star had been long since ascertained to be double, not only by Mr Bessel, but by Messrs Struve, Pond, and South, and, what is more to the present purpose, by Sir W. Herschel himself. It was only by oversight that we omitted to refer, in that work, to his account of it, which is published in his paper " on the places of 145 new double stars," in the first Vol. of the *Transactions of the Astronomical Society*, p. 178, and read in June 1821.

In large reflectors, in which only one metallic mirror is used, the disadvantage, in point of light, under which they labour, in comparison with refractors, is, however, much less formidable. A reflector of eighteen inches aperture would be equivalent to an achromatic of 15½, and one of 48 inches to an achromatic of 41½ in aperture, a size we cannot suppose, (from any thing we have yet seen,) that it is possible the latter should ever attain. Reflectors of eighteen or twenty inches are perfectly manageable, and, I apprehend, quite within the power of any good artist to execute, and (if intended only for use, and not at all for show) at no very ruinous expence. That which I habitually use, of the former dimension, is my own workmanship, and though inferior in distinctness to the exquisite one used by my father in his sweeps, is by no means an instrument to be despised. Indeed, from the experience I have had of these telescopes, I am satisfied of their applicability, even to the more exact purposes of astronomy, and that great improvements in their construction and mechanism remain to be made.

Having succeeded in observing the eclipses of Jupiter's Satellites in the day-time, and in measuring the diameters with one of his Newtonian reflectors, Professor Amici was desirous of ascertaining the dimensions of an achromatic telescope, capable of showing these phenomena with the same distinctness.

" With this view," says he, " I took a Newtonian telescope of my own making, having a focal distance of 30 inches, and an aperture of 36 lines, and I compared with it an achromatic telescope of the same length, having an English object-glass of two lenses, $2\frac{1}{2}$ inches in diameter. In applying to these instruments two equal eye-glasses, and directing them to the same object, I saw this object with most brightness through the achromatic telescope. In order to be certain of this fact, I constructed a parallelopiped, three inches long, by placing, in opposite directions, two prisms, one of colourless, and the other of obscure glass, such as those which are employed for observing the sun. This apparatus furnished a regular gradation of transparency, by placing it between the eye of the eye-glass, I could easily find the opacity necessary for intercepting entirely the light of the object which I looked at alternately with each instrument. In order to avoid all calculation, I diminished by diaphragms the aperture of the brightest telescope, till the light of the object was extinguished in the two apparatuses at the same division of the parallelopiped. After several trials I found that, in order that the *refractor* and the *reflector* should have the same brightness, the first must have an aperture of 27 lines, and the second of 36. I am of opinion, indeed, that this ratio of 3 to 4 ought to be the same for telescopes of all dimensions, as we cannot take into account the slight loss of light arising from the great thickness of the two glasses in these telescopes.

" In order, then, to see the satellites as bright as I have seen them, we require an achromatic telescope of $8\frac{1}{2}$ inches in diameter, and having a focal distance such that the instrument may magnify 400 times. The great object-glass, therefore, of $7\frac{1}{2}$ inches aperture at Naples, will show the satellites less distinctly than mine, while the 9 inch object-glass at Dorpat will show them more distinctly.

" The result obtained by Sir W. Herschel does not differ from the above. By the method of Bouguer he found that the diameters of a double achromatic, and of a Newtonian reflector, must be as 7 to 10, in order to produce the same brightness with the same magnifying power, or as 5 to 6, if the small Newtonian mirror is not used. Hence, in order that an achromatic telescope may equal his 40 feet reflector, its object-glass must be 40 English inches in diameter.

"If reflecting telescopes, for which I have a partiality, have, in general, the advantage over refractors, with respect to the distinctness of the images, magnifying power, and smaller focal distance, they must always yield to the latter on account of the smaller apertures which these require, the facility with which they may be applied to different instruments, and the immutability of the substance of their lenses, which render comparable observations made at distant epochs, and partly for the convenience of using them, arising from this, that the object-glass preserves always the well-centered position which the artist has given it. This last quality is so much valued by some observers, that they do not hesitate to prefer a moderate achromatic telescope to a good Newtonian one."

We shall now present, in a small table, the relative performances of achromatic telescopes, with double object-glasses, and Newtonian reflectors, according to Sir W. Herschel, Mr Herschel, and Professor Amici.

	Ratio of diameters when the performance is equal.			
	Achromatic.		Reflector.	
1. When the reflectors have a small mirror, - -	7	to	10	Sir W. Herschel.
2. When the small mirror is not used,	$8\frac{1}{3}$	to	10	
3. When the reflectors have a small mirror, - -	$7\frac{1}{10}$	to	10	Mr Herschel.
4. When the reflector has a small mirror, - -	$7\frac{1}{2}$	to	10	Prof. Amici.

The following table shows the diameter of an achromatic object-glass that would perform as well as Sir William Herschel's great forty feet telescope, whose mirror was *four* feet in diameter.

Achromatic Telescope.	Reflecting Telescope.	
Diameter.	Diameter.	
40 inches	48 inches	Prof. Amici.
41½	48	Mr Herschel.

Art. XXVI.—*Farther Observations on Levyne, a New Mineral Species.* By the Editor.

M. Brogniart has lately published, in the *Annales des Sciences Naturelles*, an extract of a letter from M. Berzelius, dated Stockholm, March 15th 1825, which contains the following passage: "The Levyne sent me by Dr Brewster is absolutely nothing more than chabasie, in which a portion of the lime is replaced by soda." As this passage, from which the general reader would infer that Levyne was not a new mineral species, has appeared in most of the Foreign Journals, it is necessary to correct the mistake upon which it is founded.

In June 1824, after I had determined Levyne to be a new mineral, and given it that name in compliment to Mr Levy,* I sent a specimen of it, along with various others minerals, to M. Berzelius. In the list which I retained of these minerals, I have marked this specimen *Levyne and accompanying chabasie.* Mr Haidinger, who happened to be in Stockholm in August last, wrote me that Berzelius had, by some mistake, applied the name of Levyne to chabasie, which, as he remarked, would produce great confusion. This mistake surprised me very much; but the origin of it became apparent from the following passage of a letter which I received from M. Berzelius himself, of the date of 13th September 1825.

"Among the minerals which you sent me, I found, among others, Brewsterite and Levyne. The first of these has already been analyzed by M. Retzius, who had distinguished it as a particular species, under the name of *prehnitiform stilbite*, and who had found it composed according to the following formula:

$$\left.\begin{matrix} C \\ N \end{matrix}\right\} S^3 + 4AS + 8Aq.$$

With respect to *Levyne*, I have myself analyzed it, and I have found it to be composed according to the formula of chabasie, with this single difference, that it contains, at the same time, lime, soda, and potash. But Mr Haidinger, who has seen

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* See this *Journal*, vol. ii. p. 332, where I have stated, that I sent a specimen, containing *a few minute crystals*, to M. Berzelius.

the specimen from which I took the part analyzed, insists that it is not the true Levyne. It is, however, the specimen which you sent me under that name."

It is quite obvious from this passage, that M. Berzelius has analyzed the chabasie, which accompanied the Levyne, and probably along with it the Levyne itself. The Levyne occurred only in a small cavity of the specimen, and as this cavity, with the crystals which it contained, could not have existed in the specimen when examined by Mr Haidinger, who was perfectly familiar with the aspect of Levyne, it appears to me quite certain, that M. Berzelius has analyzed a substance containing crystals both of Levyne and chabasie. Had he analyzed the chabasie alone, which was more abundant in the specimen than the Levyne, then the Levyne would have remained. This opinion is confirmed by the fact, that the result of the analysis is different both from that of the ordinary chabasie, and of the chabasie from the Giant's Causeway, the last of which I have determined optically to be a new mineral species. If M. Berzelius analyzed the chabasie only, then there will be a third chabasie, possessing the properties which he ascribes to Levyne.

In another passage of his letter to M. Brogniart, M. Berzelius adds, "The *Mesole* which I analyzed, and named somewhere in Dr Brewster's *Journal*, is in the same predicament. It is merely a chabasie, rich in soda." According to our notions of mineralogical chemistry, both the mesole and the substances analyzed for Levyne are entitled to the dignity of separate species; but it would appear from the above quotations, that M. Berzelius regards them merely as varieties of chabasie.

ART. XXVII.—*On the Torpidity of the Tortoise and Dormouse.* By JOHN MURRAY, Esq. F. S. A. F. L. S., &c. &c.

IN a little volume just published, Mr Murray has put together under the title of *Experimental Researches*, a few papers written by him at various periods, on interesting subjects in Natural History. They are six in number, viz. "On the Light and Luminous

Matter of the Glow-Worm,—on the Luminosity of the Sea,—on the Phenomena of the Chameleon,—on the Ascent of the Spider into the Atmosphere,—and on Torpidity, as connected with the *Testudo Græca*, or Common Tortoise," &c. From the last of these we extract, with the author's permission, his observations on the Torpidity of the Tortoise and Dormouse, referring to the book itself for the previous details, and much curious information on the subjects of the different essays.

The tortoise may be occasionally met with in gardens in this country. The *Testudo geometrica* I have certainly seen here; but the occurrence is rare. One of three tortoises (the common,) laid three eggs in a garden at Montrose—one of these I forwarded to Professor Jameson, of Edinburgh. The size to which this creature occasionally attains is quite monstrous. I remember, some years ago, to have seen one, then semi-torpid, exhibited near Exeter 'Change, London, which weighed, if I recollect aright, *several hundred weight.* Its shell was proportionally thick, and its other dimensions bore a corresponding ratio. It was stated to be about 800 years old. In the library at Lambeth Palace is the shell of a land tortoise, brought there about the year 1623; it lived until 1730, and was killed by the inclemency of the weather during a frost, in consequence of the carelessness of a labourer in the garden, who, for a trifling wager, dug it up from its winter retreat, and neglected to replace it. Another tortoise was placed in the garden of the Episcopal Palace at Fulham, by Bishop Laud, when Bishop of that See, in 1628: this appears to have died a natural death in 1753. It is not known what were their several ages when placed in the gardens. That of which I am about to give an account, I saw in the Bishop's garden at Peterborough, adjoining the Cathedral, in the summer of 1813. It died only four or five years ago. *Why* this Episcopal predilection is a question perhaps not unworthy antiquarian research! The Testudo græca is found in the Island of Sardinia—generally weighing four pounds, and its usually computed age is about sixty years.

From a document belonging to the archives of the Cathedral, called the *Bishop's Barn*, it is well ascertained that the tortoise at Peterborough must have been about 200 years old. Bishop Marsh's predecessor in the See of Peterborough had remembered it above sixty years, and could recognize no visible change. He was the seventh Bishop who had worn the mitre during its sojourn there. If I mistake not, its sustenance and abode were provided for in this document. Its shell was perforated, in order to attach it to a tree, &c. to limit its ravages among the strawberry borders.

The animal had its antipathies and predilections. It would eat endive, green pease, and even the leek—while it positively rejected asparagus, parsley, and spinage. In the early part of the season, its favourite pabulum were the flowers of the dandelion (*Leontodon taraxacum,*) of which it would devour *twenty* at a meal; and lettuce (*Lactuca sativa,*) of the latter a good sized one at a time, but if placed between lettuce and the flowers of the dandelion, it would forsake the former for the latter. It was also partial to the pulp of an orange, which it sucked greedily.

About the latter end of June, (discerning the times and the seasons,) it looked out for fruit, when its former choice was forsaken. It ate currants, raspberries, pears, apples, peaches, nectarines, &c., the riper the better, but would not taste cherries. Of fruits, however, the strawberry and gooseberry were the most esteemed; it made great havoc among the strawberry borders, and would take a pint of gooseberries at intervals. The gardener told me it knew him well—the hand that generally fed it—and would watch him attentively at the gooseberry bush, where it was sure to take its station while he plucked the fruit.

I could not get it to take the root of the dandelion, nor indeed any root I offered it—as that of the carrot, turnip, &c. All animal food was discarded, nor would it take any liquid; at least neither milk nor water; and when a leaf was moist, it would shake it to expel the adhering wet.

This animal moved with apparent ease, though pressed by a weight of 18 stones; itself weighed $13\frac{1}{2}$ lbs. In cloudy weather, it would scoop out a cavity, generally in a southern exposure, where it reposed, torpid and inactive, until the genial influence of the sun roused it from its slumber. When in this state the eyes were closed, and the head and neck a little contracted, though not drawn within the shell. Its sense of smelling was so acute, that it was roused from its lethargy if any person approached even at a distance of twelve feet.

About the beginning of October, (or latter end of September,) it began to immure itself, and had for that purpose for many years selected a particular angle of the garden; it entered in an inclined plane, excavating the earth in the manner of the mole; the depth to which it penetrated varied with the character of the approaching season, being from one to two feet, according as the winter was mild or severe. It may be added, that for nearly a month prior to this entry into its dormitory, it refused all sustenance whatever. The animal emerged about the end of April, and remained for at least a fortnight before it ventured on taking any species of food. Its skin was not perceptibly cold:* its respiration, entirely effected through the nostrils, was languid. I visited the animal, for the last time, on the 9th June 1813, during a thunder-storm; it then lay under the shelter of a cauliflower, and apparently torpid.

It is very singular that the lettuce and dandelion should find such predilections with the tortoise. The lactescent juice of the former, from the opium it contains, is powerfully narcotic, and I have found that the extract. taraxici, applied to the sciatic nerves of a frog, acted in a similar manner to opium, by suspending voltaic excitement. It is also remarkable that these should have been rejected when the fruit season commenced, and the strawberry and gooseberry take precedence. Its antipathy to cherries is equally curious, and not less so its aversion to fluids; in which last, however, we have an analogy in the *alpaca*, &c.

On the whole, that narcotics or sedatives should take precedence, of all other kinds of food, in the former part of the season, and those that act a different part, in the animal economy, toward the autumn, is certainly surprising.

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* Dr Davy took the temperature of the *Testudo geometrica* at Cape Town, in May—air 61°; the animal 62°.5. At Columbo, in Ceylon, on 3d March, the temperature of a larger specimen was 87°, while the air was 80°.

As a proper sequel to the preceding, I may add my remarks on

The Temperature of the Skin of the Dormouse.

In the beginning of 1824, I received two dormice from a friend in Derbyshire, and commenced a series of experiments on the temperature developed by the skin. One of these I accidentally lost, it having escaped from confinement; and I was shortly necessitated, from various avocations, to resign the prosecution of my researches with the other. The following is a note of the temperatures as recorded:—

31st January 1824, Chesterfield, Derbyshire, at 25 minutes past 7, P. M.; air of the room, 48° Fahrenheit; temperature of the dormice under the breast, 103° Fahrenheit. I soon after lost one of my prisoners.

At Hull, Yorkshire, 14th February, at half-past 8, P. M.; air 51° Fahrenheit; temperature under the breast, 62°.5 Fahrenheit. *The animal semi-torpid.*

				Air.	Under breast.
Feb.	15,	At	1 h. 15 min. P. M.	46°	104°
—	—	—	8 h. 30 min. P. M.	47°.5	69° Semi-torpid.
—	—	—	3 h. 30 min. P. M.	52°	102°.5
—	19,	—	2 h. P. M,	56°	99°
—	21,	—	10 h. 30 min. P. M.	54°.5	102°
—	22,	—	12 h. 30 min. P. M.	57°	97°

On the 14th and 15th of February, the dormouse was roused from its apparent death by heat, cautiously applied.

The box which contained the dormice had a partition. One compartment contained fresh moss, well dried, in which the animals reposed *during day*, having formed for themselves a somewhat elliptical nidus. Two openings, with slides, conducted into the *outer court*, where the dormice had their food prepared for them, consisting of wheaten bread, (sometimes softened with water,) and a basin of milk. Great attention and care were bestowed on them, and the food daily supplied. The sliding pannels were shut when the compartments were cleaned, it being easy to expel them from the one to the other, and thus prevent their escape.

Though their cage was frequently in darkness during the day, the *night season* was the exclusive period in which they took food. One of them had a singular expedient when the liquid was too low in the basin. It dipped its brushy tail (somewhat resembling that of a fox,) into the dish, and carried the milk in this manner to its mouth. When the dormice are torpid, they may be tossed up into the air like a ball, (they are rolled up like one,) without discovering any index of motion or change. By keeping the dormouse in a proper temperature during the winter, its brumal torpidity may be entirely prevented; but in this case it will not outlive the following year. The dormouse is fat and in good condition when it enters into torpidity, and it issues from this state miserably lean. My dormice were extremely timid, yet they may be so tamed as to run about the table and lick the hand that feeds them. As to their sense of hearing, I found them peculiarly affected by the higher notes, or shrill tones. The eyes were like those of albinos, and injured by strong light and exposure to day.

Dr Davy gives us the following details of temperature, which approach that of the dormouse, as stated:—

			Air.	Animal.
Columbo, Ceylon,	19th Oct.	Squirrel,	81°	102°
	8th Feb.	Common Rat,	80°	102°
	16th June.	Common Hare,	80°	100°
	4th Nov.	Ichneumon,	81°	103°
	26th Feb.	Jungle Cat,	80°	99°

Dr Davy, I think, justly infers that the temperature of the human species *increases* in passing from a cold, or even a temperate climate, into one that is warm; and I think, too, that I am warranted, from my own immediate observations and experiments on myself, to add, that the temperature of man *rises* with *increase of elevation.* On the summit of the Simplon, with the ball of the instrument below the tongue, the temperature was 100°.5; on Mount Cenis, 101°; and on the Great St Bernard, 102° nearly. The temperature of animals will, no doubt, be modified by, or have some determinate relation to peculiarities in physiological character.

ART. XXVIII.—*Observations on the Intensity of Magnetism in different parts of the Earth's Surface.* By CHRISTIAN HANSTEEN, Professor of Astronomy in the University of Norway.

PROFESSOR Hansteen of Christiana, to whose discoveries and writings we owe so much of our present information respecting the magnetism of the earth, has been so kind as to transmit to us the results of his most recent experiments upon this subject, and also a corrected and more complete copy of his chart of the magnetic lines.

In order to determine the intensity of magnetism at different places, and consequently the direction of what he calls the *isodynamical magnetic lines*, or the magnetic lines of equal intensity, he had a magnetic needle of a cylindrical form, constructed with great care. This needle he entrusted to various philosophers, who counted the time in which *three hundred* horizontal oscillations were performed, in various parts of Norway, Sweden, Denmark, Prussia, Holland, France, England, and Scotland. The greater number of these were made by Professor Hansteen himself, many of them by M. Naumann, several by M. Erichsen, and a considerable number by Professor Oersted of Copenhagen, when he was travelling in England in 1823. Those which were made by this last philosopher in Edinburgh on the 4th July, and at which we had the pleasure of assisting, were performed in the field behind Coates Crescent, and nearly at the intersection of Walker Street and Melville Street. These possess considerable interest, as being the most *westerly* of all that have yet been made.

The following table contains the result of these observations, the *first* and *second* columns containing the latitude of the place of observation, and its longitude from Ferroe; and the *third* the number of seconds in which 300 oscillations are performed by the suspended needle.

PLACES.		Lat.		Long. from Ferro.		Time of 300 Oscillations.	
Berlin - - -		52°	32′	31°	2′	760″.03	
Paris - -		48	50	20	0	753.03	
London - - -		51	31	17	34	775.34	
Edinburgh - -		55	58	14	29	820.26	
Liverpool - -		53	22	14	43	801.6	
Oxford - -		51	46	16	24	779.8	
Christiansand -		58	8	25	43	820.3	
Mandal -		58	1	25	9	814.3	
Tjos - -						816 3	
Carlscrona -		56	7	33	13	785.3	
Ystad - -		55	26	31	28	779.3	
Szrim - -		52	7	34	48	748.1	
Glogau -		51	43	33	36	748.8	
Carolath -		51	46	33	37	752.7	
Zelgos - -		53	11	32	48	759.7	
Danzig -		54	21	36	18	770.4	
Marienburg -		54	2	36	42	766.0	*
Goslina -		52	34	34	43	759.7	
Aüstrin -		52	35	32	40	762.4	*
Christiana -		59	55	28	25	814.76	
Friedrichshall,	1819	59	8	29	4	821.7	*
	1822					830.3	
Quistrum	1819	58	27	29	25	816.1	*
	1820					815.4	
Hede - -		57	58	29	48	810.8	*
Gothenburg	1819	57	42	29	38	812.2	*
	1820					812.1	
Quibille -		56	47	30	30	791.6	*
Helsingburg	1820	56	3	30	23	791.1	*
	1820					790.0	*
Helfingöer	1820	56	2	30	18	789.8	*
	1820					784.6	*
Copenhagen -		55	41	30	15	788.08	
Friedrichsburg		55	56	29	58	785.9	
Soröe	1820	55	27	29	14	790.6	
	1822					790.4	
Skieberg -		59	14	28	51	826.7	
Kongsberg	1820	59	40	27	20	845.4	
	1821					839.3	
						845.1	
						837.8	
	1821					859.5	
Bolkesjö -		59	43	27	0	834.9	
Vik - -						836.8	
Tindosen -						834.6	
Oernäs -						829.1	
Ingolfsland -		59	53	26	28	833.4	
Miland -		59	56	26	36	833.4	
Tind -		60	0			835.7	
Midböen -						836.8	
Rögsland -						838.0	
Nörsteböe -		60°	20′	26°	17′	839″.8	
Holmekjärn -		60	17	25	24	832.8	
Maursäter -		60	25	25	3	829.3	
Eifjord -						852.6	
Ullensvang -		60	20	24	18	840.7	
Johnnäs-Tangen						843.8	
Gjermundshafen		60	3	23	52	846.2	
Kaarevigen -		59	45	23	7	838.2	
Findaas -		59	45	22	54	861.7	
Siggens -						824.2	
— -						837.4	
Folgeröe -		59	48	22	56	835.9	
Engesund -		59	55	22	53	840.7	
Bekkervig -		60	1	22	50	851.0	
Bratholmen -		60	21	22	47	839.5	
Bergen -							
Fort Friedrichsberg -		60	24	22	57	850.1	
Friedrichsberg						850.5	
Lunggaards. See						849.3	
Lyderhoru, 1255 feet -						843.7	
Lövstakken, 1524 feet -						904.7	
Haugs -		60	27	23	18	845.2	
Bolstadören -		60	32	23	43	847.7	
Evanger -		60	33	23	52	845.9	
Vossevangen -		60	38	24	10	850.6	
Tvinde -		60	42	24	11	849.1	
Staleim -		60	52	24	19	848.9	
Leirdalsören -		61	10	25	29	856.3	
Leirdals -		61	8	25	30	852.2	
Maristuen -		61	2	25	54	855.3	
Nyestuen -		61	8	25	59	853.2	
Vangs -		61	6	26	23	845.6	
Slidre -		61	5	26	49	853.9	
Tumlevold -		60	51	27	38	843.7	
Grans -		60	22	28	12	842.3	
Moe -		60	14	28	11	848.3	
Sundvold -		60	4	28	7	842.6	
Johnsrud -		59	57	28	19	841.5	
Hurdal -		60	26	28	49	827.3	
Trögstad -		60	8	28	56	823.8	
Sunbye -	1822	59	36	28	35	826.8	
Sooner -		59	32	28	25	827.8	
						828.1	
Böe -		59	7	29	7	823.2	
Altorp -		58	53	29	54	816.3	
Oedskjölds-Moen		58	50	29	52	816.0	
Elleöen -		59	19	28	20	826.7	
Godtskjär -		57	26	29	43	809.9	

