THE

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EXHIBITING

A VIEW OF THE PROGRESS OF DISCOVERY

IN NATURAL PHILOSOPHY, CHEMISTRY, MINERALOGY, GEOLOGY, BOTANY, ZOOLOGY, COMPARATIVE ANATOMY, PRACTICAL MECHANICS, GEOGRAPHY, NAVIGATION, STATISTICS, ANTIQUITIES, AND THE FINE AND USEFUL ARTS.

CONDUCTED BY

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CONTENTS

OF THE

EDINBURGH JOURNAL OF SCIENCE.

No. XIII.

NOTICES TO CORRESPONDENTS.

A Correspondent who has sent us an account of some improvements on the Galvanic Battery, has omitted to inclose the last part of his letter, so that we have only a portion of his letter, without his name and address. We beg that he will have the goodness to supply this defect.

We cannot insert L.'s paper on the *London University*. We can assure him that he is as much mistaken in his facts, as he appears to us to be in his arguments. It has happened to come within our personal knowledge, that in the department to which he speaks, the greatest care has been taken to select the most distinguished of the candidates; and we are confident that there will be arrayed under the banners of that institution a phalanx of distinguished individuals, who will give a vigorous impulse to the progress of science in England.

Mr CHRISTIE's Communication reached us too late for insertion in this Number.

Mr MARSHALL's Hypothesis respecting the cause of the north-east winds in Spring, or any thing else which he may send us, will be thankfully received.

CONTENTS

OF THE

EDINBURGH JOURNAL OF SCIENCE.

No. XIV.

NOTICES TO CORRESPONDENTS.

WE shall be much obliged to Dr HARTMAN for the continuation of his valuable notices.

The Rev. W. WHEWELL's valuable paper "on the principles of Dynamics, particularly as given by French Writers," will appear in next number.

Professor OERSTED's MSS. on Thermo-electricity has reached us safely, and in good time.

We have received Professor MUNCKE of Heidelberg's observations on the 15th January. It would give us great pleasure to hear again from him.

Mr MARSHALL's Paper on the Cause of the North East Winds in Spring has been unavoidably postponed till next number.

We have received Professor SCHWEIGGER's last Packet, and shall attend to it.

Δ's Memoir on the Horary Oscillations of the Barometer at Rome was too late for this number, but will appear in our next. A proof will be forwarded to any address he may send.

In reply to the letter of A MECHANIC, we beg to inform him that the prices of a Patent are,

For England, - - -	L. 105	0	0
For Scotland, - - - -	75	0	0
For Ireland, - - - -	120		0
For the Colonies, - - - -	10	0	0
	L. 310	0	0

This is exclusive of the specification, the expence of which depends upon its length, and the number of drawings. We would not advise our Correspondent to ruin himself by such a summary process as that of taking a patent, while the present Patent Laws remain unrepealed, and a blot upon the Statute-Book.

We have already noticed the blunder pointed out by our Correspondent, and committed in Baron Ferussac's *Bulletin des Sciences Nat.* tom. v. p. 53, where the author has given from this JOURNAL, vol. ii. p. 97, an account of the discovery of a *Mine of Molybdæna* in Inverness-shire, in place of a *Mine of Black Lead.*

THE

EDINBURGH

JOURNAL OF SCIENCE.

Art. I.—*Memoir of the Life of M.* Le Chevalier Fraunhofer, the Celebrated Improver of the Achromatic Telescope, and Member of the Academy of Sciences at Munich.

Of all the losses which science is occasionally called to sustain, there is none which she so deeply deplores as that of an original and inventive genius, cut off in the maturity of intellect, and in the blaze of reputation. There is an epoch in the career of a man of genuine talent when he embellishes and extends every subject over which he throws the mantle of his genius. Imbued with the spirit of original research, and familiar with the processes of invention and discovery, his mind teems with new ideas, which spring up around him in rapid and profuse succession. Inventions incompleted, ideas undeveloped, and speculations immatured, amuse and occupy the intervals of elaborate inquiry, and he often sees before him in dim array a long train of discoveries which time and health alone are necessary to realize. The blight of early genius that has put forth its buds of promise, or the stroke which severs from us the hoary sage when he has ceased to instruct and adorn his generation, are events which are felt with a moderated grief, and throughout a narrow range of sympathy; but the blow which strikes down the man of genius in his prime, and in the very heart of his gigantic conceptions, is felt with all the bitterness of sorrow, and is propagated far beyond the circle on which it falls. When a pillar is torn from the temple of science, it must needs convulse the whole of its fabric, and draw the voice of sorrow from its inmost recesses. To those who have not studied the writings, or used the instruments of the illustrious subject of this memoir, these observations may seem extravagant and inapplicable; but there is not a philosopher in Europe who will not acknowledge their truth, as well as their application; and there is not a practical astronomer within its widest boundaries that has not felt the tide of grief for the loss of Fraunhofer flowing within his own circle.