PLACES.	Lat.		Long. from Ferro.		Time of 300 Oscillations.
Korset -	58°	49′	27°	12′	824″.5
Helgeraae -	58	59	27	34	822.7
tubberud -	59	4	27	55	818.9
Solerud -	59	21	28	9	826.5
Konnerud-Kollen 1823					875.5
Auestad -	59	49	27	53	852.1
Bragernàs -	59	49	27	53	848.6
Ravnsborg -	59	52	28	17	820.5 *
Friedrichsvärn 1824	59	0	27	44	813.5
Friedrichshavn	57	27	28	13	808.1
Aalborg -	57	3	27	36	806.0
Sporring -					799.9
Aarhuns -	56	10	27	54	796.0
Hovedkrug -					798.3
Weile -	55	43	27	12	793.9
Apenrade -	55	3	27	6	786.4
Gehlau -					787.9
Schleswig -	54	31	27	15	783.0
					785.5
Remmels -	54	7	27	18	783.0
Elmshorn -	53	46	27	18	779.1
Altona -	53	33	27	33	776.1
					774.9
Berlin -	52	32	31	2	760.4
					759.9
Lübeck -	53	51	28	21	776.2
Plöen -	54	9	28	6	780.5
Preetz -	54	13	27	57	779.0
Kolding -	55	27	27	0	789.1
Odense -	55	24	27	59	793.7
Buskerud -					845.5
Johnsknuden -					961.3
Skrimfjeld -					891.3
Rolloug -	59	59	27	5	844.0
Synhovedet -					846.3
Eje -	60	6	26	53	838.5
Ejesfjeld -					831.2
Daglio -	60	18	26	26	837.4
Torpe -	60	40	26	47	841.5
Haavi - Juni	61	7	26	42	851.2
Sept.					850.4
Urland -	61	0	24	55	849.2
Voss - Juni	60	38	24	10	856.5
Sept.					845.9
Age-Nuten -					842.7

PLACE.	Lat.		Long. from Ferro.		Time of 300 Oscillations.
Vigör -	60°	18′	24°	5′	850″.7
Bergen -	60	24	22	57	
Nyegaard -					857.1
Flöifjeldet -					854.7
Lövstakken -					844.2
Friedrichsberg					851.7
Lindaas -	60	43	23	8	843.5
Evenvig -	60	58	23	8	850.6
Yttre-Sulen -	61	4	22	45	852.1
Stensund -	61	3	22	52	852.9
Pollefjeld -					861.8
Askevold -	61	24	23	7	861.1
Vilnäs -	61	22	22	58	860.7
Sougesund -	61	22	23	11	861.7
Alden -	61	22	22	50	850.7
Bueland -	61	17	22	44	851.2
Sveen -					856.4
Quamshest -					849.8
Förde - Juli	61	32	23	48	858.9
Aug.					858.8
Jölster -	61	35	24	10	848.6
Gloppen -	61	51	24	6	861.9
Indvig -	61	49	24	34	860.4
Horningdal -	61	59	24	33	862.6
Hälsylta -	62	7	24	54	864.8
Nordal -	62	18	25	13	870.3
Veblungsnäs -	62	31	25	39	868.3
Fladmark -					862.9
Nyestuen -					862.7
Fogstuen -	62	5	27	9	856.9
Jerkin -	62	12	27	29	846.5
Foldal -	62	7	27	57	855.5
Kongsvold -	62	18	27	36	860.0
Drivstuen -	62	26	27	41	858.0
Riise -	62	31	27	41	858.1
					859.8
Näverdal -	62	42	28	6	858.7
Stöa -	62	32	28	21	860.4
Göra -	62	35	27	2	862.1
Tofte -	61	58	27	10	859.3
Vauge -	61	51	27	4	860.8
Vinje -	60	52	24	22	848.2
Nyestuen -	61	8	25	59	852.1
Skougstad -	61	10	26	12	853.7
Smedshammer -	60	29	28	14	841.9
Sundvold -	60	4	28	7	839.2

The following additional observations have been sent us by Professsor Hansteen:

Carlscrona, - - - -	735
Breslau, - - - -	741
Stockholm, - - - -	815
Hernosand, - - - -	850

These various results have been laid down on a map by Professor Hansteen; but, as they occupy only a small part of Europe, we do not think it necessary to copy his chart. Any of our readers, however, may easily lay down, upon a map of Europe, the lines of equal magnetic intensity, either from the above tables, or more simply by the following directions:

1. The line of 750, or the line in which 750 seconds are required for the performance of 300 oscillations, passes one-fourth of a degree to the south of *Paris* and *Rheims*, and one-third of a degree to the south of *Gotha* and *Gaslin*. *

2. The line of 775 passes about one-third of a degree south of *London*, and through *Amsterdam* and *Lubeck*.

3. The line of 800 passes about the fifth of a degree north of *York*, *Sporring* in Jutland, and *Falkenberg* in Sweden.

4. The line of 820 passes through *Edinburgh*, and a little to the south of *Christiansand* in Norway, and *Carlstadt* in Sweden.

5. The line of 865 passes through *Hirdal* in Norway.

As the lines are almost equidistant, and nearly parallel, all the intermediate ones may be readily inserted.

Professor Hansteen has added the following very interesting table, containing the observed dip of the needle, and the computed magnetic intensity in various parts of the world, that of the equator being unity or 1.0000. A similar table was printed in Professor Hansteen's paper, in Poggendorff's *Annalen der Physik*, but the column of intensity had been wrong computed for all the places in the north of Europe, and we are happy to be able, through Professor Hansteen's kindness, to present our readers with a corrected copy.

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* The line of 740, of which only one point has been determined, passes through Breslau.

PLACES OF OBSERVATIONS.	Dip.	Intensity.
	South.	
Port du Nord	75° 50′	1.5773
Port du Sud	70 48	1.6133
Surrobaya in Java	25 40	0.9348
Amboina	20 37	0.9532
Lima	9 59	1.0773
Magnetic Equator in Peru	0 0	1.0000
	North.	
Tompenda	3 11	1.0191
Loxa	5 24	1.0095
Cuenca	8 43	1.0286
Quito	18 22	1.0675
St Antonio	14 25	1.0871
St Carlos	20 47	1.0480
Popayan	20 53	1.1170
Santa Fe de Bogata	24 16	1.1473
Javita	24 19	1.0675
Esmeralda	25 58	1.0577
Carichana	30 24	1.1575
St Thomas	35 6	1.1070
Carthagena	35 15	1.2938
Cumana	39 47	1.1779
Mexico	42 10	1.3155
Atlantic Sea		
B. 20°46′ n.L.41°.26′w. F.	41 46	1.1779
— 11 0 - — 44 32 —	41 57	1.2617
— 12 34 - — 33 14 —	45 8	1.2300
— 14 20 - — 28 3 —	52 55	1.2830
— 20 8 - — 8 34 —	56 42	1.2510
— 21 36 - — 5 39 —	47 49	1.2617
— 25 15 - — 0 36 —	60 18	1.2830
Portici	60 5	1.2883
Neapel	61 35	1.2745
Rome	61 57	1.2642
Vesuv. Crater	62 0	1.1933
St Cruz, Teneriffe	62 25	1.2723
Valencia	63 38	1.2405
Florence	63 51	1.2782
Atlantic Sea, 32° 16′ n. 2° 52′ w.	64 21	1.2938
Barcellona	64 37	1.3482
Marseille	65 10	1.2938
Nimes	65 23	1.2938
Mailand	65 40	1.3121
Montpellier	65 53	1.3482
Airola	65 55	1.3090
Turin	66 3	1.3364
Medina del Campo	66 9	1.2938
Lans le Bourg Mont Cenis	66 9	1.3227
Como	66 12	1.3104
St Michel	66 12	1.3488
Lyon	66 14	1.3334

PLACES OF OBSERVATIONS.	Dip.	Intensity.
St Gotthardt	66° 22′	1.3138
Mont Cenis	66 22	1.3441
Ursern	66 42	1.3069
Altorf	66 53	1.3228
Atlantic 37° 14′ n. 3° 30′0″	67 30	1.3155
Sea 38 52 — 3 40	67 40	1.3155
Madrid	67 41	1.2938
Tübingen	68 4	1.3569
Atlantic Sea 38°52′n.3° 40′0″.	68 11	1.3155
Ferrol	68 32	1.2617
Paris	69 12	1.3482
Göttingen	69 29	1.3485
Berlin	69 53	1.3703
Carolath	68 21	1.3509
Berlin	68 50	1.3533
Danzig	69 44	1.3737
London	69 57	1.3697
Ystad	70 13	1.3742
Schleswig	70 36	1.3814
Copenhagen	70 36	1.3672
Odense	70 50	1.3650
Helsinburgh	70 52	1.3782
Kolding	70 53	1.3846
Soröe	70 57	1.3842
Friedrichsburg	70 59	1.4028
Aarhuus	71 13	1.3838
Aalborg	71 27	1.3660
Odensala	71 39	1.3666
Friedrichshaven	71 48	1.3842
Gothenburg	71 58	1.3826
Altorp	72 14	1.3891
Korset	72 24	1.3735
Quistrum	72 27	1.4070
Skieberg	72 29	1.3725
Elleöen	72 38	1.3340
Helgeroae	72 39	1.3980
Soner	72 41	1.3835
Christiana	72 34	1.4195
Ryenberg	72 45	1.4208
Bogstad	72 34	1.4378
Bogstadberg	73 13	1.4195
Nasoden	73 2	1.4517
Bärum	72 41	1.3902
Bolkesjöe	73 15	1.4053
Ingolfsland	73 19	1.4159
Nörsteböe	73 33	1.4136
Drammen	73 37	1.3771
Maursäter	73 44	1.4656
Ullensvang	73 44	1.4260
Gran	73 45	1.4221
Kongsberg	73 47	1.4144

PLACES OF OBSERVATIONS.	Dip.	Intensity.	PLACES OF OBSERVATIONS.	Dip.	Intensity.
Tomlevold	73° 50′	1.4246	Davis Straits 68° 22′ n. 36° 10′ w.	83° 8½′	1.6365
Bekkervigg	73 58	1.4114			
Vang	73 59	1.4308	Hare Island 70° 26′ n. 37° 12′ w.	82 49	1.6406
Bergen	74 3	1.4220			
Moe	74 3	1.4254	Baffin's Bay 75° 5′ n. 42° 43′ w.	84 25	1.6169
Maristuen	74 4	1.4058	Baffin's Bay 75 51 — 45 26 —	84 44½	1.6410
Leierdal	74 6	1.4190	Baffin's Bay 76 45 — 58 20 —	86 9	1.7052
Slidre	74 34	1.4543	Baffin's Bay 76 8 — 60 41 —	86 0	1.6885
Brassa	74 21	1.4471	Baffin's Bay 70 35 — 49 15 —	84 39	1.6837

The following table shows the law of variation from the Equator to the Pole.

Magnetic Dip.	Magnetic Intensity.
0°	1.0
24	1.1
45	1.2
64	1.3
73	1.4
76⅔	1.5
81	1.6
86	1.7

ART. XXIX.—*On the Magnetising Power of the more refrangible rays of Light.* By Mrs MARY SOMERVILLE.

WE are delighted in having this opportunity of making our readers acquainted with the beautiful experiments on the magnetising property of the violet ray, which have been recently made by our accomplished countrywoman, Mrs Somerville.

This subject has been long one of deep interest to the scientific world, but it has unfortunately been involved in a degree of uncertainty, which is seldom attached to a point of experimental inquiry.

Dr Morichini, a respectable physician in Rome, discovered this remarkable property of the violet ray. His experiments were successfully repeated by Dr Carpi of Rome, and the Marquis Cosimo Ridolfi at Florence; but as M. Dhombre Firmas, who resides at Alais, and Professor Configliachi of Pavia, had both failed in obtaining any magnetic effect from violet light, and as M. Berard, a most skilful experimenter, had observed only casual indications of magnetism, the discovery of Morichini was brought into considerable discredit, both in France and England.

Fortunately, however, for the reputation of the Italian physician, his experiments were performed both before Sir Humphry Davy, and Professor Playfair,—before the former in 1814, and before the latter in 1817. Sir Humphry Davy, whom we had the pleasure of meeting at Geneva in 1814, on his return from Italy, mentioned to us that he had paid the most diligent attention to one of Morichini's experiments, and that he saw with his own eyes an unmagnetised needle rendered distinctly magnetic by violet light.

When Professor Playfair was at Rome, he saw the experiment performed by Dr Carpi, in the absence of Morichini, before a party of English and Italian gentlemen. The following account of the experiment was drawn up from a conversation which the writer of this notice had with that distinguished philosopher, and was afterwards submitted to him for his approbation.

" The violet light was obtained in the usual manner, by means of a common prism, and was collected into a focus by a lens of a sufficient size. The needle was made of soft wire, and was found, upon trial, to possess neither polarity nor any power of attracting iron filings. It was fixed horizontally upon a support, by means of wax, and in such a direction as to cut the magnetic meridian at right angles. The focus of violet rays was carried slowly along the needle, proceeding from the centre towards one of the extremities, care being taken never to go back in the same direction, and never to touch the other half of the needle. At the end of half an hour, after the needle was exposed to the action of the violet rays, it was carefully examined, and it had acquired neither polarity, nor any force of attraction ; but after continuing the operation twenty-five minutes longer, when it was taken off and placed on its point, it traversed with great alacrity, and settled in the direction of the magnetical meridian, with the end over which the rays had passed turned towards the north.

It also attracted and suspended a fringe of iron filings. The extremity of the needle that was exposed to the action of the violet rays, repelled the north pole of a compass needle. This effect was so distinctly marked, as to leave no doubt in the minds of any who were present, that the needle had received its magnetism from the action of the violet rays."

Such was the state of this subject when Mrs Somerville directed to it her attention; and it is no slight praise to say, that she has set to rest a question on which the scientific world was divided, and that by the sagacity and ingenuity with which she has conducted her experiments, she has rendered visible, even in our northern climate, one of the most delicate of the magnetic influences, which, it was agreed on all hands, required for its developement the serene sky of an Italian climate.

The following is a general outline of these interesting experiments.

Having obtained the prismatic spectrum by means of an equiangular prism of flint glass placed in a hole in the window-shutter, Mrs Somerville took a sewing needle, about an inch long, and entirely devoid of magnetism. * Conceiving that no polarity would be superinduced if the whole needle were exposed to its action, she covered one half of it with paper, and exposed the other half to the violet rays of the spectrum cast upon a pannel at the distance of five feet. *In about two hours, the needle had acquired magnetism, the exposed end exhibiting north polarity.* This experiment was often repeated, and always with the same result.

By a similar process, Mrs Somerville ascertained that the *indigo* rays had nearly as great an effect as the violet, and that the *blue* and *green* rays likewise produced the same effect, though in a less degree.

Mrs Somerville next tried the *yellow*, *orange*, and *red* rays, but neither in them nor in the calorific rays, was the slightest effect produced, even when the experiments were continued for three successive days.

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* This was ascertained by its attracting indifferently either pole of a sewing needle magnetised in the usual way. This magnetised needle was pushed through a piece of cork, in which was inserted a glass cap, and it was in that state made to revolve freely on the point of another sewing needle.

Mrs Somerville now applied the same method to pieces of clock and watch springs, about 1½ inches long, and from ⅛ to ¼ of an inch broad,* and they were found to receive a stronger degree of magnetism from the violet rays, an effect which was attributed to their blue colour, and their greater extent of surface. Bodkins were not affected. When the violet ray was concentrated by a lens, the magnetic influence was imparted to the needles in a shorter time.

In order to give additional confirmation to these results, Mrs Somerville exposed magnetised needles, half covered as formerly, to the sun's rays transmitted through glass coloured blue by cobalt, and they were distinctly magnetised as before. Needles exposed under green glass received the same property.

Mrs Somerville now inclosed unmagnetised needles in pieces of *blue* and *green* ribband, one half of each being covered with paper, and after they had hung a day in the sun's rays behind a pane of glass, they had acquired magnetic polarity, the exposed ends being north poles, as in the former experiments. When *red*, *orange*, or *yellow* ribband was used, no magnetic influence was imparted.

In performing these experiments, Mrs Somerville found that the most favourable time of the day was from ten to one o'clock; and that, as the season advanced, the magnetism acquired was less permanent, as the needle required a longer exposure to acquire the same degree of magnetic virtue.

Although Mrs Somerville has thus established a most important fact in science, yet the subject is by no means exhausted; and we would recommend to her attention the zealous prosecution of it, in reference to the examination of the other physical properties of the solar spectrum.

More than twelve years ago, Dr Brewster communicated to the Royal Society of Edinburgh a paper, in which he endeavoured to show, that there existed visible rays beyond the spectrum, and possessing a high degree of refrangibility; and that each homogeneous colour of the spectrum was accompanied with rays of greater refrangibility. This increased refrangibility was ascribed to a change produced upon the light by

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* When these possessed any magnetism, it was removed by heating.

the collision of its particles, both at its emission from the sun, and at its refraction or reflection from solid bodies. The experiments on which these results were founded, were exhibited to the Honourable Lord Glenlee, and to Professor Russel, Vice-Presidents of the Royal Society of Edinburgh; and, in 1814, they were described to some foreign philosophers of distinguished eminence. The author, however, was desirous of extending his experiments before he gave them to the public, and his memoir is accordingly still in MS.

ART. XXX.—HISTORY OF MECHANICAL INVENTIONS AND PROCESSES IN THE USEFUL ARTS.

1. *Description of a simple Punt-Boat for saving time and labour.* By ANDREW WADDELL, Esq. F. R. S. E. Communicated by the Author.

THIS Punt-Boat is shown in Plate V., Fig 12. It is 60 feet long, 16 feet broad, and 4½ feet deep.

It carries its lading upon deck, and it is for the purpose of transporting stones and other materials for constructing wears or breakwaters, and for removing obstructions in dry and bar harbours.

In the interior of the boat below deck, there is a water-tight space built on one side, occupying about one-third of the breadth of the boat, and the whole of the length, which space has no connection with any other part of the interior.

In the bottom of this space there is an opening with a valve to shut at pleasure, capable of admitting as much water in one minute, as will sink down that side of the boat, and raise the other; thereby forming an inclined plane, and admitting of the stones or other material on the deck of the boat sliding easily overboard into the water, after the manner in which a loaded cart is emptied.

The boat will then instantly resume nearly its upright position, and the valve being left open, the water that was admitted into the above mentioned space, will run out again to the level of the water without. The valve is then to be shut, and any water that remains in the said space pumped out in a few minutes, by means of a wide-chambered pump, and the aid of one man.

A boat of this construction will be most useful in forming breakwaters, by dropping the stones at high water, or at any time in deep water, exactly on the spot wanted; but the above mentioned valve should be made to open and shut with a screw, so that, should the lading be required to be put overboard at different parts, the side of the boat might be sunk no further than to admit of a man sliding the stones down one after another.

This boat, when light, draws about one foot and ten inches, and when loaded, about four feet water, which difference of two feet and two inches, when immersed will displace a body of water equal to 36 tons weight or more.

The bilge keels attached to the bottom of the boat, are for the purpose of preventing, in some measure, its flat bottom from coming in too close contact with the mud, when deeply laden, which otherwise might prevent the boat from rising with the flood-tide, when grounded in such situations; and these bilge keels being firmly united to the bottom of the boat, serve to strengthen the whole of its frame.

2. *Method of condensing wood and giving it a closeness of grain for resisting moisture, for the construction of furniture and other purposes.* By MR JAMES FALCONER ASTLIE.

This useful process, for which the inventor has taken out a patent, consists in cutting the timber into planks with parallel surfaces. These planks are passed between parallel iron or steel rollers with highly polished surfaces, which condense the wood by their pressure. The pressure thus applied must be at first small, and afterwards gradually increased, otherwise the wood will be crushed or split. The best way of applying the principle is to place several pairs of rollers behind each other, the distance between each pair progressively diminishing. The sap or moisture will thus be forced out of the pores of the wood, and the ends and sides of the plank, and it will thus be rendered stronger, heavier, and harder, and less pervious to moisture, than in its natural state. When used in furniture, it is less liable to scratch, and does not shrink. Oak and mahogany admit of much more compression than fir or other slight woods, and Honduras mahogany may be rendered as hard and heavy as the best Spanish. If one of the rollers is sufficiently bright, a finished polish will be left upon the surface. This plan is particularly useful in ship carpentry, for making wooden bolts, trenails, and dowels of a compact quality.

3. *Discovery of a Fine Sand for Flint Glass at Alloa, superior to that from Lynn Regis.* By ROBERT BALD, Esq. F. R. S. E. Civil Engineer.

At a late meeting of the Royal Society of Edinburgh, Mr Bald read an account of a fine sand which he had found at Alloa, and which was superior to the sand of Lynn Regis, so long used both in Scotland and England for the manufacture of flint glass.

This material occurs among the lower strata of the coal field of Alloa, in the form of a whitish sandstone, which has been long worked for building, and it can be so easily obtained that it may be delivered at Alloa for a shilling a ton, whereas the Lynn Regis sand costs 20 shillings in Scotland Upon examining this sandstone, Mr Bald found that it consisted of pure crystals of silex held together with only a slight quantity of matter, from which it could be easily separated by washing, and he immediately recommended it as a substitute for the Norfolk sand. A specimen of flint glass was accordingly made with it by Mr Marshall of the Alloa Glass-Works, and we have no hesitation in saying that it is perfectly colourless, and equal to the finest flint-glass we have seen. We have also examined with the microscope the sand itself when washed, and are satisfied that it is entirely free of all foreign matter.

This discovery is of great importance to the glass manufacturers of Scotland, and we trust that this respectable body will evince their gratitude to Mr Bald for the great benefit which he has conferred upon them.

ART. XXXI.—ANALYSIS OF SCIENTIFIC BOOKS AND MEMOIRS.

I. *Considerations on Volcanos,—the Probable Causes of their Phenomena,—the Laws which Determine their March,—the Disposition of their Products,—and their Connection with the present State and past History of the Globe; Leading to the Establishment of a New Theory of the Earth.* By G. POULETT SCROPE, Esq. Secretary to the Geological Society. London, 1825.

ALTHOUGH geology has of late years been cultivated by men of genuine talents, and has now begun to assume the form of a science, yet it has not been entirely wrested from the dominion of the Charlatans. This numerous and thriving race, after being driven from the domains of natural philosophy, and, more recently, from those of chemistry, found a hospitable shelter among the strongholds and obscurities of geological speculation. No sooner was the barbarous vocabulary acquired from a few lectures, than every valley came under the surveillance of a philosophical surveyor. Its strata, both visible and invisible, were speedily pourtrayed in all the prismatic tints; the process by which the Almighty made it was soon discovered, and our young geologist appeared before the public with this *magna charta* of his claims to be enrolled among the sages of his country. The transactions of our scientific bodies, and all the numerous records of wisdom, were filled with these precious compositions; and the republic of letters was threatened with a second deluge from the aqueous vapour which was thus suddenly precipitated upon her territory.

From the recollection of such things, it is refreshing to contemplate geology and mineralogy under their new aspect. Men of genius and science have entered upon these delightful studies; men of fortune have journeyed into distant lands to explore their mysteries; and the various attainments of modern research have been called into requisition to illustrate the structure and formation of our globe.

The work of which we propose at present to give a copious analysis, is one of those excellent productions which appear at very distant intervals, and give a new tone to scientific inquiry. Mr Poulett Scrope has not only enjoyed numerous opportunities of studying many of the grand operations which he describes, but he has exercised unusual diligence in making himself acquainted with the facts and reasonings of our most eminent geological travellers. When we say, that this work was written after visiting the active volcanos of Ætna, Vesuvius, and Stromboli, and exploring the extinct craters of Auvergne, of Italy, of the Rhine, and of the North of Germany, we offer our readers some pledge for the accuracy of its facts, and the soundness of its reasonings.

The work commences with a descriptive account of the Volcanic Phenomena, in which the author treats of the number and dispersion of volcanic vents on the surface of the globe, a detailed catalogue of which is given in an appendix. The number already known is supposed very much within that which really exists, for many reasons, but particularly because the intervals of rest between eruptions are often of such long duration that the former activity of the vent is unrecorded, and again, because it is probable that numerous vents exist under the sea, whose activity, however frequent, cannot be made known to us till the peak of the volcano rises to within a short distance of the surface. Volcanic phenomena are classed into *subaerial*, or those which take place in the open air, and *subaqueous*. Of the former class, which is more open to study than the latter, some take place from *new*, others from *habitual* vents. The last are most common, and most accessible to observation. The condition of all habitual volcanos, or sources of erupted matter, appears to belong to one or other of the three following phases:

1. In which the eruption is permanent (as in Stromboli, &c.)
2. In which eruptions are frequent, prolonged, and of moderate violence, and the intervals of repose short.
3. In which intense eruptive paroxysms, of brief duration, alternate with lengthened intervals of quiescence.

These phases are separately considered, and examples given of the phenomena of each, as well as a particular description of all the remarkable circumstances which accompany and characterize a volcanic paroxysmal eruption, and which appear to the author to present so great an uniformity in all places, and at all times, as to warrant the conclusion that the main phenomena are invariably the same; "no farther discrepancies existing, than what are fairly referable to the modifications produced by local accidents, or by differences in the intensity of volcanic force developed, and in the mineral quality of the erupted substances."

In Chap. II. the immediate causes of these phenomena are investigated; and it is observed, that all their circumstances, as well as the direct observations of the author himself, Spallanzani and others, go to prove the existence, between every volcanic vent, of a mass of lava, or crystalline rock in a state of actual ebullition; the generation, or expansion, of electric fluids within its interior producing intumescence and elevation, and the explosions which take place from its surface. The nature of this elastic fluid has been ascertained by direct experiment, and it appears to consist almost wholly of aqueous vapour or *steam*. The uniform dissemination of air-vesicles through many lavas proves the vapour to have been generated throughout every part of their mass. We must then suppose the existence of water in combination with the other elements of the rock. This leads to an examination of the nature of lavas; and the author finds reason to conclude, that the crystalline particles of which they are composed were not formed as the substance cooled; that few or no lavas are ever reduced naturally to complete *fusion* (none in fact but the glassy lavas, obsidian, pearlstone, &c.); but that they consist of crystalline particles of various sizes, which, when the rock is solid, contain very minute portions of water mechanically combined with their substance,* that is, intervening between the parallel plane surfaces of the crystals. In this case, any continued accession of caloric to a mass of such rock confined beneath the crust of the earth, and already at an intense temperature, must sooner or later so increase the expansive force of the confined water, as to reduce more or less of it to vapour, breaking through or heaving upwards the confining crust, and causing the lava to intumesce and rise outwardly in a state of imperfect liquefaction through any fractures which this violent expansive effort may create in the overlying beds. The liquidity of lava consists, under this idea, not in its absolute fusion, but in the mobility afforded to its component crystals by the intervention of more or less of highly elastic vapour between the opposite facets, and the degree of liquidity will therefore depend on the quantity of vapour generated through the substance, and the *size* of the component crystals. But at a certain term in the relative proportion of these circumstances, the vapour will become so abundant as to enable a part of it to unite into bubbles, which, by their inferior specific gravity, are urged to rise upwards, and escape from the surface of the liquefied mass in which they are formed. "The quantity of vapour discharged in this manner consists therefore at all times of the surplus of that which has been generated in the lava beyond what is necessary to communicate to its component crystals the degree of mobility required for the union of this surplus vapour into parcels or bubbles, and the rise of these, when formed, to the surface." The explosions of all volcanic eruptions are produced by the rapid ascent and escape of such bubbles, collecting as they rise through the lava into prodigious volumes of vapour; and the remainder of these parcels of vapour, which are prevented from thus escaping by the superficial induration of the exposed masses of lava, occasions the cellular and cavernous structure of such rocks, both on the large and small scale. The consolidation of liquefied lava, under these circumstances, takes place, not only by loss of temperature, but also, and chiefly, by the immediate escape of

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* This, at least, is the temporary assumption of the author, who, in a later part of the work, observes, that he inclines to suppose the water itself may be generated, together with other fluids, by the volatilization of a superficial pellicle of the proximate crystals, and the combination of the oxygen and hydrogen set free by this process, through the intense temperature pervading the mass. Such a supposition, if not supported, is perhaps not opposed by the present state of chemical knowledge; and would explain all the phenomena of lavas, as well as the idea of a mechanical interposition. In short, the existence and general dissemination of water, or rather steam, in lavas, is a positive fact, susceptible of direct and incontrovertible proof; and it is indifferent to the purpose of the author how, or at what time, we suppose it to be produced there.

the vapour (which alone occasions the mobility of the crystals) on their superficial exposure to the outward air; subsequently, by exudation through the pores or interstices of that hardened surface, the process is propagated to the interior of the bed of lava. Consolidation may also take place by increase of pressure on the lava, without any change in its temperature; the vapour being condensed till the crystals reunite, more or less conformably, according as they have been more or less broken up, or *disintegrated*, by mutual friction when in motion, and by the disaggregative force of the vapour generated within them.

Having developed these original ideas as to the nature of lava, which are supported by facts and arguments, the author goes on to explain all the phenomena of earthquakes and volcanos, and the circumstances of disposition, structure, and mineral character in volcanic rocks, by the assumption, which, however, is strongly supported by a large body of evidence, that the interior of the globe, at no great depth from the surface, consists of a mass of crystalline rock at an intense temperature; and, therefore, that a continual supply of caloric passes off from the centre towards the circumference, wherever the nature of the superficial rocks allows of its transmission, or temporary vents are opened for its more free escape.

Where the superficial rocks, from their constitution, (as is presumed to be the case with the schistose strata, the limestones and sandstones,—or, when consisting of unstratified crystalline rocks, from the intumescence and refrigeration they have undergone,) are very inferior conductors of caloric, the heat transmitted from below will be concentrated in the beds of denser crystalline rock beneath these, and continually augment their temperature, and with it their expansive force. The overlying rocks will sooner or later necessarily yield to this force. At this time, the expansive force will be greatest in the lower parts of the crystalline bed. The upper will be therefore raised *en masse*, in a solid state. This forcible elevation must be accompanied by the rupture and dislocation of the overlying rocks; and every such fracture in the earth's crust must create a jarring shock and vibratory motion in them, which will be propagated along the prolongation of each rocky bed, with an intensity proportionate to its solidity; the strata which are only in contact with those broken through, sharing in the vibration in an inferior degree. These shocks are earthquakes, none of which are supposed to take place without a certain, though often inappreciable elevation of the surface of the globe. The fissures formed in this manner will be more or less wedge-shaped; some opening outwardly, some downwards. The latter allow of the sudden expansion and liquefaction of the intensely heated rock in which they are formed, and by this process the fissure is filled with intumescent lava. Where the fissures are broken through, the upper beds of the heated crystalline rock, *contemporaneous* veins, or subordinate masses are produced, where, through overlying strata of other characters, *injected* veins or dikes. The friction occasioned by the resistance of the sides of the cleft to the rise of the crystalline matter partially disintegrates the crystals, and gives a finer grain to the substance of the vein than that of the including rock;

and also often occasions the crystals composing the lateral parts of the vein to be more comminuted than those in the centre. The matter filling these veins is immediately consolidated both by loss of temperature and pressure, and the fractured rocks are thus repaired and strengthened. An interval of tranquillity will then succeed, until a similar expansion occurs. It is thus that the overlying rocks which form the surface of the globe must be progressively elevated more and more, by the successive dilatations of the inferior lava-bed, unless some avenues are opened within a limited distance, for the more tranquil escape of the subterranean caloric.

But the formation of such apertures (*volcanic spiracles*) must sooner or later result from the continuance of this process; for, at every crisis of expansion, those cracks only are repaired by the injection and consolidation of lava, which open downwards. Others which increase in width towards their upper extremity, will remain open, and effectually weaken that part of the crust of rocks across which they are broken. Subsequent expansions, taking effect most powerfully on these weak points, will widen and extend these fissures, until some one is sufficiently deep and broad to permit the lava in the lower parts of the fissure to rise by its intumescence into communication with the atmosphere on one or more points at the upper extremity, thus producing a volcanic vent or vents.

In most instances, the fissure must be narrow, irregular, and intricate, and the distance great from the external surface to the focus of ebullition. The intumescence will be proportionately slow, and the repressive force, consisting of the weight of the rising column of lava, and the accumulation of fragments broken from the sides of the fissure, may stifle the ebullition before the lava has reached the lips of the orifice. Such may be called an abortive eruption, vapour alone escaping outwardly before the fissure is closed. The author attributes the clouds of smoke or vapour, and projections of fragments that have been discharged during violent earthquakes from crevices in the soil to a subterranean effervescence of this nature.* But where the width of the fissure, and other circumstances permit it, the lava reaches the mouth of the vent, and a regular volcanic eruption occurs.

The author proceeds to examine the laws which regulate the developement of the eruptive force. This is opposed by the repressive force, consisting of,

1. The supported column of liquid lava;

2. The reaction of the vapour generated from the impediments to its expansion;

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* It appears that the aqueous vapour emitted from fissures in the surface soil during earthquakes is in general very great; since Ferrara mentions that extraordinary storms of rain immediately follow the occurrence of these phenomena. In the violent earthquake which affected the whole northern coast of Sicily in 1823, a remarkable dense black cloud collected over the district affected, and shortly was condensed into terrific deluges of rain. The same thing happened during the great earthquake of Catania in 1693, and that of Calabria in 1783.

3. The external pressure on the surface of the intumescent lava.

Of these elements, the last is the most subject to variation, particularly from changes, 1. In the dimensions of the vent; and, 2d, In the quantity and weight of matter pressing on the surface of the lava within the vent. 1. The violent rise and explosive escape of the elastic fluids must at first break up and enlarge the fissure, and consequently, the energy of the eruption will progressively increase from its commencement; but, 2d, the weight and consolidation of the lava protruded from the orifice, and above all, the immense accumulation of fragmentary ejections within and around the vent, must, before long, give the predominance (unless under extraordinary circumstances) to the force of repression; the crisis of the eruption is past, its violence diminishes progressively, and it is at length wholly checked. Hence, a general law is deduced, that the developement of volcanic action universally tends to its own extinction by augmenting the opposite force of repression.

The author then considers the condition at this time of the dilated mass of lava below, or the focus. Its temperature has been suddenly lowered below that of the surrounding crystalline mass—it therefore abstracts caloric from thence. If this accession of caloric keeps pace exactly with the increase of the repressive force, the eruption is permanent. If not, the continual increase of the expansive force in the lower parts of the crystalline bed, resolidifies the upper parts, and seals up the vent.

But the expansive force of the focus continues to increase, and, perhaps at length overcomes the resistances opposed to it. If it break out repeatedly in the same direction, it produces an *habitual volcano,* and finally a *volcanic mountain.*

If the repressive force prevail till the focus is equalized in temperature to the stratum in which it lies, it shares in the general expansive force of that stratum. This is continually increasing, and must at length find a vent, generally on the same spot as before, and hence the frequency of habitual volcanos. If on a fresh point, probably on the continuation of the original fissure, the rocks having been shattered along that line by the earlier shocks; hence the linear trains of volcanic vents so often noticed. The distance of the new from the former vent, must depend on local circumstances in the structure, tenacity, and other elements of resistance in the overlying rocks. In this manner, the draught of caloric, passing from the great reservoir below to the exterior of the globe, is shifted from one vent to another; the focus of each active volcano abstracting caloric from its inclosing walls; neighbouring vents will also more or less retard the activity of each other; and the extreme energy of one may cause the absolute *extinction* of the other. Other more tranquil modes of escape for subterranean caloric are found by the author in thermal springs, which result from the condensation of aqueous vapour percolating through minor crevices from the subterranean heated lava-rock. So long as by these, or other modes, the caloric passes off in the ratio in which it is received from below, the *general* expansive force remains invariable. If not, this force increases, and must at length prevail over the united forces of repression, and produce elevations of the superficial strata, earthquakes, &c. The author thus distinguishes between the general or *primary*, and the local or *secondary* expansive forces, each having their peculiar force: the first residing in the general subterranean bed of heated rock; the second in minor and less deeply seated foci. The laws thus determined hold good, whatever the scale of magnitude of the phenomena they give rise to, whether the elevation of a few square yards of rock, or of a whole continent; a quiescent interval of a few hours, or of centuries.

Every habitual volcano acts, therefore, as a *safety-valve* to the globe, the caloric which emanates from its anterior passing off by means of this vent into outer space. But these eruptions are necessarily accompanied by circumstances tending to impede their continuance, and they are thus, in the generality of cases, rendered intermittent. Where the opposing forces of expansion and repression are in equilibrio, the volcano is in the first of the phases noticed above. Where they oscillate frequently about an equilibrium, in the second. Where the oscillations are on a large scale, in the third. The first case must necessarily be very rare. In the instance of Stromboli, our author attributes the permanence of its eruption solely to the peculiar form of the crater; the aperture of the volcano having a high and sloping ridge only on one side; on the other a precipitous slope down to the sea, which is there unfathomable. Owing to this remarkable figure, less than one half of the scoriæ projected from the aperture at each explosion fall again into it, and, consequently, there can be no accumulation of fragments on the surface of the lava within the vent, which always remains level, or nearly so, with the mouth of this aperture, without being discharged otherwise than in fragments tossed up by the bubbles of vapour which escape from it. The volcano of Bourbon again, a similar example of almost continual eruption, is shown by the author to owe this character to another peculiarity of form. This volcanic mountain is a complete obtuse cone, and there exists at the apex an almost permanent source of a very fluid and glassy lava, which slowly boils over the lips of the circular orifice, and flows rapidly on all sides down the steep slopes of the cone. Thus, in this, as in the former instance, the force of repression remains fixed, and that of expansion being always slightly in excess, the eruption is permanent. Where, however, these forces are so nearly in equilibrio, a very slight addition to that of repression may stop the eruption for a certain time, and Mr P. S. supposes that even changes in the density of the atmosphere will occasionally produce this effect; and that a permanently active volcano, whose phenomena are, according to him, occasioned by the ebullition of water in the focal lava, from constant and uniform additions of caloric to it, will be as sensible as the barometer to variations in the pressure of the atmosphere on the surface of the supported column of lava; the ebullition ceasing for a few minutes or hours as the density of the atmosphere increases, and increasing in energy as it is diminished. Observation confirms this opinion. Stromboli is made use of as a weather-glass, and securely relied on by the fishermen of the Lipari isles; other volcanos likewise have been observed to augment their activity in tempestuous weather, and, in general, to be most violent in the stormy season of the year. Earthquakes also have been often observed to coincide in time with hurricanes or violent storms; and the author notices the probability that a diminution of the pressure of the atmosphere, taking place simultaneously on a large extent of the earth's surface, beneath which the ever-active force of expansion is continually pressing upwards, and often restrained by only the slightest degree of superiority in the combined forces of repression, may occasionally give the predominance to the former force, and determine one of those partial elevations of the crust of the globe to which he attributes the phenomena of earthquakes.

It is remarked, that an individual volcano may occasionally pass from one of the phases, distinguished above, into another; or may even exist in two phases at once, having a double system of operations, corresponding to two different foci, seated one below the other; the latter perhaps at a considerable elevation in the chimney or main vent of the volcano, and giving rise to minor and frequent eruptions; the former at a much greater depth, and productive of rare and violent *paroxysmal* eruptions. It is obvious that the last system must be in activity wherever the supply of caloric is in a faster ratio than its drain through the activity of the upper focus. The paroxysmal eruptions leave usually a prodigiously wide and deep crater, which is subsequently filled up by degrees by the eruptions of the minor and upper focus. Such alternations of minor and paroxysmal eruptions appear to have produced the colossal crateral cavities of volcanic countries, most of which have one or more recent cones rising from within their circuit, such as Vesuvius within the crater of Somma; the Peak of Teneriffe, and the cone of Chahorra, from the circus described by Von Buch; that of Bourbon from the successive circuses described by St Vincent; those of Volcano, Astroni, the lake of Roneiglione, &c. &c.

The author now proceeds to examine the laws which determine the *disposition* of volcanic products on the surface of the globe. The simple cone is first considered, resulting from the accumulation of fragments projected by a series of explosions from a single aperture. Its figure is a truncated cone, containing a funnel-shaped cavity called the crater. The line in which the inner and outward slopes meet is the ridge. Its regularity is liable to disturbance from many causes, such as the fissure-like form of the vent, which usually gives an oblong figure to the cone; the vicinity of other vents; violent prevailing winds; and, above all, the subsequent emission of a current of lava from the same orifice by which one side of the crater is broken down. Examples of these, and other varieties of figure, are given from Auvergne, Italy, &c.

The composition of the cone is next dwelt on, and the nature of the fragments, which are either, 1. *Scoriæ*, or portions of lava torn from the surface of that which has risen within the vent, by the explosive escape of the ascending volumes of steam. Their distinctions of shape, structure, and size, are accounted for, particularly the difference of the scoriæ of feldspathose lavas (pumice,) and those of basaltic composition. 2. Fragments of other rocks broken from the sides of the fissure by the force of the ascending fluids. These may consist of primitive, secondary, or any class of rocks. The remarkable fragments found in the conglomerates of Somma, and the Eiffel, are attributed to the alteration of calcareous and granite fragments by the volcanic heat, new minerals being produced from the decomposition of these, and the reaggregation of their elements in other forms. Fragments of either kind are, if the eruption continues long enough, completely pulverized by repeated projections. The electrical phenomena, developed during eruptions, are supposed by the author to be owing to this immense friction. The height to which fragments of a large size are carried, exhibits the prodigious escaping force of the steam-bubbles. Vesuvius has been seen to launch scoriæ 4000 feet above its apex, Catopaxi 6000. The latter projected a mass of rock of 1000 cubic feet to a distance of three leagues. This explosive force proves the vapour to be propelled from a great depth, and at an intense heat. A volcanic cone is shown to be stratified in planes parallel both to the inner and outer slopes of the hill; and, owing to this peculiarity of structure, the character of such a hill may be recognized even from the smallest remaining fragment. A plate gives a view of the Capo de Miseno, which offers a natural section of such a cone. The author next discusses the laws of the protrusion and disposition of lavas, when expelled, *en masse*, in a more or less fluid state from the volcano; beginning with a notice on the mineral nature of lavas, and their differences of specific gravity and texture, by which their *fluidity* is invariably determined. He classes them into the *heavier* lavas (basalt,) in which the ferruginous minerals, augite, hornblende, mica, or titaniferous iron, are abundant; and the light lavas (or trachytes,) in which the minerals are rare, and felspar, or some equivalent of low specific gravity, almost the sole ingredient. The *fluidity* of a lava, or the facility with which it moves in obedience to its own gravitating force, is compounded of its *liquidity*, of the mobility of its parts, and of its specific gravity. But the liquidity of lavas, it has been seen before, varies with the average comminution of their crystalline particles, under the same circumstance of pressure and temperature. Hence lavas, of the same mineral quality, and therefore of equal specific gravity, when produced under similar circumstances of temperature and pressure, will possess a degree of fluidity inversely proportioned to the average size of their crystalline particles, or *grain*. And, *vice versa*, when their grain is of the same degree of fineness, their fluidity will be proportioned to their specific gravity, *i. e.* to the proportion of ferruginous minerals in their composition.