Joseph Fraunhofer was born at Straubing, in Bavaria, on the 6th March 1787. His occupations in the workshop of his father prevented him from giving a regular attendance at the public schools. At the early age of eleven he was deprived of both his parents, and the person to whose charge he was entrusted destined him for the profession of a turner; but his weak frame being ill suited to such an occupation, he was apprenticed to M. Weichselberger, manufacturer and polisher of glass at Munich. Being too poor to pay any thing to his master, he was taken on the condition that he should work for him six years without any wages.

At Munich Fraunhofer frequented the Sunday school, but as his attendance was irregular, it was a long time before he learned to write or to count. In 1801, in the second year of his apprenticeship, an accidental circumstance gave a new turn to his fortune. Two houses having tumbled down suddenly, Fraunhofer, who lived in one of them, was buried under its ruins; but while others perished, he fortunately occupied a position to which it was considered practicable to open a passage. While this excavation was going on, the King Maximilian often came to the spot to encourage the workmen and the young prisoner; and it was not till after a labour of four hours that they were able to extricate him from his perilous situation. His majesty gave directions that his wounds should be carefully attended to, and as soon as he had recovered, he was sent for to the palace to give an account of the peculiarities of his situation during the accident, and of the feelings with which he was actuated. On this occasion his sovereign presented him with eighteen ducats, and promised to befriend him in case of need.

Mr Counsellor Utzschneider, afterwards his partner in the great optical establishment at Benedictbauern, took him also under his protection, and occasionally saw him. Fraunhofer, full of joy, showed him the king's present, and communicated to him his plans, and the way in which he proposed to spend the money. He ordered a machine to be made for polishing glass, and he employed himself on Sundays in grinding and finishing optical lenses. He was, however, often baffled in his schemes, as he had no theoretical and mathematical knowledge. In this situation M. Utzschneider gave him the mathematical treatises of Klemm and Tenger, and pointed out to him several books on optics. Fraunhofer soon saw, that, without some knowledge of pure mathematics, it was difficult to make great progress in optics, and he therefore made them one of the branches of his studies.

When his master saw him occupied with books, he prohibited him from using them, and other persons whom he consulted did not encourage him to undertake the study of mathematics and optics without assistance, and at a time when he was scarcely able to write. These obstructions, however, served only to redouble the efforts of our author; and though he had no window in his sleeping chamber, and was prohibited from using a light, yet he acquired a considerable knowledge of mathematics and optics, and endeavoured to apply them to his own schemes.

In order to obtain more leisure, he employed the remainder of the royal present in buying up the last six months of his apprenticeship; and that he might gain some money for his optical experiments, he engraved visiting cards without ever having been taught the art of engraving. Unfortunately, however, the war which then desolated Europe put an end to the sale of his cards, and left him in greater exigencies than before.

Nothwithstanding the kind assurances of protection which the king had given him, Fraunhofer had not courage to request it, and he was therefore compelled to devote himself to the grinding and polishing of glasses, still continuing to devote his Sundays to the study of the mathematics.

Mr Utzschneider was at this time seldom at Munich, and could do nothing for our young artist; but he recommended him to a professor of the name of Schiegg, well versed in mathematics and natural philosophy, who paid frequent visits to Fraunhofer.

About this time was formed the celebrated establishment at Benedictbauern, near Munich, by MM. Reichenbach, Utzschneider, and Liebherr, and in August 1804, they began the manufacture of optical and mathematical instruments, which were divided by the new machine of Reichenbach and Liebherr. The whole of the apparatus was made there excepting the lenses, for they could not procure good crown and flint glass, and wanted also a skilful optician. With this great defect, the establishment would certainly have failed, unless they had endeavoured to supply it.