The author illustrates these propositions, by showing, from observation, that the basaltic lavas have generally flowed farther, and spread over a larger surface than the trachytic; and also, that the lavas of either class have spread in a horizontal direction, more or less, in proportion to the abundance of the heavier minerals in their composition, and the fineness of their grain. The fact has been long ago remarked, but the explanation of it is presumed to be novel. The disposition of a body of lava, emitted from an orifice in the surface of the earth, is, in strictness, determined by, 1. The force of expulsion—2. Its fluidity—3. The external circumstances that may render this fluidity more or less permanent—4. Those which favour or impede the lateral extension to which it is urged by its fluidity. On the compound influence of these circumstances depend the direction taken by the lava, the velocity of its progress, the extent of its superficial spread, and, consequently, the figure of the rock into which it congeals. According to these, lavas assume the form either of sheets, streams, hummocks, or domes. Examples are given, in numbers, of their modifications of form; and it is observed, that the general bulkiness of the trachytes is simply accounted for by their imperfect fluidity, (owing to a coarse grain and low specific gravity) without presuming that they have swelled up like a bladder from below, according to the vague and anomalous idea of Humboldt and De Buch. The author proves, from his own observations, however, in opposition to the statements of Beudant and other writers, that, under favourable circumstances, the trachytic lavas have often spread into bulky *sheets* and *streams, (nappes et couleis)* particularly in the Mont Dor; from which he gives a section where beds (slightly inclined away from the centre of the mountain with a quâquâversal dip,) both of trachyte, (of the *standard* trachyte of the French geologists) and of basalt, alternate with *each other,* and with interposed beds of ashes, or volcanic conglomerate. The author mentions one vast stream of feldspathose lava (clinkstone) which appears to have flowed from the summit of the Mezen, in Velai, into the bed of the Loire, thirty miles distant, with an average width of six miles, and a thickness of 500 feet; thus rivalling the colossal trachytes of the Andes. Clinkstone, or the laminar variety of trachyte, is presumed to have possessed in general a superior fluidity, owing to the parallelism of its crystals, as a very small proportion of elastic vapour interposed between these would give a great mobility to the mass, *in the direction of their longest axes.* The crystals of all lavas, indeed, are supposed by our author, when in motion, rather to slide or slip past one another by means of the intervention of a small quantity of fluid between their flat surfaces, than roll over one another, as is probably the case with the globular particles of perfect fluids. This would naturally result from their peculiar kind of fluidity, and also explains the extreme difficulty with which lavas in motion are induced to swerve from the direction they have once taken. The smallest obstacle is sufficient to check their progress for some time, and even to consolidate the lava to some distance back from the obstacle. These solidified parts, when again broken up by the increased impetus of the lava behind, occasions the *brecciated* character of some lavas, where angular fragments are enveloped in a paste of the same material. The zoned and ribboned structure of pearlstones is similarly accounted for. This sluggishness of lava currents occasions great accumulations of the substance on those points where its motion was checked and diverted, as in the angles of water courses, &c.; and examples are given from the Vivarais, where huge patches of columnar basalt occupy the concave elbows of the gorges of the granite mountains, the connecting strips being shallow, or having altogether disappeared. The curious procedure of lava, when it meets with a perpendicular obstacle, such as a wall, which it cascades over *without touching it,* is then noticed and explained; as also the arched gutters and caverns often formed from its subsidence; and its effect on grass, trees, and fragments of other rocks; on marshy ground, and when it enters the sea or any body of water. Its progress below the water is shown to be similar to that on dry land, though slower, with the same degree of fluidity. The water is heated and discoloured by it, and fish often killed in numbers. The fossils of Monte Bolca are attributed by our author to such a catastrophe, since the beds in which they occur are topped by basalt and volcanic calcareous conglomerate.

The consolidation of lavas is next treated of. This is effected equally by the condensation or escape of its fluid vehicle. Its condensation takes place either by increased pressure or diminished temperature. This mode of consolidation is supposed peculiarly favourable to the reunion of many of the disintegrated crystals, the gradual diminution of the vapour bringing the particles by slow degrees within the sphere of their reciprocal attractive forces, while the remaining elasticity leaves a sufficient mobility to permit of the reversion of their poles in obedience to these forces; and thus a partial recrystallization may be expected to take place. Such crystals, it is shown, will have their longest dimensions perpendicular to the pressure upon that part of the lava.

But that portion only of the elastic fluids will be condensed, which cannot effect its direct *escape.* This is completely prevented in some cases, as in *dikes,* &c. But where the lava is exposed to contact with air or water, this escape takes place to a greater or less degree, in one or both of two modes; viz. 1. By ascent in bubbles through the liquid lava. The more fine-grained the lava, the more spherical the bubbles, from the equalization of the pressure on all sides. These vesicles are often elongated as the lava moves onwards; their size will be proportioned to the specific gravity and liquidity, in other words, to the fluidity of the lava, and the same circumstances determine the proportion of vapour which escapes in bubbles, to that which remains behind. Of the latter, a part escapes in the 2d mode, viz., by percolation through the pores and crevices of the already solid exterior. This process advances from the surface inwardly, with a rapidity proportioned to the porosity of the resulting rock, which will vary directly with the average size and irregular arrangement of its crystalline particles.

From these considerations, the author deduces the following propositions, as to the conduct of different varieties of lava, when protruded upon the surface of the earth.

1. If of extremely fine grain, and low specific gravity, the superficial congelation of the mass will be rapid, that of the interior slow; its fluidity considerable; air-bubbles spherical, sometimes elongated horizontally or vertically; the scoriæ of such lavas is pumice. Owing to the extreme slowness of the consolidation of the interior, and its great mobility of parts, a more or less perfect recrystallization, or concretionary process, will take place. Pearlstones, radiated or not, or variolites, will be produced; and

these concretionary parts, if subsequently drawn out by the renewal of motion in the lava, will give rise to veined, marbled, and brecciated rocks. Numerous examples are given to show how completely these anticipations accord with observation.

2. A higher specific gravity, with an equally fine grain, increases the fluidity of the lava and its extent of lateral spread; the bubbles of vapour will rise with greater force to the surface, which they will rend and break up, leaving it bristling with asperities from the rapidity with which the exposed surfaces congeal. Beneath this surface large cavernous blisters will be frequent; and the lower part of the current, on the contrary, very compact. The great slowness with which this lower part congeals will afford scope for the play of affinities, modified by the extreme fluidity which it derives from its high specific gravity, the result of which, as is shown in a subsequent chapter, will be tendency to the prismatic or columnar divisionary structure. The fine-grained basalts are specimens of this variety.

3. A coarse grain, coupled with a high specific gravity, by diminishing the fluidity of the lava, increases the bulk or thickness of the beds into which it is disposed, creates a porous texture, and a general dissemination of rude angular cells. Such a mass will contract greatly on cooling, and exhibit wide and numerous fissures of retreat; by which the surface of the current, particularly, will be shattered into rude flakes or angular fragments.

4. A lower specific gravity, together with a large crystalline grain, by wholly preventing the vapour from uniting or ascending in bubbles, will render the mass still more generally porous, and more bulky in figure; as is, in fact, the case with the earthy trachytes, lava sperone, piperno, &c.

5. When the component crystals are still larger, that is less disintegrated, nearly the whole of the vapour will be condensed by gradual cooling, without much derangement in the position of the crystals, and the rock will, therefore, be more compact and freer from pores. Some of the very large-grained trachytes, dolerites, syenites, and granites may be taken as examples of this structure. If the crystals are non-conformably arranged, the fluidity of the lava is at its minimum. If conformably, as in the clinkstones, and other laminar crystalline rocks, the fluidity may be considerable in the direction of the parallel plane surfaces of the crystals.

6. Some masses of crystalline rock, the author supposes, may be occasionally elevated in a *solid* state (by the expansion of lava at a great depth beneath) without suffering any disintegration whatsoever, having either been previously cooled down, or being preserved from ebullition by the pressure of overlying strata, which are elevated together with them. Such a circumstance would be in complete conformity with all the laws of subterranean effervescence, and in the granitic axes of most mountain chains, we recognize facts which can only be accounted for by such a mode of production.

The aqueous vapours that escape from most lavas, as they are consolidated, are accompanied by mineral substances, which become more and more abundant as the lava cools, and the quantity of steam exhaled diminishes. These substances are, by the author, supposed to proceed from the internal decomposition of some of the ingredients of the lava by its intense heat, as the pressure created by the elasticity of the interstitial fluid diminishes, owing to its expansion and partial escape through the pores and fissures of the rock above. Specular iron is evidently a sublimation produced in this manner, as well as the delicate crystals of hornblende, augite, melilite, and other minerals which occur in the cellular cavities and fissures of some lava rocks. Sulphur is similarly sublimed, and the same origin must be allowed to the sulphates of lime and ammonia, the muriates of soda and ammonia, &c., which are deposited often in great abundance at the sides and edges of the *fumarole*. Other minerals resulting from this internal decomposition are taken up in solution by the steam, and deposited in crystals or concretions, calcareous, siliceous, &c., in the vesicular cavities of the rock. The cells of most amygdaloids are, however, supposed to have been filled by subsequent filtration of water, carrying in solution mineral particles from overlying rocks, and the author supposes the pressure of a high column of water, (as in lavas of submarine origin,) necessary to effect its penetration through the minute-pores of the lava rock.

The sulphuric and muriatic acids are also often met with among the emanations of the *fumarole*, and their action on the lava composing the sides and borders of these crevices, produces new decompositions and combinations. The sulphate of alumine of the Italian and Hungarian alum works has this origin. These superficial alterations of lava have acquired for the spots where they occur, and which are always within the craters of some volcano, the name of solfatara or souffrière.

Thermal springs, and the generality of mineral sources, are attributed by Mr Poulett Scrope to the condensed vapours escaping from a subterranean mass of lava. Some are intermittent like the Geisers, and the cause of this phenomenon is dwelt on, and explained. The permanent gases evolved from lavas are next treated of; and an instance related by M. Bory de St Vincent, of seven or eight birds being seen to drop suddenly, while flying over the volcano of Bourbon, is supposed to offer some confirmation of the poetic fable respecting the Lake Avernus.

The circumstances which determine the time occupied by lavas in cooling, will depend on the figure of the mass, external circumstances, and the structure and composition of the lava. Instances are quoted of currents retaining a great heat for a considerable time. That of Jorullo, in Mexico, is by no means cool yet, though produced in 1759.

The next chapter treats of the divisionary structure assumed by lavas on their consolidation. This process must be accompanied, at all times, by a diminution of volume or contraction. Were it to commence at the centre of a mass, no separation of parts need take place; but if at the surface, different centres of contraction must establish themselves, and fissures of retreat be formed between them. The figures these circumscribe, tend to approximate to the hexagon. But since there is no opposition to the contractile force, in a direction perpendicular to the surface, which subsides freely as the mass below contracts, no fissure, or very few will be formed parallel to that surface; and by the inward propagation of the retreat, the hexagons will be lengthened into hexagonal prisms. The slower the process of solidification, and the finer the grain of the lava, the more regular will be the prisms, *ceteris paribus;* hence the interior, or lowest parts of a current alone, in general, require this structure, which does not become visible till denudation has exposed these parts. This is rarely the case with recent lavas; and hence arises, according to our author, the common error of supposing the columnar division confined to the older basalts. This structure is very frequent in dikes, both in the older and recent vocanic formations; the columns being always perpendicular to the sides of the dike. When lava rests on a convex surface, the columns diverge; when on a concave, converge upwards; being always perpendicular to the surface on which the process first acts. The author remarks, that those of the *peaks* of basalt, which are so numerous in basaltic districts, will be found to consist of a group of convergent columns; this disposition affording the maximum of resistance to the action of rain and frost, in separating the columns, and breaking up the bed, of which the remainder has probably been destroyed in this manner. More than one kind of divisionary structure may occur in the same rock; smaller prisms are sometimes formed within the large. The globiform structure is next accounted for, and its occasional subdivision into radiating prisms, or concentric leaves. The angulo-globular structure accompanies a tendency to the formation of globular concretions. The tabular, lamellar, and slaty, or schistose divisionary structures, are supposed to be confined to lavas in which the crystalline particles are disposed more or less conformably, owing to which their mobility is considerable in the direction of their parallel plane surfaces, and null in the transverse direction. Hence, retreat fissures will be produced in abundance, parallel to the largest plane surfaces of the crystals, and few or none will be formed transverse to these. By the frequency of such transverse fissures, the cubical or rhomboidal structure is produced.

The author next touches on the question, as to the cause of the difference of mineral composition in lavas. He inclines to attribute this variety to certain alterations undergone by the rock, originally of an uniform (perhaps granitic) composition, during its rise to the surface of the globe; which was probably attended by repeated alternations of intumescence and reconsolidation, from changes in the relative proportions of the intense heat and pressure to which it was subjected. The principal varieties of lava are found in nature to have been usually produced successively, often alternately, from the same or proximate vents. The opinion of the *antagonism* of trachyte and basalt, put forth by Humboldt and Beudant, is combated by our author, and numerous examples adduced of their successive emission from the same volcano. He then notices on the error of limiting the production of trachyte or basalt to particular ages of the globe, or making "formations" of them—both are produced before our eyes by recent and still active volcanos; the error arises from the terms trachyte and basalt not having been confined, as of right, to a mineralogical meaning.

Having thus far traced the laws which determine the disposition of the substances produced by a single volcanic eruption, whether in a fragmentary form, or as more or less liquid lava, the author proceeds to examine the circumstances that result from the accumulation of such products, by repeated eruptions from the same vent. The simple cone, by this process, becomes enlarged into a *volcanic mountain,* composed of hardened lava-streams, (each of which acts as a solid rib or buttress to the hill,) and intervening beds of conglomerate. The sides of this hill are frequently, during eruptions, split by the pressure of the column of lava, within the central aperture or chimney of the volcano. The lava then flows out through orifices, formed successively at different levels, one below the other; examples of such occurrences are given from the phenomena of Ætna, Vesuvius, Iceland, &c. It is a general fact, that, in the eruptions of volcanic mountains, or *habitual volcanos,* the elastic fluids are chiefly discharged from the central crater, but the lava is emitted from apertures in the side, or at the base, of the mountain. Minor and local earthquakes are occasioned by these rendings of the frame-work of the mountain, which is even sometimes split in two. The consolidation of the lava that occupies these fissures, produces numerous vertical dikes, which, cutting across its other component beds, acts as braces or ties to the frame-work, and increase its general solidity. Somma presents an example of such dikes in great numbers. The fissures are in this manner hermetically sealed, as it were, and never open a second time. Thus, with the height and bulk, the strength of the mountain increases, without any conceivable limit; and the author thinks it an erroneous idea, that such limit exists, and that, at a certain height, eruptions can no longer take place from the summit of the cone, since every lateral eruption adds to the strength of the mountain's flanks, and to the resistance they oppose to the lateral pressure of the internal column of lava. *Parasitic* cones are thown up by the gaseous explosions which take place from these lateral vents. They have each their crater, and each marks the source of a current of lava. Ætna has nearly seventy such cones scattered on its flanks, many of considerable size. Vesuvius exhibits but a few, but is itself a parasitic cone, thrown up in the centre of the old crater of Somma. The skirts and base of a volcanic mountain are usually covered with conglomerates of an alluvial character, deposited by torrents of water, proceeding either from the violent rains, which usually follow an eruption, or from the melting of snows. These debacles of mud and water, are called by the inhabitants of Vesuvius, *lave d'acqua.* In Iceland, they constitute the most destructive part of the volcanic phenomena. Such deposits are often carried to some distance from the foot of the mountain, and are found alternating with the currents of lava which have flowed farthest from the centre of eruption;—trees and plants are found buried in them. The *surturbrand* of Iceland is of this origin. If the sea washes the foot of a volcano, these, and other of its products, will be mingled with marine deposits, and often carried by currents to a distance. This was the origin of the stratified tufas of Campania, and the environs of Rome. In Hungary, pumice conglomerates alternate with tertiary limestone, as basaltic peperinos do in Auvergne, the Vicentine, and the Val Demona in Sicily.

The craters of volcanic mountains are subject to a series of changes, by which they are alternately filled up and emptied again. The large crater, left by any paroxysmal eruption, is gradually filled by the accumulating products of minor eruptions, until it is replaced by a convexity of summit. This form is, as we have seen, the most favourable to the permanence of the eruptive process; but, at the same time, the quantity of matter accumulated above the focus, and, therefore, the obstruction to the escape of the caloric in as quick a ratio as it is received there from below, is at its maximum; consequently, the probability of the recurrence of a paroxysmal eruption, from this inferior focus, is greatest at this time, and such a phenomenon will, therefore, probably soon occur. By this, the mountain is once more gutted. The crater left by these paroxysms, is usually a deep elliptical chasm, resulting from the enlargement of the original fissure of eruption, by the violent ascent of the elastic fluids. Examples are given, in great numbers, of such craters, and of the changes they have undergone. Paroxysmal eruptions of this kind have, in some instances, blown into the air the whole frame of the mountain, and replaced it by a lake. The eruption of Vesuvius in 79 A. D., is supposed to have thus shattered one-half of the original cone of Somma, burying Pompeia and Herculaneum under its fragments. Such craters are often occupied afterwards by lakes, particularly where the conglomerates are of a feldspathose nature, since these form, by mixture with water, a mud or clay, which is impervious to water. Other lake-basins, in volcanic districts, are formed by explosions from a deep focus, on some fresh point of the earth's surface, as are some in the Eiffel and Auvergne, which have been drilled in this manner through rocks of greywacke slate and granite, the fragments of which are scattered on all sides. The bursting of lakes in the interior of volcanic craters, gives rise to what the author calls, Eluvial deposits; the trass of the Rhine, the moya of America, and some tufas, are attributed to this origin. These conglomerates sometimes assume a divisionary structure on desiccation, and *set* very firmly, so as to be used as building-stone; the tufas, which have not been thus forcibly mixed with water, seldom cohere so compactly. Organic remains occur, of course, also in these conglomerates, particularly wood. The primary vent of a volcano is sometimes shifted laterally; the original crater remaining *extinct*, and usually reduced to the state of a solfatara. Teneriffe and Bourbon are noted examples of this circumstance.

The next chapter is upon Subaqueous Volcanos, which are supposed by Mr Scrope to be much more numerous than is generally imagined. Indeed, all insular volcanos (and most of those we are acquainted with are of this character,) have been originally produced by submarine vents.

The observed instances of eruptions from the sea are indeed few in number. Our author mentions those off St Michael, one of the Azores in 1638, 1720, and 1811; of Santorini, and the Isola Nuova in the Archipelago; another off the coast of Iceland in 1782; and one amongst the Aleutian islands in 1814. But, on reflection, we must conclude, that the weight of the water above the vent, and the refrigerating effect of its contact, must, in all cases, condense the escaping volumes of steam, and prevent their rising to the surface, and rendering the eruption visible there, except when the orifice of the volcano has been raised by the accumulated products of repeated eruptions, to within a short distance of that level; so that numerous eruptions may be continually taking place within the depths of the ocean, without our being aware of their occurrence in any way. There is no reason for concluding such eruptions to proceed in any very different manner from those which are *subaerial*. The expansive force and temperature of the lava must be extreme, and proportioned to the great excess of the repressive force occasioned by the pressure of the supported column of water. The lavas, when emitted, will, therefore, from the intensity of their temperature, and the resistance opposed by this dense medium to the exudation of the confined vapour, *retain* their fluidity much longer in the open air, and, consequently, spread laterally to a far greater distance from the vent, with a similar inclination of surface. According to this, lava-beds, produced at the bottom of the sea, ought to exhibit a greater lateral extension, compared with their bulk, than those which have flowed from subaerial volcanos; and, in fact, the great horizontal dimensions of the flœtz-trap formations of Ireland, Germany, Iceland, Faroe, the Hebrides, &c. have long been a subject of remark. Again, since little or no vapour can escape from the surface of the lava, such beds should show very few scoriæ or scoriform parts on their upper surface; and, on the contrary, vesicles, or air-cells, may be expected often to abound through the *interior* of the rock, the extreme tension of the steam causing its parcels to expand as the lava flows on, while the rapid consolidation of the surface, and the weight of the sea above, must prevent their rising upwards.

These characters also accord with the appearances of many of the flœtz-trap rocks, amygdaloids, &c. which seem clearly to be the products of submarine vents. Of the fragments thrown up by the explosions of submarine eruptions, some will accumulate round the orifice in rude beds, others be dispersed by currents, and mixed or interstratified with other marine deposits. In the north of Italy and Sicily, are frequent examples of calcareo-basaltic conglomerates, (peperino) as well as of beds of basalt, alternating repeatedly with compact limestone strata. The hills of the Phlegræan fields near Naples, the author supposes to have been thrown up by subaqueous eruptions from a very shallow shore, which has been subsequently elevated above the sea-level, by subterranean expansion.

When the summit of a submarine volcano is raised above the surface of the sea, it conforms to all the laws, already investigated, which regulate the conduct of a *subaerial vent*. Its elevation takes place in one or both of two modes, viz. 1. By the accumulation of matter, protruded by repeated eruptions. 2. By elevation, *en masse*, from the expansion of the inferior lava. The latter mode will be often accompanied by the heaving up of more or less extensive masses of the neighbouring strata. Examples are given of volcanic islands, which appear to owe their elevation from the depths of the sea to these different processes. Iceland, Teneriffe, Sicily, and some of the Leeward Isles, are quoted as islands which have risen by the joint effect of both the above modes of subterranean activity; the Isle of France, Pulo Nias, some of the Madeiras, and of the Hebrides, as instances of the latter mode acting alone. The author supposes the coralline islands of the Pacific to be mostly based upon volcanic submarine eminences; their circular or elliptical figure corresponding to the ridge of the central crater of a volcano. Many have been subsequently raised far above the level of the ocean; and the earthquakes, to which they are so often liable, prove their elevation to be owing to subterranean intumescence, and to be still in progress, while the continual growth of fresh coral on their shores, augments at the same time their horizontal extent.

Chapter IX treats of Volcanic Systems.

The volcanic vents observable on the surface of the globe, are arranged either in detached groups, as those of Iceland, the Azores, Canaries, Cape Verd Isles, &c.; or, and this is the prevailing case, in linear trains, at a greater or less distance; often so close, that the products of the neighbouring volcanos are in contact, and produce strings of volcanic mountains, such as occur in France, Germany, the Leeward Isles, Java, Sumatra, Japan, Kamschatka, &c. The most remarkable series of vents of this kind on the globe, is that prodigious train which, beginning in the Andaman and Nicobar Isles, runs through Sumatra, Java, Sumbawa, Sumba, Timor, and the whole group of the Moluccas, whence, taking a northerly direction, it has produced the Philippines and Loochoo Isles, Japan, Jesso, the Kurile group, and the peninsula of Kamschatka. Thence it diverges to the east, forming the chain of the Aleutian Isles, and appears to be continued southerly along the western coast of North America into California, Mexico, Guatimala, Nicaragua, Panama, and the vast volcanic range of the South American Cordilleras, even to Terra del Fuego. If, as appears most probable, such trains of volcanic vents indicate fissures, broken through the superficial strata by subterranean expansion, what a prodigious compound fracture in the crust of our globe does this immense chain of volcanos disclose to us. In these systems, some few vents remain occasionally active, others closed, the former acting as *safety-valves* to the neighbouring districts. In case of their permanent obstruction, some fresh vents must be produced, or some former orifice re-opened; while violent earthquakes, and elevations of the neighbouring strata, will precede, or accompany this change. The author then dwells on the appearances in the constitution of the known surface of the earth, which indicate numerous and forcible elevations of strata, by subterranean expansions, more particularly in the elevated or mountainous districts, which, according to him, are those points or lines that have suffered the maximum of elevation, from the extreme developement of the expansive process beneath them. But since, as has been stated above, and as is shown to be conformable to observation from a variety of instances, the existence of active volcanos obviates the occurrence of such extensive elevations of the superficial strata, by letting off, through fissures in these strata, the superfluous caloric which would otherwise accumulate and produce successive powerful expansions of, in the great bed of lava beneath them, we must expect to find such spiracles to be frequent in the lower levels of the globe's surface, and rare in those higher,—and this is precisely true to the letter; for we know of very few volcanic vents in the interior of the continents, or amongst mountain ranges, while they rise in vast numbers from the depths of the ocean. If the Andes are urged as a striking exception, it is replied, that this great range is itself composed almost wholly of volcanic, or, at least, *pyrogenous* rocks, which, like Ætna, Teneriffe, &c. have swelled to their immense height by the accumulated ejections of very productive vents.

But, notwithstanding the distance usually interposed between the principal trains of volcanic vents, and the elevated continental ranges, Mr Scrope thinks he perceives a frequent and remarkable parallelism in their direction. Thus, the volcanic trains of France, Germany, and Italy, run decidedly parallel to the opposite ranges of the Alps and Apennines; that immense chain which encircles the Pacific, is almost uniformly parallel to the neighbouring high lands of Asia and America, &c.; and he is thus led to suppose, that the creation of *fissures of elevation*, and the protrusion through them, of crystalline rock, chiefly in a more or less solid state, together with the heaving, dislocation, and contortion of the strata on either side the cleft, that process, in short, to which he attributes the production of mountain ranges, was the *immediate* and *primary* result of partial expansions of the subterranean lava-bed at a great depth; while the *fissures of eruption*, which give rise to the properly so called volcanic eruptions, on different points of these cracks, were *secondary* and *incidental* results of this process, being chiefly occasioned by the lateral drag of the superficial strata towards the line of elevation, which the action of a powerful force, heaving them upwards on this line, must necessarily produce. The author remarks, that the generalization of this important fact, that the elevation, *en masse*, of the solid strata, composing the crust of the earth, has been inversely proportional to the developement of the volcanic phenomena in the same quarter of the globe, demonstrates, that the subterranean bed of intensely heated crystalline rock, (or lava,) whose local existence was proved in the early part of his essay, must extend generally beneath the whole surface of the globe. The transmission of caloric to this bed, from within, appears also to have been uniform and constant, having produced successive expansions in it, and proportional *elevations* of the overlying surfaces in those parts where no facilties existed for the outward escape of the caloric, and continual *eruptions* attended with little or no elevation, wherever vents were created for the extravasation of the heated and intumescent matter.

In the Xth Chapter, "on the Developement of Subterranean Expansion in the elevation of strata, and production of continents above the surface of the ocean," the author quits the volcanic phenomena, properly so called, to apply the knowledge with which the investigation of these phenomena has furnished him, on the nature and mode of action of subterranean caloric, to account for the geological features of the continental formations. And herein appears to consist a main distinction between the geological theory brought forward by Mr Poulett Scrope, and those of Hutton, or other writers on the same subject, who may seem to have forestalled him in some of his principal conclusions; viz. that, while the latter class of theorists directed their efforts to prove that the chief appearances in the constitution of the earth's crust could only, or could most rationally, be explained by the hypothesis of an intense central heat producing elevations, &c., the author we are at present reviewing, directly demonstrates the existence of this central heat, and elevating power, from the phenomena of volcanos and earthquakes; draws from the same source, conclusive evidence of the laws under which it acts; and goes on to show, that such a power must, in the nature of things, have given rise to those elevations of continents and mountain ranges, with all the minor phenomena of inclined and distorted strata, dikes, veins, faults, &c. which it is one of the chief objects of geological inquiry to account for.

This chapter commences with the remark, that the arenaceous and sedimental strata, which compose the major part of the surface of our continents, are found to assume a great degree of inclination, and more irregularities of position, as we approach the chains of mountains, or lines of maximum elevation and disturbance. They, however, almost universally lean against masses of crystalline rocks, which form the geological axis of every mountain. Of these rocks, some are stratified, or rather have a laminar structure, as gneiss, mica-slate, &c., and show marks of the action of some violent force upon them, in their repeated flexures, cracks, and highly inclined position; others are unstratified, (granite, syenite, porphyry, serpentine, diallage-rock, and greenstones, &c.,) and usually underlie the others, or cut through them in the manner of immense dikes. The latter are supposed by the author to be portions of the subterranean crystalline bed, protruded by inferior expansion, sometimes in a state of partial liquefaction, at others as a solid mass, through a longitudinal cleft broken across the superficial strata. The laminated crystalline rocks, which formed the lower portion of these strata, were forced likewise through the fissure by the tremendous friction of the rising mass, and, during this process, were folded into repeated doublings, like those produced in a bale of cloth or linen, by a powerful pressure, acting nearly in the direction of its layers. In general, the central axis of unstratified crystalline rock, will appear like a vast dike intruded between the replicated schists on either side; at others, these protruded strata will still cover the axis like a mantle. Where the temperature of the exposed parts of the crystalline axis was intense, a superficial intumescence may have taken place, the liquefied matter overspreading the edges of some of the overlying or protruded strata, and thus giving rise to the appearance of secondary granites, syenites, porphyries, &c. Portions of lava will also be injected between the folds of the lower schists; and into any crevices or fractures formed in them. At the same time, the upper strata recede, in a lateral direction, from the axis of elevation, slipping down the inclined planes of their stratification, by the influence of gravity, and become also more or less bent and folded together, owing to the resistance opposed to this subsidence, by the inertia of their distant unelevated parts. Curvatures and replications could, however, only take place where the strata were in a semi-solid state, or where the peculiar structure of the rock was favourable to the partial mobility of its parts; and this appears to have been particularly the case with the laminar and schistose rocks, whose parallel plates of mica are enabled to slip, with more or less facility, over one another; such rocks appear to have often suffered an extraordinary degree of replication. By the subsequent destruction of the extreme flexures of these folded strata, they seem, to a traveller passing across their edges, to alternate repeatedly in a recurring series. Where the induration was more complete, or the structure of the rock unfavourable to flexibility, as in the compact and massive limestone formations, numerous fractures, fissures of all sizes, often of great width, will have been broken through them, and the intervening masses of strata more or less dislocated and disturbed in their position, sometimes, perhaps, left in isolated patches on the summit or flanks of the protruded crystalline rocks. This appears to have been the origin of the insulated pyramids of dolomite, which rise from the great porphyry district of the Tyrol. Indeed, any one acquainted with the aspect of the limestone formations of the whole range of the Alps, will acknowledge, that, in this irregularity of position and inclination, their perpendicular escarpments, and chasm-like vallies, these vast masses of strata accord precisely with what might be expected from a mode of elevation, such as is here attributed to them. Thus, of the fissures broken through the elevated strata, those which descended sufficiently in depth, and opened into the inferior lava-bed, occasioned extravasations of this substance, producing *dikes*, &c. others which were too narrow and intricate to allow of their occupation by the intumescent matter, were yet permeable to the vapours that rose from this subjacent and intensely heated mass, bringing with them both earthy and metallic sublimations, which would be deposited on the sides of the fissures, together with fragments broken from these sides, or fallen from their upper parts, whence the *mineral veins*. Those fissures which did not communicate with the heated lava-bed, were filled in part, or altogether, by rubbish alone, and these are the *faults* or *slips* of miners. The formation of calcareous and other *breccias*, and *veined marbles*, is accounted for by the smallest of these fractures; the still unconsolidated juices of the rock oozing into its cracks and crevices, and filling them with a deposit of *finer* matter. The quartz veins of the arenaceous and micaceous rocks are attributed to the same process.

The author goes on to draw a distinction between the *primary* range, or axis of elevation, along which the overlying strata were burst open and elevated, solely by the developement of subterranean expansion beneath, and those *secondary* ranges, or axes of elevation, which consist in the convex flexures produced on either side of, and more or less distant from, the primary axis, by the replication of the elevated strata, as they slipped away from this axis. Whatever expansions took place in the inferior crystalline mass beneath these secondary convexities, were occasioned by the reduction of pressure on it, not by the absolute increase of its expansive force, as in the primary axis. These secondary ridges are more or less parallel to the primary. The occurrence of proximate ranges of elevation, or any other causes productive of local variations in the resistance opposed to the lateral movement of the strata, would occasion proportionate aberrations from this parallelism. The intervals between these parallel ranges, that is the concave flexures, or fractures, produced the longitudinal vallies of mountain districts. In the north of Scotland, such vallies, separated by intervening secondary ridges, are numerous and remarkable, forming the basins of the greater number of her lakes and æstuaries. The author supposes even the great valley of Switzerland, on one side of the Alps, and that of Lombardy on the other, to be examples of longitudinal vallies having this origin. The range of Jura on one side, and that of the Apennines on the other, are in this view, the secondary ridges occasioned by the replication in the strata, which were driven laterally towards the north and south, by the forcible elevation of the primary range of the Alps. In England, the flœtz strata are supposed, by the author, to have slid in a lateral direction towards the German ocean from off the elevated range of Devon, Wales, Cumberland, and Scotland.

But besides the longitudinal fractures of the superficial strata, others will often have been formed in a direction *transverse* to the axis of elevation, by local irregularities in the mode or time of elevation. Many of the transverse vallies of mountain chains are referred to this origin, particularly those deep chasm-like gorges which contain lakes at the foot of the higher Alps, both on the north and south. The waters of the ocean retreating from the surfaces, thus suddenly raised above their level, would retire with immense impetuosity through these fissures, and enlarge and deepen them, leaving vast accumulations of transported fragments at the lower extremity of such gorges, where the velocity of the debacle was first checked. (Diluvium of Switzerland, Piemont, the Italian lakes, &c.) Other transverse vallies were, perhaps, wholly scooped out by these retreating waters, which would excavate their channels along those lines into which they were directed by the accidents of level, and the greater or less resistance of the rocks over which they rushed. These vallies, according to the author, have been enlarged and modified, and many others, particularly all the smaller ramifications, entirely excavated, by causes still in action, more especially the fall of water from the sky, and the erosive force of its descent from higher to lower levels. It is remarked, that there are good reasons for concluding that the quantity of water circulating over the globe's surface in this manner, in given times, has progressively diminished, with its diminution of temperature, from the earliest ages of the world; so that we need not shrink from attributing to its agency effects far exceeding in magnitude those of which it appears capable at present. "One decided proof of the slowness of the process of excavation, wherever it occurs, exists in the *sinuosity* of water-channels, and in such a case, and such are met with even amongst the largest river vallies, it is idle to talk of transient deluges or debacles as the excavating agent."

With regard to the periods at which the different continents may have been heaved upwards, our author concludes, from the analogy of the volcanic phenomena, that such elevations took place by successive shocks; the greater number being of minor violence, similar to the earthquakes which occur at present; but some of prodigious power, (paroxysmal expansions,) and analogous to the paroxysms of habitual volcanos. If it is true, that outliers of the plastic clay and chalk have been recognized on the highest summits of the Alps, it would appear that this colossal chain, and perhaps with it the whole continent of Europe, owes its elevation from beneath the sea to some catastrophe of this nature, at what we are accustomed to reckon a comparatively recent geological epoch. The traces of diluvian action, the boulders of the Alps and Sweden, and the alluvium of the north of Europe, may have been produced by the retreat of the ocean from this elevated surface, and the successive oscillatory movements to which it must have been subjected before it regained its level. Other paroxysmal expansions may have occurred in earlier ages of the globe's history, and in the old red sandstone formation, it is observed, we may perhaps trace the result of such a catastrophe. The occurrence of repeated elevations on a large scale, is, indeed, attested by numerous geological facts. It is also probable, from what we know of the power by which they are occasioned, that they were far more frequent and violent in the early part of the history of the earth than they can be at present; for, unless we suppose the proportion of caloric transmitted from the interior of the globe towards its surface to have been always on the increase, (which is directly the reverse of the opinion professed by the author,) it is clear, that the continual and general increase of the repressive force, by the additions made to the solid strata of the globe, in the products of volcanos, and incrusting springs, and also to the body of water and atmospheric fluids which press upon that surface, must have proportionately diminished the ratio of subterranean expansion, from the commencement of the process up to the present day. The author then adverts to the mineral nature of the general subterranean bed of crystalline rock, (or lava.) This he concludes to be probably granitic; and supposes that some of the elevated portions of it, may, by the effect of repeated intumescences, and reconsolidations, under varying circumstances of temperature and pressure, by which the component minerals would be more or less disintegrated, decomposed, and their elements recombined in new proportions, and on separate points, have been converted into syenite, greenstone, porphyry, compact felspar, serpentine, diallage rock, &c. The analogy of ordinary volcanic rocks, in which such changes, to a certain extent, indisputably take place under similar circumstances, supports this conjecture; and since all the above varieties of rock are found in nature to graduate into one another, it cannot be unreasonable to suppose all may have been elaborated from the same *raw material.*

The work would appear to have terminated naturally here, at least the author is anxious to keep the part of which we have now given a summary, and in which he has endeavoured to confine himself within the bounds of strict logical inference, (deducing from the evidence of the volcanic phenomena, a certain degree of knowledge as to the nature and mode of operation of subterranean caloric, and applying this knowledge to account as well for the detail of these phenomena, as for the inequalities in the surface of the globe,) separate from the concluding chapter, which contains theoretical matter of a more general and less substantial character; in short, an attempt to sketch the outline of what may be called the History of the Globe.

To this, indeed, the author was naturally led by the results of his previous investigations; for having proved the existence of a vast subterranean reservoir of caloric, the effect of which is still to occasion violent changes in the superficial crust of the globe, and which appears to have formerly produced similar changes of far greater magnitude, it is impossible not to suppose the same cause to have had a large share in the original formation and disposition of that crust. In fact, the elevating process, which, in the foregoing chapter, is shown to have produced the present irregular disposition of the superficial rocks, presupposes a peculiar arrangement of these beds, previous to their elevation above the sea level.

The crust of the globe must then have been composed of concentric coats, consisting of, *1st,* The secondary and transition series of strata; *2dly,* The series of laminar and schistose crystalline rocks, viz. gneiss, mica-talc and chlorite, schists, &c.; *3dly,* and finally, the granitoidal matter, confined at an intense heat by the compression of the overlying strata.

The origin of the sedimental and arenaceous deposits of the ocean, composing the first series, discloses itself by the organic remains contained in them, and their analogy to the actual deposits of our rivers, lakes, and seas. The fragmentary rocks apparently owe the magnitude of the scale on which they have been sometimes produced to the violent oscillatory movements to which, as has been noticed above, the ocean must have been subjected by any paroxysmal elevation of a large portion of its bottom. Even where the elevation took effect only on strata already raised above the sea-level, the effect on the waters of the globe would be still most powerful; for the *radius* of the *globe being dilated on that point,* a proportional body of water must rush immediately towards the opposite, or antipodal point, to preserve the equilibrium of the globe, and a series of violent oscillatory movements must take place general to the whole ocean, and producing a permanent alteration in the relative levels of land and water all over the earth; these effects being proportioned to the mass of mat-

-ter raised, and the amount of its elevation. The coarser fragments transported by such moving waters, will have been deposited in the longitudinal vallies of mountain ranges, and wherever the currents were first considerably checked. The finer detritus will have afterwards subsided, when the ocean had regained its equilibrium, and mixed with the precipitations which were taking place contemporaneously from its waters, and with the bituminous and calcareous matter, proceeding from the decomposition of vegetable and animal substances, the shells of molluscæ, coralline bodies, &c. produced the sedimentary formations. As the depth of these beds of pulpy matter increased, the consequent pressure upon the lowest of them, by bringing the similar particles slowly and gradually within the sphere of action of their mutual attractive forces, occasioned the successive formation of separate horizontal concretions, *or strata,* more or less fully consolidated, which some subsequent expansion elevated above the sea-level, where they lost by drainage all the water they contained, and were by desiccation still farther indurated.

The author opposes the Huttonian theory, that these strata were hardened by heat from the interior of the globe, which he thinks wholly disproved by the occurrence of clays and shales beneath indurated strata. The consolidation of limestones, sandstones, &c. he attributes solely to a concretionary action, accompanied by a more or less imperfect crystallization of the very finest particles which act as a cement to the coarser. The more complete the process of crystallization, the more solid and compact the rock; and therefore the larger the proportion of precipitated matter, (which, as being much finer than any sediment, is more favourable to crystallization) the more crystalline and the harder will be the strata. It is well known that, amongst the stratified rocks, the older are generally the most crystalline, and hence we should expect the quantity of matter precipitated by the waters of the ocean to have been greater in former times than now. The author attributes this to the higher temperature of the ocean in those ages, and the greater quantity of mineral matter carried into it in a state of solution by the vapours evolved from the interior of the globe. Even the more completely crystalline rocks, such as statuary limestone, quartz rock, and rock salt, appear to the author in the light of precipitations from the primitive ocean, where, at this time, the sedimentary matter predominated, mica, talc, and chlorite slates were deposited. With regard to gneiss, the lowest of the stratified rocks, the author considers it to share in a very slight degree in the character of a sedimental rock, to have been in short a granite which, after a great degree of intumescence, was reconsolidated by the pressure it sustained between the expansive force of the granite beneath, and the weight of the solid strata which had settled above it, as well as of the ocean and atmosphere.

The author then generalizes these views as to the origin of the different rock formations, in a "Sketch of a Theory of the Globe," of which the following is a brief abstract.

The mass of the globe, or at least its external zone to a great depth, is supposed to have been originally granitic, and that, on reaching its actual orbit, perhaps before, a great proportion of the pressure was removed which had previously preserved it in a state of crystallization, notwithstanding its intense temperature, (perhaps as an integrant part of the sun, from which the author is inclined to think it a projected fragment,) according to the notion of Buffon and Laplace.* Violent superficial expansion was the result of this diminished compression; the dilatation decreasing towards the interior, from the surface, which would be completely volatilized to that point where the disaggregation of the granite was wholly checked by the pressure of the zone of liquefied matter gravitating towards it. Where the elastic fluid generated between the crystals of the rock, and which occasions its liquefaction, was produced in sufficient abundance, that is, in the outer and highly disintegrated zones, the superior specific gravity of the crystals forced it to rise upwards, and thus a great quantity of aqueous vapour was urged towards the surface of the globe: as this vapour rose into outer space, its continued rarefaction must have lowered its temperature till a part was condensed into water, which fell back in torrents upon the surface of the earth, giving rise to the primeval ocean, which, however intensely heated below, would be retained in a fluid state by the loss of temperature sustained from the vaporization of its surface, and the pressure of the highly condensed atmosphere upon it. This ocean will have contained, both in solution and suspension, the earthy substances which proceeded from the volatilization of the superficial granite, or which were carried upwards by the ascending vapour from the disintegrated mass below. The dissolved matters were silex, carbonates and sulphates of lime and magnesia, muriates of soda, and other mineral substances which water at an intense temperature, and under such peculiar circumstances, may be supposed capable of holding in solution. The suspended substances were all the lighter and finer particles of the upper beds where the ebullition had been extreme, but, above all, their *mica,* which, from the tenuity of its plate-shaped crystals, will have been most readily carried up by the ascending fluid, and will have remained longest in suspension. When the excess of vapour had effected its escape from the disintegrated granite, the crystals of felspar, and those of quartz, which had remained undissolved by the heated water, subsided first, together with the smallest and least buoyant crystals of mica; and these crystals would naturally arrange themselves so as to have their longest dimensions parallel to the surface on which they were deposited. This mass, when subsequently consolidated by pressure, formed the gneiss formation, which graduates downwards into granite. Upon this, the larger plates of mica and quartz grains would continue to be deposited, while, at the same time, a large quantity of the silex, held in solution by the ocean, was precipitated as the water cooled. Thus was produced, by degrees, the mica-schist formation, graduating downwards into gneiss. On some spots, and perhaps at a

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* The author, in a note, compares the globe at this time to an aerolite, in which the superficial crust of vitrified matter bears some analogy to that which then perhaps formed on the surface of our planet..

later epoch, instead of silex, carbonate of lime was precipitated, together with more or less of micaceous sediment, producing the saccharoidal limestones. Upon this mica-schist, and graduating into it, were deposited in turn, as the waters of the ocean cooled, and its local disturbances ceased, or recommenced, other stratified rocks, composed sometimes of a mixture, sometimes of an alternation, of precipitated, sedimentary, and fragmentary matter, giving rise to the *transition* formations.

In this manner was formed the first crust or solid envelope of the globe. But beneath this crust a new process had now commenced, occasioned by the increase of temperature and of expansive force of the upper granite beds; which, having been greatly reduced in temperature by the dilatation it had endured, and the partial vaporization of the water it contained, now began to receive an accession of caloric from the more intensely heated nucleus. The first effect of such an increase in the expansive force of this zone, opposed as it was by the increasing pressure of the strata, whose progressive deposition was going on above, would be to consolidate the intermediate bed of gneiss; the next, to produce, sooner or later, the disruption of the solid crust, which impeded its actual expansion. This result took place on those parts where accidents of texture or composition in the oceanic deposits led to them to yield most readily; and in this manner were formed, in the primeval crust of the earth, those original and deep fractures, through some of which (fissures of elevation) were protruded portions in a more or less solid state of the inferior granite, together with replications of the foliated rocks, (as described in a former chapter;) while others (fissures of eruption) gave rise to local extravasations of the heated crystalline matter in the form of lavas, that is, still farther liquefied by the greater comparative reduction of the pressure they supported. By these partial elevations of the superficial strata, violent movements were at times, as has been mentioned before, communicated to the waters of the ocean which broke up the projecting eminences, and distributed their fragments in conglomerate or sedimentary strata. At first, the surface of the globe consisted chiefly of mica-schist; and hence mica and granular quartz predominate in the earlier conglomerates and sedimentary strata, (grey-wacke, grey-wacke slate, quartz-rock.) Precipitations of silex and carbonate of lime, continued to mix with the sediments of this period, and Mr Scrope supposes quartz rock and transition limestone to owe their dark colours to admixture with the finest particles of mica. For a long time, it is probable that local developements of subterranean expansion, producing partial elevations of the earth's crust, local extravasations of crystalline rocks in the form of dikes, beds, &c. and local deposits of conglomerate beds, alternated with periods of comparative tranquillity, during which the finer sedimentary deposits and precipitations took place, and hence the alternations of the various sedimentary and arenaceous strata which compose the secondary formations. Meantime, as the temperature of the ocean decreased, it began to be thickly peopled with organic beings, animals, and vegetables of simple structure; the latter giving rise by their carbonization to the coal strata. At length, as the temperature of the ocean and atmosphere diminished further, the quantity of water taken into circulation decreased; the continents were no longer deluged by perpetual floods of rain, and organized nature took possession of them also; the marine deposits contained less of precipitated matter, and became more earthy, and less crystalline; strata of shales, dull limestones, chalk, marl, sands, and clay, succeeded those of clay-slate, marbles, and sandstones, until the gradual change wrought by the slow refrigeration of the outer zones of the globe brought about the condition in which it exsists at present.

The author remarks that, from the circumstances of their origin, the rock formations of every kind or age must have been more or less strictly *local;* and that, though the formations of any particular epoch will unquestionably have some points of general resemblance all over the globe, it would be absurd to suppose the same series of beds to have been deposited contemporaneously over the whole of its surface.

The author sums up, by attributing the production of the mineral masses, as at present observable on the surface of our planet, to three sources, distinct in their nature, but of which the products have been often confused and mingled together from circumstances of isochronism or collocation. These are, 1. The precipitation of some minerals, particularly silex and carbonate of lime, from a state of solution in water, as its temperature was diminished, &c.

2. The subsidence of suspended or fragmentary matter from water; together with the accumulation and decomposition of the shells of molluscæ, corals, &c.

3. The elevation of crystalline matter through fissures in the crust of the globe.

The author conceives, that all the characteristic differences observable in the successive formations of every kind, may be satisfactorily traced to the gradual diminution in frequency and energy of those productive causes, the varying nature of the original materials acted on, and the chemical and mechanical changes they have undergone during the process; and with due allowance for these circumstances, these three modes of production are perhaps fully equal to account for the origin of all the mineral masses of the earth's surface. They have also one immense advantage over other hypotheses, and which speaks volumes in their favour, and "*this is, that they are all still in operation,*" and producing results completely analogous to those which are here attributed to them. In fact, (the author says,) the theory of the globe, which I have thus hazarded, consists simply in the application of those modes of operation which nature still employs, on a large scale, in the production of fresh mineral masses on the surface of the earth, to explain the origin of those which we find there already.

If, after fair discussion, and with all reasonable allowances, it is found adequate to this purpose, its truth will be established on the soundest possible basis—the same upon which rests the whole fabric of our knowledge on every subject whatsoever, the supposition, namely, that the laws of nature do not vary, but that similar results always are, have been, and will be produced, by similar preceding circumstances.

An appendix is added to the work, containing a list of known volcanos in recent or habitual activity; and an examination of the anomalous phenomena described by M. de Humboldt, as having accompanied the eruption of Jorullo in Mexico.* The work is illustrated by engravings, lithographs, and numerous wood-cuts.

II. *An Account of the Earthquakes which occurred in Sicily, in March* 1823. By Sig. Abate Ferrara, Professor of Natural Philosophy in the University of Catania.

(Concluded from last Number, p. 161.*)*

When the people about Ætna perceived their houses beginning to shake, they turned their eyes towards the volcano, and waited in expectation of an immediate eruption. And while they looked, fearful apprehensions filled their minds, and they prayed that the event, be it what it would, might take place at once.

The philosopher, who observes the phenomena of nature, for the sake of reducing to the same class those of an analogous origin, and thence to deduce them from the same cause, observes the link which connects earthquakes with volcanic operations, and sees with the ignorant vulgar, those mighty forces preparing in the subterranean furnace which are able to put in motion immense masses of the solid globe, and to agitate them as water is agitated by a violent wind. The eruption of Ætna in 1811 was interesting from the grandeur of the spectacle which it presented, and no less so, from the instruction which it conveyed to the naturalist. A new opening was made on the surface of the mountain. Explosions of tremendous force preceded the emission of immense columns of smoke and inflamed masses of matter, which were incessantly thrown upwards, and whose approach was announced by horrid roarings and explosions, which filled the air to a great distance. Each explosion was accompanied by shocks: and as the interval between them was of but a few minutes duration, the city and country, to a vast extent, were in a continued undulation. For many days at Catania, eighteen miles distant, we were rocked as though we had been upon the sea. Some of the shocks were very violent. The door of my chamber, which I left purposely ajar, kept a continued beating against its side posts. The shocks lasted as long as the volcano was in operation, that is, for more than nine months; and when the external phenomena disappeared, the internal fire not being yet extinguished, deep subterranean rumblings and explosions were heard, and shocks felt at each report.

When the fire invests substances, it rarefies their masses to a great degree; the acquisition of new volume produces a proportionate expansion; and under the action of an enormous accumulation of inflamed matter, a passage is made for it with sudden and fearful energy. The expansion of

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* See our Last Number, p. 50.

water, for example, under a medium pressure of the atmosphere, is 1728 times its first volume, and it increases in the ratio of the heat. At 230° of Fahr. the pressure is equal to four atmospheres only. The explosion of a single barrel of powder, shocks and overthrows the whole vicinity. If, then, a subterranean stream of water falls upon places where volcanic fires are burning, it is at once converted into steam, acquires a density proportioned to the resistance of the mass of earth above it, circulates about, and agitates the most solid mountains and great tracts of land, until, losing its heat in the cavities of the earth, it returns to the state of water, without having given any external marks of its existence. It seems that the return of the terrible phenomenon is owing to the flow of water into places on fire—of water, the streams of which are determined only by accidental causes.

The vast furnace in the interior of the earth being inflamed, the fire attacks every thing exposed to its influence, some are liquefied, while others are converted to vapour; these, developing their volumes, form a system of force moving with immeasurable power. The subterranean cavities, little able to contain them, are violently convulsed in all their dimensions; and this effect is transmitted by the solid earth, to distances proportioned to the quantity of force, to the transmissive power of the body moved, and to various local circumstances favourable, or otherwise, to the propagation of motion. After having combated with the obstacles which oppose them, roaring under the earth, like the winds of Æolus, to find an outlet from the places in which they were produced, they circulate in various canals, until a cold temperature deprives them of the heat which gave them such power, and they sink into their former state. Often, however, they drive before them the matter which the heat has liquefied; and urging it towards the ancient mouths of volcanoes, discharge it in flaming rivers in the midst of the terrible phenomena which they themselves produce.

Urged by the passion for observation, I have often descended into the horrid cavity of the crater, and approached near the blazing brink of the new orifices which have vomited forth streams of fire in my own time; I have seen immense torrents of aqueous vapour urged from the vast chimney, whose base is lost in the deep furnaces below; I have been bathed in the water, to which the vapour was reduced by the low temperature of the atmosphere into which it entered; often have I seen it fall in fine showers all around me. Having penetrated into the recesses of the globe, it is in this manner forced out again by the heat to which it is exposed. I have observed the hydrogen gas; one time burning with its peculiar colour; at another, bursting forth with a loud, deep explosion; the sulphuric and muriatic vapours, whitening the immense clouds of smoke, and filling all the air with their suffocating breath; or, seizing upon the solid substances around, remaining fixed upon them. Fused substances, forced up by the elastic vapours, are disgorged from the same mouths, spread about in torrents of fire, and consolidated by the contact of the air. Is it not possible that the seat of these products may not be extremely deep, and that yet they may reach the surface? Who knows, but, in other places, those grand laboratories of nature, from causes which will always elude our investigation, may be so deeply seated, that their productions never arrive at the surface, and that no other evidences of their existence, no other effects of their action are perceptible, but the shaking of the earth, and the rumblings which the aëriform elastic vapours make in the cavities of the earth.

Three principal furnaces have their outlets on the three sides of Sicily, and each with a force proportioned to the circumstances which supply it with combustible matter. Ætna on the eastern side, by the immensity of its power, rules the whole island. When in full action, the island trembles to its foundation, and feels the mighty power which has borne rule there from time immemorial. Its roarings are heard from one extremity to the other; but the parts most agitated are those in its neighbourhood, and those between it and Cape Passora, a space of about a hundred miles.

The mountain of Sciacca, on the southern shore towards the west, seems to cover a place where the elements have been in ceaseless operation for ages. From dark caverns, which open in the more elevated parts, torrents of water, in the form of heated vapour, with sulphurous gases, are ejected. Having penetrated into the internal recesses, but unable to extinguish the fermentation, the water becomes invested with fire, is converted into vapour, and thus exhaled into our atmosphere. The extrication of the steam causes, in the internal caverns, a deep roaring, and often fearful convulsions, felt at a distance. At such times, Sciacca, at the foot of the mountain, experiences the most violent commotions. In 1578, it was reduced to ruins. In 1652, for fifteen days, it suffered the most severe and unremitted shocks. For some months, in 1724, the earth was so frequently and violently agitated, that all the inhabitants fled into the country. In September 1726, all the western part of Sicily was shaken with the greatest severity; and, in Palermo, at that time, many lives were lost, and many edifices destroyed; in June of 1740, Sciacca felt twenty-two shocks, with injury to buildings, and loss of lives; that of the 25th was of such immense force, that it extended as far as Palermo. After the middle of December 1816, the inhabitants heard extraordinary rumblings under the mountain, and in January of the succeeding year, the shocks were so frequent, that twelve were sometimes counted in one day, and so violent, that it seemed that the foundations of buildings must be rooted up—the rumblings and explosions under the mountain became fearfully loud—and the sea dashed in great waves against the shore at its foot. Sambuca, fifteen miles distant, suffered much injury. A strong odour of sulphur pervaded the air all about Sciacca. While nature was in this agitation in the western part of the island, the eastern was enjoying perfect quiet. Over against Sciacca, at the distance of seventy miles, Pentellaria rises from the sea, and presents the same phenomena: an island of lava, and other burnt matter, and streams of heated vapour of water, and of sulphur issuing incessantly from its cavities, show a great fermentation in the deep caverns under the sea, and to which little is wanting to renew its ancient conflagrations. Off the northern coast of Sicily, is situated a chain of islands, extending from east to west, and terminating with Ustica at the distance of forty-two miles from the western shore of Palermo. All of these islands, sons of volcanic fire, which has raised them from under the depths of the sea, bear the impressions of the terrible element; and some are still burning, and serve as outlets to the subterranean furnaces. Vulcano, twenty-two miles from Cape Milazzo, burns, roars, thunders, and throws out continually immense columns of smoke and flame. Stromboli ceases not a moment in vomiting forth smoke, flame, and streams of vapour, which, rushing from the inflamed mouth, produce a horrible roaring, spreading terror among all the Eolian islands, and the adjacent coasts of Sicily, and Calabria. Lipari still preserves in its baths, a part of that heat, which one day fused into glass the matter of which it is formed. The action of these islands has almost always troubled Sicily. Early one morning, in February 1444, enormous masses of heated matter, amidst huge volumes of smoke and flame, were raised from the summit of Vulcano, hurled about the sea to the distance of six miles, while strong shocks agitated this island and Sicily. Other flaming masses were thrown out on the 24th of August, 1631, which, driven by the wind, passed over Naso in Sicily, directly in front of Vulcano, and, on the next day, this unhappy city, by the violence of the convulsions of the earth, was entirely laid in ruins. Many persons were injured. A cleft was made in the soil, from which a very strong odour of sulphur issued. On the 22d of April 1717, at dawn of day, a deep subterranean murmur was heard, accompanied by a severe earthquake, the shocks of which were felt all along the northern shore, even to Messina. But the places which suffered most, were those nearly over against Vulcano, as Milazzo, Pozzodigotto, Castroealo, twenty-six miles distant from it. The last city was entirely ruined. Shocks were renewed in the same places in 1732; and with much greater force in 1736, when the whole northern coast was violently affected, particularly Palermo, Ciminna, which was much damaged, and Naso, which suffered still more. On the 4th of May 1739, about 5 o'clock, P. M., the inhabitants of St Marco, a town, back of Naso, saw thrown from the mouth of Vulcano, immense clouds of smoke and burning matter, which, driven by the wind, came roaring and thundering over Sicily, letting fall perpendicularly into the sea, and on the neighbouring shore, flaming matter which gave out on every side bright sparks, and struck with fearful crashes. It passed over Naso and St Marco, and went on wasting itself in the interior. Such phenomena were unlucky omens to these unhappy towns. At 12 o'clock, on the 9th, a dreadful howling from Vulcano, was followed by a violent shock, which, after a few moments, was repeated with many explosions; more than a hundred were counted within six days, and another on the twenty-first. Great rocks were detached from the mountains in the vicinity. Another flaming mass on the 9th of June, darted from Vulcano and passed over Sicily; shocks were felt till the 22d, accompanied by howlings and numerous explosions from the burning mountain. St Marco suffered exceedingly, but Naso was entirely destroyed. The volcanoes of Eolia contributed much to the earthquakes of Calabria and Messina in 1783. Stromboli was almost always in great commotion. For many days it seemed like a mad bull, which, raised above the waves, by his roaring filled Calabria and Sicily with terror. Vulcano often accompanied it, and its deep rumblings, and vast columns of smoke and flame, were terrible.

After the violent earthquake of Sciacca in 1816, the same evil fortune happened to other parts of the island. On the 15th of April 1817, a severe shock terrified the people of Caltagirone in Valdinoto, and of the neighbouring places. One happened at Catania in October, and another on the 20th of February of the following year, 1818, which was enormous. All the towns about Ætna were ruined, and many lives lost. Catania felt its injurious effects. It was felt all over the island, since at Palermo it produced three undulations. Others which followed it, and which continued to agitate Catania and the neighbouring region until April, were felt with greater force. All these shocks were the precursors of the grand eruption of Ætna, which burst out on the 27th of May 1819, and which lasted until August. While Sicily was trembling, the volcano was making its preparations in silence. The effects of the operations of Ætna, are felt in places at a great distance from the mountain. After the troubles of February and April, Catania and its vicinity enjoyed repose until the 8th of September, when all Madonia was convulsed. Other shocks succeeded in October and November. On the 25th of February 1819, a very severe one was felt, which extended to a great distance. At Palermo, three motions were produced, the last of which was very violent. The shocks in the whole of the vast extent of the mountains, where so much injury was done to the houses of the numerous inhabitants of these regions, were always preceded and followed by subterranean murmurs, and distant explosions. Under these places, it seems that those substances were deposited, which Ætna inflamed and ejected from its mouth in the following May; because, after the eruption commenced, Madonia was left quiet; while Ætna, which, till this time, and during the agitations of Madonia, had remained perfectly calm, became convulsed with earthquakes. They accompanied the eruption.

With the extinction of the conflagration in August, all the phenomena ceased, and the earth was no longer agitated. But in 1822, Ætna showed that the fermentation within its furnaces was again at work. On the 5th of April, rumblings and continued explosions were heard, which were followed by great clouds of smoke, violently driven from the crater by the impetuous current of elastic vapours. A shower of sulphurous ashes fell all around. On the 6th, a violent shock convulsed all the towns between Ætna and Madonia, Capizzi, Cesarà, Sperlinga, Troina, Gangi, Gagliano; but in the midst of these, Nicosia seemed the centre of impulse in all the shocks which followed throughout the month. Its soil appeared on the point of being torn up by force, many buildings were destroyed, and its inhabitants fled in consternation to find an asylum in the country. The immense clouds of smoke, and earthy ashes, which were ejected from June to October; which covered the more lofty part of the mountain with a gray stratum; which filled the atmosphhere, and gave out through the whole region a strong odour of sulphur, clearly prove that all these commotions were produced by forces collected in the recesses of Ætna.

While Nicosia and the whole space between Madonia and Ætna were in such commotion, Sicily to the west, and all the northern coast, enjoyed perfect quiet; but a sad reverse was preparing. In October, Ætna ceased throwing out sulphurous ashes and sand, and with it ceased all its noises, and shocks, and all was calm. In February, in the beginning of the next year, small motions of the earth were felt along the northern side of the island, which were the preludes to the scene that presented itself in March.

The direction of the motion was from N. E. to S. W. as was proved by all the phenomena mentioned in the beginning. I will not be guided by the injuries suffered in different parts, for these spring from a complication of causes; from the soil, its greater or less capacity of receiving and communicating motion; from the manner in which it presents itself to the progressive motion, and from the state of the edifices. These circumstances may sometimes produce anomalies which easily deceive those who do not bestow in the examination of them the attention which they deserve; but without fear of error, I may say, that in general the shock was much the most forcible on the northern shore, and at a little distance from it; and that it went on gradually, diminishing towards the interior. The moving force, then, must have been in operation somewhere under the sea opposite this part of the island. Naso was almost entirely ruined; Patti, and all the towns about Capes Orlando and Calava, and which are nearer Eolia, were considerably damaged. Some very small, thinly inhabited towns lost little, because they had little to lose; others were in some measure defended by their situations. Palermo, at the bottom of a bay which curves towards these burning islands, and surrounded by large and high mountains on the other side, was exposed to the whole force of the motion against it; this it was, together with the degraded state of its buildings, which brought such ruin upon this beautiful city. Every thing seemed then to announce to us, that the most expansive vapours which proceed from the burning furnaces of Eolia, in developing their immense volumes, urged against the sides of those cavities which once contained the matter of which all these islands are formed, produced the motion that struck obliquely against Sicily, and moving along the shore towards the west, spread despair throughout Palermo. After the shock of the fifth, their motion was more free; and they were heard murmuring under the soil near our island, seeking an outlet from the obscure caverns in which they were generated, but not propagating their motion to any considerable distance. The course of that of the seventh was in the same direction with that of the fifth; but that of the thirty-first was in a direction directly opposite, since it was felt at Messina, and not at Palermo. The undulations were determined by the horizontal direction of the motion; the perpendicular shocks, by a force acting from below upwards, which supposes a much greater depth in the situation of the acting force, than the other, without ever being in any case nearer the surface. Every one may easily distinguish the difference which subsists between the superficial motion caused by the rapid passing of a heavy carriage, or by the sudden combustion of a large quantity of confined powder, which would cause the darting of a large accumulation of electric fluid to restore the equilibrium between the earth and the atmosphere, were it possible for it to collect in the midst of so many conducting bodies which seem designed to restore the equilibrium instantly; between this motion and the deep, heavy earthquake, armed with such terrible power, which agitates so violently a great extent of the globe, which sometimes seems ready to tear it from its very foundation, and which has all the characters of an effect sprung from most wonderful degrees of force, and of force which, placed deep in the earth, moves and convulses those great masses lying between it and the surface.

The idea of forces and effects like these, fills with fear the miserable mortal who creeps upon the face of the earth, and brings his pride down to the dust. When he sees the earth reel, and the great fabrics which he has raised with so much confidence rushing to ruin, he despairs of finding any where one firm support to his frail existence.

The chinks and fissures formed in many places, and to which the vulgar attribute much importance, are in consequence of the quaking of the soil, and to which the softness of the earth, and the loss of its internal support have given rise. The country of Bosco, about Ogliastro, of which I have already spoken, became furrowed with diverse, long, tortuous, deep clefts, the sides of which, in some places, sunk down; in other places, portions of the surface passed down over inclined planes below them, and took new positions; the olive-trees which some of these carried with them, were much injured by the breaking and displacing of their roots. This land is formed of an immense deposit of argillaceous chalk, more than a hundred feet deep. The water which penetrated it (and the winter there was very rainy) loosened the earth, and carried a great part of it into the internal cavities below; the surface, thus wanting solid support, under the shock of the earthquake, became filled with depressions, caverns, and inequalities. The same may be said of a great aperture made in the vicinity of Colesano, which, dilating itself day after day, threatened to render those places inaccessible. Copious showers alone produce such effects in the chalky land of many parts of Sicily. This want of firm bases frequently causes the overthrow of great rocks at the time of earthquakes. Well do we remember, that, in the earthquake of the 5th of February 1783, a mountain, a mile to the south of Scilla, and which was a mile and a half in length, fell over into the sea of Calabria, and formed two new promontories.

If all these facts induce us to place in Eolia, the causes of the physical events of the past March, it is necessary to inquire if these islands exhibited, at that time, any phenomena, which may corroborate our opinion.

I will mention, therefore, in this place, many facts, about which there can be no uncertainty, and which will be of the greatest importance, should any one wish to push the conjecture which I have announced in this memoir, to certain evidence.

Since September of last year, the daily quantity of smoke from Vulcano, has been much greater than usual; and flame has often been visible in the evening. Explosions have been frequently heard on the neighbouring coasts of Sicily. But Stromboli has exhibited the greatest activity for almost fourteen months without intermission. Shocks have been very frequent, and so strong as to fill the islanders, although accustomed to them, with great apprehensions. The island, with the blazing mountain itself, seemed often on the point of being torn up from its foundation. The volcano opened two new mouths on the side which looks towards the sea, and belched out from them fearful clouds of sand, and burning rocks, which, after darkening the air, fell to the earth. Fortunately their direction was not towards any of the little habitations, or cultivated fields of the island. One forest only on the side of the mountain suffered some injury. The inhabitants often found themselves enveloped in thick clouds of black smoke and ashes, which the wind drove among them. But only one man was struck by the burning rocks hurled through the air with immense violence. The scoria and ashes did much damage to the cisterns of the island, and to the terraces which serve as tiles over them. Torrents of black smoke, ashes, and sand, were often ejected and thrown to various distances. The greatest shocks were sometimes followed by a thick dry cloud, which filled the air of the whole island.

The shock of the 5th of March was very strong at Stromboli, at Saline, formerly Didime, and at Lipari. The inhabitants of Lipari did not doubt that their houses would this time be reduced to ruins; and they have not yet ceased giving thanks to Heaven, for defending them from utter destruction. They affirm that a moment after the shock, all their thoughts were turned upon the disasters which might happen to places on the neighbouring coast of Sicily, and at Palermo; towards which the direction of the motion seemed to be. Lipari lies between us and Stromboli. Since April the parts of our island which were before agitated, have been left in repose; but shocks are still frequent at Stromboli, and keep the poor inhabitants there in continued fear. The subterranean furnace seems to have lost much of its power, as the elastic vapours generated there shake but a very limited space, and the new apertures of the mountains emit now and then but a very small quantity of fine sand, which is always the last product of an expiring conflagration.

From what I have laid down, it is just to conclude, that the fires of Eolia are those which have, for a long time, been preparing the event of last March; that it was produced by motions generated in those mighty furnaces, and that those motions were propagated to great distances. If Sicily, then, is so often shocked, the powers which agitate it must exist in volcanoes that burn within its own bosom, and in the surrounding sea.

Situated in the midst of such grand operations of nature, Sicily must be exposed to all the effects which such powerful causes are capable of producing. The chemical subterranean operations require that the earth should every where be traversed by vast cavities and canals, running in various directions; and the forces of the operations act on the different parts of these cavities. But it is natural to believe, and many facts in this memoir demonstrate the truth of it, that places in the vicinity of the three great volcanic outlets, ordinarily feel the force with the greatest violence. In this respect, the situation of Palermo is very advantageous; since it is distant from Ætna, and from Eolia, and it is near to Sciacca only, which is the least energetic. And this grand and respectable city would be less exposed to such grievous disasters, than all the other cities of Sicily, did its edifices possess that character, which they might easily be made to possess, which constitutes true solidity and resisting firmness.

III.—SCHOW'S *Essay on Botanical Geography.* Copenhagen. 1823.

(Concluded from last Number, p. 167.)

III. *Regnum Labiatarum, et Caryophyllearum,* the Midland Flora, (*Flora Mediterranea.*) This region is bounded on the north by the Pyrenees, the mountains of the south of France, the Alps, and the mountains of the north of Greece, and thus includes the three Peninsulas of the south of Europe, the Pyrenæan Peninsula, Italy, and Greece; besides, there belong to it Asia Minor and its Islands, Egypt and the whole of the north of Africa, as far as to the Deserts; lastly, the Canary Islands, Madeira, and the Azores. That which especially marks this region, is the great abundance of the two families mentioned above, the *Labiatæ* (in a strict sense) and the *Caryophylleæ* which, as well towards the north as towards the south, as also in North America on the same parallel, are proportionally much rarer. To its characteristic forms there belong further, *Compositæ, Stellatæ, Asperifoliæ;* although they are also found in a similar proportion in other parts of the earth possessing a similar climate. Many tropical families appear here, either with single representatives, or several species, as *Palmæ, Laurineæ, Aroideæ, Terebinthaceæ, Paniceæ, Cyperaceæ propriæ;* families, which decrease from the Equator towards the poles, are here more numerous than in the north of Europe, for instance, *Solaneæ, Leguminosæ, Malvaceæ, Urticeæ, Euphorbiaceæ.* The forests consist chiefly of *Amentaceæ* and *Coniferæ,* the underwood of *Myrtineæ, Ericaceæ, Terebinthaceæ,* &c. A number of evergreen trees show themselves; vegetation never entirely ceases; green meadows are more rare. The subfloras belonging to this, are the Spanish, Portuguese, Italian, in which may be reckoned the south of France, the Grecian, the Levantine, or that of Asia Minor, the Egyptian, the Atlantic, that of Canary, which probably might also include that of Madeira and of the Azores. But these Floras reciprocally run so into each other, that it is difficult here to define the provinces. However, it appears most proper to admit the following five provinces; (a) *Provincia Cistorum,* which includes Spain and Portugal. Although the genius *Cistus* is spread over the whole region, it seems, however, to be most numerous in the Pyrenean Peninsula; (b) *Provincia Salviarum et Scabiosarum,* the south of France, Italy, Sicily; (c) *Provincia Labiatarum frutescentium,* the Levantine Flora, Greece, Asia Minor, and the southern part of the Caucasian countries; (d) *Provincia Atlantica,* north of Africa, of which I do not know any characteristic that I can give, and probably it might be included under the second province; (e) *Provincia Sempervivorum,* the Canary Isles, perhaps also the Azores, Madeira, and the north-west coast of Africa. Many *Sempervira,* some succulent *Euphorbiæ* and *Cacaliæ* characterize particularly this province.

IV. *The Eastern Temperate part of the old Continent,* namely Japan, the north of China and Chinese Tartary, probably form a peculiar region; but we are too little acquainted with these districts to be able to admit it with certainty, and still less are we able to mention any thing characteristic in its Flora. Of Japan's 358 genera, 270 occur also in Europe and North Africa, and about the same number in North America, so that its Flora seems to occupy a middle place between those of Europe and North America; the vegetation approaches nearer to the tropical than in Europe; for we meet with the families of the *Cycadeæ, Scitamineæ, Musæ, Palmæ, Anonaceæ, Sapindaceæ;* in particular, the approach to the Flora of India is remarkable. The families *Rhamni* (*Frangulaceæ, Dl.*) and *Caprifolia* are found in a relatively considerable number, and exhibit several peculiar genera; thence, perhaps this region might deserve the name (*Regnum Rhamnorum et Caprifoliorum.*)

V. *Regnum Asterum et Solidaginum.)* The eastern parts of North America, with the exception of those that belong to the first region, without doubt comprehends two regions, for amongst 417 genera in *Walter's* Flora of Carolina 117 are wanting in *Barton's* Flora of Philadelphia. The northern parts of North America have truly but few genera which are absent in the southern; but this only shows, that there occurs here a similar relation to that which takes place between the north and south of Europe. The southern region will include Florida, New Orleans, Georgia, and Carolina; the northern contains the other states of North America. What characterizes this region are, besides the numerous species of genera *Aster* and *Solidago,* the great number of species of *Oak* and *Fir,* the very few *Cruciferæ* and *Umbellatæ, Cichoriaceæ,* and *Cynarocephalæ,* the want of the genus *Erica,* and a larger number of *Vaccinia* than in Europe.

VI. (*Regnum Magnoliarum.*) This, which includes the most southern parts of North America, is separated from the preceding region by the number of tropical forms which here appear, and show themselves more frequently than on the similar parallel in the old continent, (*Scitamineæ, Cycadeæ, Anonaceæ, Sapindaceæ, Melastomeæ, Cacti,* &c.), from which it is besides distinguished by a smaller number of *Labiatæ* and *Caryophylleæ,* and by more trees with broad shining leaves, and splendid blossoms (*Magnolia, Liriodendron, Æsculus,*) or with pinnate leaves (*Gleditschia, Robinia, Acacia, Schrankia,* &c.), I have adopted the name of Magnolias, although they are also found in the southern part of the preceding region, because I know not any better.

VII. (*Regnum Cactorum, Piperacearum, et Melastomearum.*) This region I propose should include the lowest districts of Mexico, West Indies, New Granada, Guinea, and Peru, perhaps also of Brazil. The three families mentioned appear peculiarly to characterize these countries, for the first belongs exclusively to America, the two others possess but few species out of that country; also *Palmæ, Rubiaceæ, Soluneæ, Boragineæ, Passifloreæ, Compositæ,* are here more common. We may admit of several provinces; (a) *Provincia Filicum et Orchidearum,* comprehends the West Indies; (b) *Provincia Palmarum,* the continent of South America. Brazil ought certainly to form a peculiar province, if, indeed, it does not make a distinct region. *Melastomeæ* and *Palmæ* appear to belong to the more numerous forms.

VIII. (*Regnum Cinchonarum.*) It appears from *Humboldt's* works, that the middle districts (with regard to elevation) of South America, should form a distinct region, as they considerably differ from the low lands; the proposed name seems proper, at least for Peru and New Granada; but, certainly not for Mexico, where the species of *Cinchona* are wanting.

IX. (*Regnum Escalloniarum Vacciniarum et Winterarum.*) In this are placed (also according to *Humboldt's* works) the highest parts of South America; besides the plants mentioned, there belong also to this region many species of *Lobelia, Gentiana, Calceolaria, Salvia,* several European Genera of Grasses, *Bromus, Festuca, Poa,* and *Cichoraceæ, Hypochæris, Apargia;* alpine forms also show themselves, (*Saxifraga, Draba, Arenaria, Cerastium, Carex,* and *Gentiana.*) Perhaps, also, those parts of the high lands of Mexico, where the species of oak and fir flourish, belong to the same region, though, in all probability, they will form a peculiar province, (*Provincia Quercuum et Pinorum.*)

X. (*Regnum Chilense.*) It appears that Chili may form a distinct region, for, amongst the genera which are known from thence, not one-half are found in the low districts of South America; it has, perhaps, a stronger resemblance to the high lands in the genera *Calceolaria, Escallonia, Weinmannia, Bæa, Campanula, Budleia,* but, however, scarcely sufficient to reduce it to a province. The Flora of this country appears to be essentially different from those of New Holland, the Cape, and New Zealand; though there is found an approach to them in *Goodenia, Araucaria, Proteaceæ, Gunnera, Ancistrum.*

XI. (*Regnum Compositarum arborescentium.*) Includes Buenos Ayres, and, in general, the eastern side of the temperate part of South America. It has been already remarked, that the Flora of this part of the earth, in a considerable degree, agrees with that of Europe; among 109 genera, 70 are likewise found in Europe, 85 in the North Temperate Zone; on the other hand, it differs considerably from the Floras of the Cape, and of New Holland, for *Proteaceæ, Epacrideæ, Ericaceæ, Irideæ, Ficoideæ, Geraniæ, Myrtineæ, Mimoseæ,* are either entirely wanting, or occur but sparingly. It is also very different from the Flora which is found on the west coast of America; for, amongst the 109 genera mentioned, only 35 are found in Chili. The characteristic of this region appears to be the great number of the arborescent *Syngenesiæ* (particularly of the subfamily *Boopideæ,*) which, however, do not exclusively belong to this region, but are also found in Chili, and at the Cape. I have hence taken the name, though a more intimate acquaintance with this Flora, at present so little known, may perhaps oblige us to change it.

XII. (*Regnum Antarcticum.*) Includes the countries near the Straits of Magelhan. The vegetation here also approaches very near that which is found in the north Temperate Zone; for, amongst 82 known genera from thence, 59 have also species in the northern hemisphere; the northern Polar forms even show themselves, such as *Cariceæ, Saxifrageæ, Gentianeæ, Arbutus, Primula.* Some resemblance to the Highlands of South America, and to Chili, is shown in the genera *Calceolaria, Ourisia, Bæa, Bolax, Wintera, Escallonia;* to the Cape, in the genera, *Gladiolus, Witsena, Gunnera, Ancistrum, Oxalis;* to New Holland, in *Proteaceæ, Mniarum.* The characteristic forms I dare not determine; but as most of the species known from hence, and some of the genera, are peculiar, so it ought certainly to form a distinct region.

XIII. (*Regnum Novæ Zeelandiæ.*) Well deserves, on similar grounds, to be a separate region, although its vegetation is a mixture of that which is found on the three nearest continents, South America, South Africa, and New Holland. It has, in common with South America, *Ancistrum, Weinmannia, Wintera;* with South Africa, *Mesembryanthemum, Gnaphalium, Xeranthemum, Tetragonia, Oxalis, Passerina;* with New Holland, *Epacris, Melaleuca, Myoporum;* with both the latter, the families *Proteaceæ* and *Restiaceæ;* several *species* are also in common, both with New Holland and Van Diemen's Land, for instance, *Mniarum biflorum, Samolus littoralis, Gentiana montana;* the first is also found in the Straits of Magelhan.

XIV. (*Regnum Epacridearum et Eucalyptorum.*) Includes the temperate part of New Holland, together with Van Diemen's Land. This region is very marked; the families *Stackhouseæ* and *Tremendreæ,* are quite peculiar to New Holland; *Epacrideæ* nearly so; *Proteaceæ, Acaciæ aphyllæ,* and the great number of *Myrtineæ* (especially of the genera *Eucalyptus, Leptospermum, Melaleuca*) *Stylideæ, Restiaceæ, Casuarineæ,* *Diosmeæ*, separates it from most other regions. The tropical part of New Holland, according to *R. Brown*, can hardly be united to this, but must be either a particular region, whose Flora resembles that of the Indian Flora, or else a province of this latter region.

XV. (*Regnum Mesembryanthemorum et Stapeliarum.*) This includes the southern extremity of Africa, the Flora of which is distinguished by a high degree of peculiarity. By the families *Proteaceæ, Restiaceæ, Polygaleæ, Diosmeæ*, it distinguishes itself from most others, excepting that of New Holland, and from this it is distinguished by the two numerous genera *Mesembryanthemum* and *Stapelia*, and by the family *Ericaceæ*, which is here more numerous than any where else. There belong, moreover, to the characteristic of this region, the many *Irideæ, Geranieæ, Oxalideæ*, and the extraordinary large number of *Compositæ*. On the other hand, there grow here, as well as in New Holland, but only very sparingly, these characteristic forms of the northern Temperate Zone, *Cruciferæ, Ranunculaceæ, Rosaceæ, Umbelliferæ, Caryophylleæ.*

XVI. (*Regnum Africæ occidentalis.*) We know only Guinea and Congo, of which the vegetation, as has already been remarked, has a very low degree of peculiarity, and is a mixture of the Floras of Asia and America, though it resembles most that of Asia. The American tropical families, *Nopaleæ, Piperaceæ, Palmæ, Passifloreæ*, are either entirely wanting, or occur sparingly; *Leguminosæ* are more numerous than in America. Above two-thirds of the genera, and some of the species of Guinea, are found also in East India. On the other hand, this region approaches America, in possessing many *Rubiaceæ*, also in the genera *Schwenkia, Elais, Paullinia, Malpighia*, and several more which are wanting in Asia, and in several species which it has in common with America. A considerable number of *Gramina* and *Cyperaceæ*, with the peculiar genus *Adansonia*, belong to the characteristics of this country, but I dare not name the region from thence. The interior of Africa is unknown to us.

XVII. (*Regnum Africæ orientalis.*) Of the east coast of Africa, and the islands adjacent, we know tolerably well the islands of Bourbon and France; Madagascar but little, and the east coast itself, scarcely at all. The Flora of the two first mentioned islands has a considerable resemblance to that of India. Amongst 290 known genera, $196 = \frac{2}{3}$, are found also in India, and of the species, not a few are likewise Indian; many of these may, however, have been introduced by the constant intercourse there is between the two parts of the globe. Numerous in species are the genera *Eugenia, Ficus, Urtica, Euphorbia, Hedysarum, Panicum, Andropogon, Sida, Pandanus, Dracæna, Conyza*, which, for the greater part, have also many species in India. In *Ferns* these islands are particularly rich. On the other hand, their Flora differs considerably from the South African; it has, however, some resemblance, in single representatives, of the Cape genera *Erica, Ixia, Gladiolus, Blæria, Mesembryanthemum, Seriphium,* and several arborescent *Syngenesiæ.* Still much less resemblance is there to the extra-tropical parts of New Holland. The likeness is stronger to the tropical part of that country, as its Flora also approaches that of India. Single genera only it seems to have in common with America; for instance, *Melicocca, Ruizia, Dodonæa, Dichondra.* These are probably peculiar; *Latania, Hubertia, Poupartia, Tristemma, Fissilia, Cordyline, Assonia, Fernelia, Lubinia,* and others. Madagascar appears to possess a very peculiar Flora; it agrees most with the last mentioned islands, and several genera are only found on them and Madagascar; for example, *Danais, Ambora, Dombeja, Dufourea, Didymeles, Senacea;* several species also are common to both, as *Didymeles Madagascariensis, Danais fragrans, Cichona afro-inda;* but, however, among 161 known genera from Madagascar, 54 only are found in the islands of France and Bourbon; so that there might be good grounds for forming a separate region of the first, unless, perhaps, the east coast of Africa might come under the same. With New Holland and the Cape, Madagascar has still less resemblance than the two other East African islands.

XVIII. *Regnum Scitaminearum,* (the Indian Flora.) To this belong India, east and west of the Ganges, together with the islands between India and New Holland, perhaps also that part of New Holland which lies within the tropics. The *Scitamineæ* are here far more numerous than in America, likewise, although in a less degree, *Leguminosæ, Cucurbitaceæ, Tiliaceæ;* the before mentioned South American forms are more seldom, or else wanting. This region should certainly be divided into several provinces, but, as yet, we know too little of it, for us to undertake such a division with any degree of certainty.

XIX. *The Indian Highlands* ought to have one, or probably two regions, with a vegetation different from that of the Lowlands; in the middle region, *Melastomæ, Orchideæ,* and *Filices,* appear to prevail; in the higher, the vegetation approaches very near the European and North Asiatic, and partly the Japanese; these districts probably form one region with the whole of central Asia.

XX. Of *Cochinchina's* and the *South of China's* Flora, it partly comes near India's, especially in regard to *families;* but, however, *Loureiro's* Flora contains a very large number of peculiar *Genera.* It is true, that many of these genera ought probably to be reduced; but, after all, the vegetation of this tract will most likely be sufficiently peculiar for it to form an individual region.

XXI. The Flora of *Arabia and Persia,* seems likewise, with good reason, to deserve to be separated from that of India, as it is already sufficiently separated from the Mediterranean region (III.); for, amongst 281 genera in *Forskal,* 109 only are found in the south of Europe; more likely does the Flora of Nubia, and part of central Africa, belong to this region. With regard to the numerous species of *Cassia,* and gummiferous

Mimosæ, this region might, perhaps, deserve the name of the region of *Cassiæ* and *Mimosæ.*

Abyssinia probably forms a distinct region, as the high land has such a different climate.

XXII. *The Islands in the South Sea,* which lie within the tropics, form, perhaps, a separate region, though with but a small degree of peculiarity. Among 214 genera, 173 are found in India; most of the remainder are in common with America, for instance, *Chiococca, Weinmannia, Guajacum.* Of species, they have, in common with Asia, *Zapania nodiflora, Kyllingia monocephala, Fimbristylis dichotoma, Tournefortia argentea, Plumbago Zelanica, Morinda umbellata, Sophora tomentosa*; with America, *Dodonæa viscosa, Sapindus Saponaria*; with both, *Rhizophora mangle*; and also some in common with New Holland, as *Daphne Indica.* Peculiar families, or such as have there a decided maximum, can scarcely be given; though, on the other hand, most of the *species* are peculiar. The *Bread Fruit* belongs to their characteristic, though this tree is not altogether peculiar to the South Seas.

Art. XXXII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Hansen's Parabolic Elements of the second Comet of* 1825. The following elements of this comet have been computed by M. Hansen of Seeberg.

	Mean time.
Passage of Perihelion at Naples, 1825,	Dec. 10th. 4192
Log. of Perihelion Distance,	0.092836
Long. of Nodes,	215° 42′ 28″
Long. of Node mean that of Perihelion,	256 57 21
Inclination of Orbit,	33 27 40
Motion	Retrograde.

Zach's *Cor. Astron.* vol. xiii. p. 376.

2. *M. Capocci's new elements of the Comet of* 1825. In our last Number, we gave Capocci's first elements of this comet. The following are his corrected ones,—

	Mean Time.
Passage of Perihelion at Naples, 1825,	Dec. 10th. 601
Log. Perihelion Distance,	0.0930643
Long. of Perihelion,	318° 44′ 26′
Long. descending Node,	35 43 51
Inclination of Orbit,	33 30 29

3. *Pons and Capocci's Observations on the tail of the second Comet of* 1825. This comet has been observed by M. Pons every day from the

10th till the 18th October. On the 11th, the tail was very narrow at its setting out from the nucleus, and grew less to a certain distance, when it widened in the form of a fan. On the 12th, its body was more rough, and the tail a little curved, being very narrow at its origin, and wide at its termination. On the 13th its tail was very shapeless, being considerably bent towards the middle, and as it were in detached pieces. On the 14th, it had a more uniform aspect. On the 15th, the tail was divided into two very sensibly. On the 16th, the tail was very small and faint, and consisted of two parts, one of which was more distinct than the other; and on the 17th, the tail was a little curved.

M. Capocci has also remarked, that the long tail of this comet is subject to continual and very perceptible changes in a short space of time. He believed that he had almost seen the undulations which Pingré had remarked in the comet of 1779. On the night of the 7th or 8th of October, *the tail was divided into three branches*, the chief of which was interrupted by a considerable space almost void of light, after which the nebulosity reappeared, which extended itself to a great distance, bending itself on the side opposite to the path of the comet.

4. *Hansen's elliptical elements of the second Comet of* 1825. Having perceived that the parabolic elements of this comet, which he calculated, and which we have given above, differed more than three minutes from observation, M. Hansen computed the following elliptical elements, which agree very accurately with the observations made at Seeberg, Florence, Turin, Naple, and Vienna.

		Mean Time.
Passage of Perihelion at Seeberg,	1825, Dec. 11,	48915
Long. of node,		215° 37′ 26.″ 4
Long. of node *minus* that of Perihelion,		257 26 24.4
Inclination of Orbit,		33 37 46.8
Eccentricity,		0.9 765 025
Log. of Perihelion distance,		0.092180
Revolution,		382 Julian Years.
Motion		retrograde.

Zach's *Cor. Astron.* vol. xiii. p. 495.

5. *Fifth Comet of* 1825. The following are the elements of this comet calculated by M. Capocci:

Passage of Perihelion,	1825, Sept. 16^d 4866 M. T. Naples.
Perihelion distance,	3.1971
Long. of Perihelion,	46° 34′ 15″
Long. of node,	211 58 50
Inclination of Orbit,	60 5 35
Motion	Direct.

6. *Mr Pond's Observations on the Double Star ζ Bootis.* The following account of this interesting double star was sent by Mr Pond to Mr South. "I first observed ζ Bootis to be a close double star at Lisbon in the year 1795, with a *seven* feet reflector, which the late Sir W. Herschel made for me ex-

pressly with the greatest care. I immediately communicated the circumstance to him, and he wrote me in answer, that, in consequence of my information, he had examined the star, and found it as I described, but reckoned it at that time among the most difficult. I brought the same telescope to England, and used it afterwards in Somersetshire for several years, but could never again see the same star distinctly double, which I attributed to change of climate. The star is now much more easily seen. Our transit telescope separates it with ease. I recollect, at Lisbon, that it was only on very favourable nights that I could see it double." *Quart. Journn.* No. xl. p. 419.

OPTICS.

7. *Luminous Phenomenon observed between Paisley and Glasgow.* On the morning of the 14th instant, about 6^h 37′. I was gratified by the sight of a luminous globe or *bolide*, while going from Paisley to Glasgow. It was tranquilly stationary as if equipoised, and of a similar specific gravity with the plane it seemed to float upon. Its form was somewhat elliptical and translucent in consistency, faintly luminous. After a short while it discharged sparks, and this discharge was subsequently repeated, and by the impulse springing from the re-action of the atmosphere, the *bolide* moved from north to south, maintaining the horizontal plane, not in any section of the arc of a parabola. The star-like sparks were bright and silvery, and void of any chromatic tint. The meteor was interesting and beautiful, and altogether expressive of having its dependence on an electro-magnetic principle. The night had been wet and tempestuous, and the entire day discovered a horizontal parallelism of the clouds in the distant sky; the clouds were chiefly *cumulostrati.* At 4^h 50′ A. M. before leaving Paisley, thermometer 43° 5′ Fahr. and the hygrometer of de Saussure, 94°.—J. MURRAY.

II. CHEMISTRY.

8. *On the Sulpho-Napthalic Acid newly discovered by Mr Faraday.* This name has been given by Mr Faraday to a new acid which he discovered by subjecting napthaline to the action of sulphuric acid. It is a solid crystalline substance, deliquescing in the cold air, fusing at 212°, and charring and burning with much intense flame by a higher heat. The salts which it forms with bases are all soluble in water, and in alcohol. By Mr Faraday's analysis, the elements of the salt approximate closely to

1 Proportional of Barytes,	7.80
2 Ditto of Sulphuric Acid,	8.00
20 Ditto of Carbon,	12.0
8 Ditto of Hydrogen,	.8

Abstracting the barytes, the remaining elements indicate the composition of the pure acid, which thus appears to contain above three-fifths of hydro-carbon. *Ann. of Phil.* lxiii. 228.

III. NATURAL HISTORY.

ZOOLOGY.

9. *Fossil bones near Montpellier.*—M. Marcel de Serres has announced to the Royal Academy of Sciences, the discovery of large quantities of fos-

sil bones in caverns of calcareous strata, in the neighbourhood of Lunel-Vieil, near Montpellier. The bones found in the Kirkdale caves, have occasioned a good deal of speculation among the English geologists, and the proposition of theories to account for their appearance; and the present discovery is likely to add a few more to the number. M. de Serres has, besides bones of herbivorous and carnivorous animals, found some not hitherto met with in a fossil state, viz. the bones of the *camel.*

Among the carnivorous animals he places, in the first rank, lions and tigers, much superior in size and strength to the present living species,—animals whose canine teeth are about 16 centimetres in length, and 39 millimetres in breadth. Along with these enormous bones are found others approaching to the species of lions and tigers now existing; and with them are mixed bones of hyænas, panthers, wolves, foxes, and bears, (differing but little from the badger,) and of dogs. Mixed with these bones of carnivorous animals, are found great quantities of the bones of herbivorous quadrupeds, among which the discoverer met with several species of hippopotamus, wild boars of large size, peccaris, horses, camels, many species of stag, elk-deer, roebuck, sheep, oxen, and lastly, several species of rabbits and rats.

What renders this circumstance more remarkable is, that the bones of the animals thus buried, (which are sometimes in such quantities that the caverns of Lunel-vieil resemble cemeteries,) seem to have no connection with the habits of the animals to which they have belonged. By the side of an entire or broken jaw of a carnivorous animal, is often found the bones of herbivorous races, and all are so mixed, that it is rare to meet with two entire bones which have belonged to the same animal, or at least to animals of the same genus.

These fossil bones are thus disseminated in these caverns without order, and never entire; and as they are found in the middle of alluvial land which contains a great quantity of rounded pebbles, it may be supposed that they have been transported thither by water. These bones all contain animal matter, and what is singular enough, the earth where they are found, contains more animal matter than the bones themselves, when it has not been cleaned from the bony fragments which are contained in it.—*Bull. des Sciences, Nat.* 1826, No. 9. p. 81.

10. *Crocodiles of Egypt.*—In the sitting of the Academy of Sciences of the 6th February, M. Geoffroy-Saint-Hilaire presented from M. Caillaud a mummy crocodile, 7 feet 1 inch in length, in a state of perfect preservation. He had formerly maintained, in opposition to the opinion of M. Cuvier, that there were two species of Egyptian crocodile—one, a sacred animal—mild, and of smaller size, the other the well-known crocodile of the Nile; while M. Cuvier was rather inclined to suppose that the second species was the crocodile of St Domingo. The inspection of this mummy seems to have decided the question. This second species differs from the other chiefly in the structure of the head, the jaws being more lengthened, and indicating a creature of less strength. It was known among the ancients by the name of *Suchus.* A live individual of this species was exhibited at Paris in 1823.—*Le Globe,* No. 22, Feb. 1826.

11. *On the Egg and Tadpole of Batracian Reptiles.*—At the sitting of the Academy of Sciences of the 13th February 1826, M. Dutrochet read a memoir on this curious subject. Spallanzani had conjectured that the egg of the Batracians was nothing but the tadpole itself in a spherical form. This opinion was at first doubted by M. Dutrochet; but future examination discovered to him, that, among this class of reptiles, the fœtus exists prior to fecundation, which, as is well known, does not occur till the extrusion of the egg; and that this fœtus is a kind of polypus—a simple globular sac, which, containing the emulsive matter for the nutrition of the tadpole, lengthens gradually into a plicated tube with numerous convolutions. M. Dutrochet had formerly remarked, in his examinations of insects, that the larvæ of the bee and wasp might also be found in the egg before fecundation in a similar state.—*Le Globe*, No. 24, Fev. 1826.

BOTANY.

12. *M. Ramond on the Vegetation of the Summit of the Pyrenees.* In a memoir on this subject read at the Academy of Sciences on the 16th January 1826, M. Ramond remarks, that, from the base of a high mountain to its summit, the vegetation presents a foreshortened view of the same modifications which are observed from the same base to the Poles. In proof of this, M. Ramond describes the *Pic du Midi*, which rises 1500 toises above the level of the sea. On its summit, the barometer stands between 19 inches and 20 inches 3 lines. The greatest height of the thermometer, in summer, does not exceed 62° or 63° of Fahrenheit, and by supposing that, at that height, the variations will be proportioned to those at the level of the sea, the minimum will be 35° or 36°. On the same principle it will be found, that the thermometer should descend in winter, in places inaccessible to man, to —14° of Fahrenheit. Hence M. Ramond concludes, *that the temperature on the Pic du Midi varies* between the same limits as in *regions situated between* 65° *and* 70° *of latitude.*

"I have ascended, says M. Ramond, 35 times into this island, lost in the middle of the vast ocean of air, and I have remarked, that not a flower appears till the summer solstice. The spring consequently does not begin at that height till the summer has commenced at the foot of the mountain." This peak is accessible only during three months of the year. The month of September is the most convenient for ascending it. In July and August it is not uncommon to see snow fall, which remains for a long time.

M. Ramond, even in that climate, has collected 130 species of cryptogamic or phanerogamous plants, which preserve themselves under the snow. On a small spot, accidentally laid bare, he observed 7 species of plants which vegetated vigorously.

It is a curious circumstance, that the species observed in the *Pic du Midi* are related to the same genera as the species collected by Captain Parry in Melville Island, near the Pole. This island, notwithstanding its extent, presents only 113 species, which is 17 less than M. Ramond has collected on the *Pic*. In the island, as on the Pic, there is only one shrub, which is the willow, reduced to the same dimensions. The climate, however, is not so rigorous on the *Pic* as on the Polar island. The winters are certainly less severe, but the summers are not more warm.

Leaving the summit of the mountain, M. Ramond describes the modifications which vegetation experiences as we descend towards its base, and he speaks particularly of certain vegetables belonging to warm latitudes, which are found in very limited spaces. If we do not admit that these plants prove the existence of ancient communications with the countries to which their species belong, we must recognize an alarming number of particular creations. M. Ramond endeavours to explain these facts by geological considerations, which, however, he offers only as simple hypotheses. *Le Globe,* Jan. 19, 1826, Tome iii. No. xii. p. 62.

ART. XXXIII.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE NOVEMBER 17, 1825.

66. Nov. 23. For Improvements in Machinery for preparing, drawing, roving, and spinning Flax, Hemp, and Waste Silk. To ALEXANDER LAMB, London, and WILLIAM SUTTILL, Middlesex.

67. Dec. 14. For Certain Improvements in Chronometers. To JOHN GOTLIEB ULRICH, Middlesex.

68. Dec. 15. For Certain Improvements in generating Steam. To JOHN MACCURDY, Middlesex.

1. Jan. 4, 1826. For a New Method of manufacturing or preparing an Oil or Oils, extracted from certain vegetable substances, and the application thereof to Gas Light and other purposes. To EDMUND LUSCOMBE.

2. Jan. 4. For certain Improvements on Machines for scribbling and carding Sheep's Wool, Cotton, &c. To EZEKIEL EDMONDS of Bradford.

3. Jan. 4. For a method of conducting to and winding upon Spools or Bobbins, rovings of Cotton, Flax, Wool, or other fibrous substances. To JOSEPH CHESSEBOROUGH DYER of Manchester.

4. Jan. 18. For the Preparation of substances for making Candles, including a Wick constructed for that purpose. To MOSES POOLE.

5. Jan. 18. For an Improved Power-Loom for the weaving of Silk, Cotton, Linen, &c. To JOHN HARVEY, Surrey.

6. Jan. 18. For Methods of seasoning Timber. To JOHN STEPHEN LANGTON, county of Lincoln.

7. Jan. 30. For Improvements in the Manufacture of Hat bodies, communicated by a foreigner residing abroad. To JAMES BLYTH WAYNMAN.

8. Feb. 1. For Improvements in the Construction of Carriages and Harness. To THOMAS COOK, Surrey.

9. Feb. 1. For Improvements in Looms, and implements connected therewith. To T. W. STANSFELD, and W. PRITCHARD, Leeds.

10. Feb. 1. For an Apparatus for propelling Carriages on common roads, or on railways. To GOLDSWORTHY GURNEY, Middlesex.

11. Feb. 2. For a new Method of bleaching the Pulp for making Paper. To JAMES BROWN, county of Edinburgh.

12. Feb. 10. For an Improvement or Improvements in the process of refining Sugar. To CHARLES FREUND, Middlesex.

13. Feb. 11. For a Machine for effecting an alternating motion between bodies revolving about a common centre. To J. LEAN, Bristol.

14. Feb. 11. For certain Apparatus for the concentrating and crystallization of aluminous and other saline and crystallizable solutions, &c. To JOSIAS CHRISTOPHER GAMBLE, county of Dublin.

15. Feb. 16. For a new Preparation of fatty substances, and the application thereof to the purposes of affording light. To NICOLAS HEGESIPPE MANICLER, Surrey.

ART. XXXIV.—CELESTIAL PHENOMENA,

From April 1st 1826, to July 1st 1826. Adapted to the Meridian of Greenwich, Apparent Time, excepting the Eclipses of Jupiter's Satellite's, which are given in Mean Time.

N. B.—The day begins at noon, and the conjunctions of the Moon and Stars are given in Right Ascension.

APRIL.

D.	H.	M.	S.	
1	3			♀ Conj. ζ ♓
1				☽ Conj. β ♑ and ν ♒
4				☿ Greatest Elong.
6	13	21	37	Em. II Sat. ♃
6	14	10	44	Em. I. Sat. ♃
6	21	26		● New Moon.
8	3			♀ Conj. ο ♓
8	13			☽ Conj. ☿
9	12	52	49	☽ Conj. δ ♈
9				☽ Conj. ☿
10	14	21	52	☽ *A* ♉
11	0	9	20	☽ Conj. 2 κ ♉
11	17	48	0	☽ Conj. ι ♉
12	1			☽ Conj. ♄
12	9	49	0	☽ Eclipses ζ ♉
13				☿ Stationary.
13	9	27	19	☽ Eclipses ν ♊
14	0			♅ in Quad. with ☉
15	0	58		☽ First Quarter.
15	8	6	27	Im. } IV. Sat. ♃
15	12	8	27	Em.
15	10	23	25	Em. III. Sat ♃
15	10	33	42	Em. I. Sat. ♃
16	5	23	4	☽ Eclipses 1 α ♋
16	6	33	29	☽ Eclipses 2 α ♋
20	3	43		☉ enters ♉
21	4	53	56	☽ Conj. ι ♍
21	19	26		○ Full Moon.
22	11	5	41	Im. } III. Sat. ♃
22	14	21	29	Em.
22	12	28	9	Em. I. Sat. ♃
23	9	11	40	☽ Conj. κ ♎
23	13	27	50	☽ Conj. λ ♎
23	18	0	11	☽ Conj. 1 β ♍
23	18	1	30	☽ Conj. 2 β ♍
24	2	15		☿ Inf. Conj. ☉
24	22	30	29	☽ Conj. ρ Oph.
25	19	1	31	☽ Conj. 1 μ ♐
25	19	36	44	☽ Conj. 2 μ ♐
26	21	9	47	☽ Conj. *d* ♐
28				♅ Stationary.
28	1	3	38	☽ Conj. β ♑
28	13	3		☾ Last Quarter.
29				☽ Conj. ν ♒

MAY.

D.	H.	M.	S.	
1				♃ Stationary.
1	8	51	18	Em. I. Sat. ♃
1	10	31	22	Em. II. Sat. ♃
2				☽ Conj. λ ♓
4				♄ Conj. ο ♉
4	19			♂ in Opposition to ☉
6	14	16		● New Moon.
7				☿ Stationary.
7	20	23	29	☽ Conj. *A* ♉
8				☽ Conj. ♀
8	6	9	10	☽ Conj, 2 κ ♉
8	10	45	53	Em. I. Sat. ♃
8	13	8	42	Em. II. Sat. ♃
8	23	45	21	☽ Conj. ι ♉
9	12			☽ Conj. ♄
9	15	45	46	☽ ζ ♉
10	15	28	20	☽ Conj. ν ♊
13	12	26	3	☽ Eclipses 1 α ♋
13	13	38	14	☽ Conj. 2 α ♋
14	12	12		☽ First Quarter.
15	12	40	29	Em. I. Sat. ♄
18	15	30	36	☽ Conj. ι ♍
20	20	11	19	☽ Conj. κ ♎
21				☽ Eclipsed Invisible.
21	0	25	54	☽ Conj. λ ♎
21	3	16		○ Full Moon.
21	4	8		☉ enters ♊
21	4	55	56	☽ Conj. 1 β ♏
21	4	57	14	☽ Conj. 2 β ♏
22				☿ Greatest Elong.
22	8	59	54	☽ Conj. ϱ Oph.
23	5	1	23	☽ Conj. 1 μ ♐
23	5	35	40	☽ Conj. 2 μ ♐
23	13			☽ Conj. ζ ♉
24	6	24	20	☽ Conj. *d* ♐

D.	H.	M.	S.	
24	9	3	48	Em. I. Sat. ♃
24	14			♀ Conj. ♄
25	9	26	56	☽ Conj. β ♑
26	20	45		♃ in Quad. with ☉
28	1	46		☾ Last Quarter.
28	10	14	49	Em. III. Sat. ♃
31	10	58	28	Em. I. Sat. ♃

JUNE.

D.	H.	M.	S.	
2	10	19	22	Em. II. Sat. ♃
3	1	11	48	☽ Conj. δ ♈
4	2	32	28	☽ Conj. *A* ♉
4	11	1	4	Im III. Sat ♃
4	12	15	33	☽ Conj. 2 κ ♉
5				☉ Eclipsed Invisible.
5	5	54		● New Moon.
5	18			♀ Conj. ε ♊
5	21	39	19	☽ Conj. ζ ♉
6	1			☽ Conj. ♄
6	21	11	10	☽ Eclipses ν ♊
9	17	58	28	☽ Conj. 1 α ♋
9	19	11	4	☽ Conj. 2 α ♋
12	19	54		☽ First Quarter.
13				♂ Stationary.
14	23	57	50	☽ Conj. i ♍
15	20			☿ Conj. ι ♉
15	22			☽ Conj. ♂
16	19	45		♄ Conj. ☉
17	6	9	26	☽ Conj. κ ♎
17	10	29	8	☽ Conj. λ ♎
17	15	3	58	☽ Conj. 1 β ♏
17	15	5	17	☽ Conj. 2 β ♏
18	19	25	58	☽ Conj. ρ Oph.
19	10	54		○ Full Moon.
19	15	26	59	☽ Eclipses 1 μ ♐
19	16	1	4	☽ Conj. 2 μ ♐
20	16	34	38	☽ Eclipses d ♐
21	12	44		☉ enters ♋
21	19	6	51	☽ Conj. β ♑
22				♀ μ ♋
24	5			☿ Sup. Conj. ☉
26	19	25		☾ Last Quarter.
27				☿ η ♋
30	7	58	50	☽ Conj. δ ♈
29	11			Ceres Opposit. ☉

Times of the Planets passing the Meridian.

	Mercury.		Venus.		Mars.		Ceres.		Jupiter.		Saturn.		Georgian.	
D.	h.	′	h	′	h	′	h	′	h	′	h	′	h	′
APRIL.														
1	1	6	0	22	14	35	18	9	9	50	4	21	18	59
15	0	46	0	36	13	37	17	24	8	55	3	36	18	8
MAY.														
1	23	14	0	53	12	18	16	38	7	54	2	43	17	9
5	22	29	1	10	11	4	15	34	7	0	1	55	16	12
JUNE.														
1	22	32	1	33	9	37	14	29		56	0	57	15	5
15	23	17	1	50	8	35	13	16	5	4	0	6	14	5

Declination of the Planets.

	Mercury.		Venus.		Mars.		Ceres.		Jupiter.		Saturn		Georgian.	
	°	′	°	′	°	′	°	′	°	′	°	′	°	′
APRIL.														
1	13	24 N	5	34 N	16	48 S	22	57 S	10	41 N	21	38 N	21	50 S
15	16	55	12	15	16	43	23	22	11	0	21	47	21	48
MAY.														
1	10	38 N	18	41 N	16	0 S	23	57 S	11	7 N	21	58 N	21	48 S
15	8	33	22	29	15	6	24	47	10	58	22	7	21	49
JUNE.														
1	14	39 N	24	36 N	14	21 S	25	59 S	10	30 N	22	16 N	21	53 S
15	21	59	23	38	14	27	2	27	9	55	22	22	21	57

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a globe, and determine their risings and settings.

ART. XXXV.—REGISTER OF THE BAROMETER, THERMOMETER, AND RAIN-GAGE, *kept at Canaan Cottage.* By ALEX. ADIE, Esq. F. R. S. Edin.

The Observations contained in the following Register were made at Canaan Cottage, the residence of Mr Adie, by means of very nice instruments, constructed by himself. Canaan Cottage is situated about 1½ mile to the south of Edinburgh Castle, about 3 miles from the sea at Leith, and about ¼ of a mile N. of the west end of Blackford Hill. The ridge of Braid Hills is about 1 mile to the south, and the Pentland Hills about 4 miles to the west of south. The height of the thermometer is about 260 feet above the level of the sea. The morning and evening observations were made about 10 A.M. and 10 P.M.

DECEMBER 1825.

D.of Week.	Day of Month.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	33	34	33.5	24	35	29.5	29.35	29.02	
F.	2	36	36	36	32	35	33.5	28.72	28.74	
S.	3	35	34	34.5	30	36	33	28.85	28.96	.15
S.	4	38	30	34	30	39	34.5	29.08	29.29	
M.	5	35	37	36	25	39	32	29.58	29.31	.08
T.	6	40	37	38.5	35	42	38.5	29.18	29.17	.01
W.	7	43	44	43.5	32	45	38.5	29.25	29.22	.03
T.	8	44	42	43	42	45	43.5	29.30	29.38	
F.	9	42	42	42	36	44	40	29.44	29.44	.25
S.	10	43	42	42.5	42	45	43.5	29.51	29.58	.10
S.	11	44	43	43.5	42	44	43	29.72	29.62	.22
M.	12	42	43	42.5	41	44	42.5	29.52	29.33	
T.	13	42	34	38	40	44	42	29.25	29.22	.30
W.	14	37	35	36	29	44	36.5	28.78	28.67	.37
T.	15	42	46	44	33	53	43	29.00	28.88	.24
F.	16	44	43	43.5	37	46	41.5	29.10	29.35	.05
S.	17	45	47	46	39	48	43.5	29.38	29.26	
S.	18	47	40	43.5	43	50	46.5	29.07	29.12	.05
M.	19	37	37	37	32	49	40.5	29.03	29.02	.06
T.	20	42	43	42.5	34	43	38.5	29.10	29.10	
W.	21	46	42	44	40	48	44	29.19	29.16	
T.	22	39	37	38	34	43	38.5	29.37	29.53	
F.	23	41	41	41	33	43	38	29.41	29.35	
S.	24	38	40	39	35	44	39.5	29.66	29.52	
S.	25	45	35	40	37	56	46.5	29.17	29.63	
M.	26	35	32	33.5	32	37	34·5	29.55	29.67	.05
T.	27	30	30	30	26	35	30.5	29.67	29.63	
W.	28	34	34	34	26	36	31	29.53	29.43	
T.	29	36	31	33.5	29	36	32.5	29.45	29.40	
F.	30	32	27	29.5	27	35	31	29.45	29.50	.05
S.	31	27	22	24.5	23	31	27	29.48	29.40	
	Sum,	1214	1160	1187	1040	1314	1177	907.95	907.90	1.99
	Mean.	39.16	37.42	38.29	35.55	42.39	38.97	29.256	29.255	

JANUARY 1826.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
S.	1	32	36	34	16	37	26.5	29.34	29.29	.07
M.	2	35	37	36	31	37	34	29.56	29.66	.06
T.	3	37	36	36.5	34	39	36.5	29.87	29.93	.02
W.	4	35	33	34	32	41	36.5	30.03	30.03	.03
T.	5	36	34	35	31	37	34	29.98	29.97	.10
F.	6	34	34	34	32	37	34.5	29.93	29.88	.15
S.	7	35	27	31	32	37	34.5	29.87	29.90	
S.	8	31	23	27	23	34	28.5	30.05	29.97	
M.	9	26	23	24.5	16	27	21.5	29.92	29.73	
T	10	34	31	32.5	21	35	28	29.45	29.53	
W.	11	27	26	26.5	21	33	27	29.57	29.56	
T.	12	28	23	25.5	21	32	26.5	29.60	29.63	
F.	13	25	23	24	19	29	24	29.71	29.77	
S.	14	15	17	16	13	27	20	29.83	29.89	
S.	15	17	15	16	12	26	19	30.05	30.16	
M.	16	17	37	27	10	26	18	30.12	30.01	
T.	17	40	43	41.5	36	40	38	30.00	29.93	
W.	18	45	36	40.5	38	47	42.5	29.86	29.85	.02
T.	19	38	35	36.5	34	44	39	29.88	29.89	
F.	20	41	45	43	29	44	36.5	29.90	29.82	
S.	21	46	36	41	40	48	44	29.71	29.91	
S.	22	40	44	42	29	46	37.5	29.88	29.70	
M.	23	40	34	37	34	44	39	29.93	30.09	
T.	24	40	37	38.5	30	42	36	30.07	29.98	
W	25	41	40	40.5	33	45	39	29.98	30.00	
T.	26	41	35	38	31	43	37	30.04	29.90	
F.	27	41	40	40.5	26	44	35	29.87	29.86	
S.	28	40	41	40.5	35	44	39.5	29.76	29.70	
S.	29	40	42	41	30	45	37.5	29.58	29.39	
M.	30	44	40	42	39	40	39.5	29.23	29.20	.10
T.	31	44	42	43	34	46	40	29.00	29.25	
		1085	1045	1065	862	1196	1029	923.57	923.48	.55
		35.	33.71	34.35	27.81	35.31	31.56	29.793	29.781	

FEBRUARY 1826.

D.of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
W.	1	42	32	37	37	45	41	29.35	29.46	.04
T.	2	45	49	47	30	49	39.5	29.23	29.10	
F.	3	50	40	45	45	50	47.5	28.98	29.15	.12
S.	4	42	40	41	35	46	40.5	29.40	29.37	
S.	5	44	42	43	38	45	41.5	29.17	29.11	.10
M.	6	51	47	49	38	54	46	28.75	28.61	.06
T.	7	43	40	41.5	39	45	42	29.56	29.83	
W.	8	48	46	47	37	50	43.5	29.75	29.98	
T.	9	46	44	45	44	49	46.5	29.82	29.93	
F.	10	43	38	40.5	40	45	42.5	29.90	29.88	.14
S.	11	36	36	36	33	43	38	29.82	29.67	
S.	12	46	40	43	34	50	42	29.54	29.71	
M.	13	45	47	46	37	49	43	29.53	29.16	
T.	14	46	37	41.5	37	45	41	29.63	29.67	
W.	15	47	48	47.5	33	51	42	29.41	29.38	.03
T.	16	47	42	44.5	41	51	46	29.40	28.90	
F.	17	45	37	41	37	47	42	28.91	29.06	.21
S.	18	36	33	34.5	29	42	35.5	29.16	29.24	
S.	19	39	36	37.5	31	42	36.5	28.66	29.08	
M.	20	08	38	38	30	45	37.5	29.30	29.57	.17
T.	21	44	41	42.5	33	48	40.5	29.86	29.51	
W.	22	50	42	46	39	53	46	29.20	29.16	.38
T.	23	41	38	39.5	35	45	40	29.35	29.49	
F.	24	45	47	46	34	47	40.5	29.68	29.46	
S.	25	47	37	42	35	49	42	29.48	29.63	.26
S.	26	41	41	41	35	47	41	29.87	29.73	.26
M.	27	43	41	42	36	46	41	29.58	29.63	
T.	28	49	46	47.5	36	52	44	29.66	29.50	
		1239	1145	1192	1008	1330	1169	824.35	823.77	1.77
		44.25	40.92	42.58	36	47.5	41.75	29.762	29.742	

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