Mr Utzschneider now undertook a journey to make inquiry respecting crown and flint glass, and respecting a skilful working optician; but, after all his labours, he was convinced that the new establishment had no alternative but to form an optician within its own bosom. Through Captain Grouner of Berne, he had heard of the labours of Louis M. Guinand, an optician at Brenetz, in Neuchatel, (See this *Journal*, No. iv. p. 353.) and having received from him some specimens of his flint glass, he was so pleased with them that he paid a visit to Brenetz, and engaged Guinand to accompany him to Munich. As soon as he arrived there, which was in 1805, M. Utzschneider constructed furnaces for carrying on the experiments upon a well organized plan. The first attempt created much expence, on account of the repeated experiments which it required, but it nevertheless furnished several good pieces of both kinds of glass. The optician, Riggl, polished the first lenses in 1806 and 1807. At this period Fraunhofer found himself in a very critical situation. Professor Schiegg always encouraged him to go to M. Utzschneider, but Fraunhofer was long in resolving to do this, believing that the latter had forgotten him, and knowing that he was well satisfied with his own optician.

M. Utzschneider received Fraunhofer in a very friendly manner, and after a short conversation, it was agreed that he should also become an optician in the establishment. Fraunhofer was then employed to calculate and polish lenses of considerable dimensions which came from the furnaces of Benedictbauern. These lenses were destined for the instruments of the observatory of Buda. It was afterwards agreed to transfer all the optical part of the establishment to Benedictbauern, and to give the complete direction of it to Fraunhofer. Our philosopher had already studied catoptrics, and had even written a Memoir on the aberration which takes place without the axis in reflecting telescopes. He showed that hyperbolic mirrors are preferable to parabolic ones, and he also communicated the invention of a machine for polishing hyperbolic surfaces. He now, however, resolved to give up this branch of the subject, as his time was fully occupied in the preparation of lenses.

One of the most difficult problems in practical optics is to give to spherical surfaces the last polish with that degree of exactness which theory requires, because this final operation destroys in part that form which had been previously given to the surfaces. M. Fraunhofer succeeded in remedying this evil by a machine which not only did not injure the fine surface obtained by grinding, but which actually corrected the irregularities committed in the first operation. It has also the advantage of making the result independent of the skill of the workman.

In examining the glass which he used in reference to the undulations and striæ which it contains, he found that, in the flint glass manufactured at Benedictbauern, there was often not a single piece free of those irregularities which disperse and refract the light falsely. Pieces of the same melting had not even the same refracting power, and this was perhaps more common in the English and French flint glass. After obtaining these results, Fraunhofer reconstructed the furnaces, procured the necessary instruments, and took the direction of all the meltings.

He had learned from experience, that flint glass could be made so that a piece at the bottom of the pot had exactly the same refractive power as a piece from the top; but his success was of short duration, for the succeeding meltings showed that this was merely accidental. Undaunted, however, by failure, he recommenced his experiments, in which he always melted four quintals at once, and after long and severe labours, he discovered the numerous causes which occasioned his want of success.

As the English crown glass had many undulations and impurities, Fraunhofer resolved to manufacture it also. Difficulties of a new kind here presented themselves, so that he did not partly succeed till after a whole year's labour. He found also, that with whatever degree of accuracy he followed the theory in the construction of achromatic object-glasses, his expectations were never realized. On the one hand, he was convinced that it was wrong to neglect certain quantities, such as the thickness of the lens and the higher powers of the apertures, merely to obtain commodious formulæ; and on the other hand, there was no exact method for determining the exponents of refraction and dispersion in the glass, used for achromatic object-glasses. The first of these inconveniences he avoided by a new method, in which he neglected no quantity upon which the required degree of exactness depended. Hitherto, achromatic object-glasses had only been calculated for rays proceeding from a point in the axis of the lens, but Fraunhofer considered the deviations from all points situated without the axis, and this is always a minimum in his object-glasses. In this consists principally the difference between his glasses and those made in England.

The difficulty hitherto experienced in determining the refractive and dispersive powers of bodies, arises chiefly from the circumstance that the spectrum has no definite termination, and that the passage from one colour to another was so gradual, and indistinctly marked, that in large spectra the angles could not be measured with a greater accuracy than from ten to fifteen minutes. In order to avoid this inconvenience, Fraunhofer succeeded, by a very ingenious contrivance, in obtaining homogeneous light of each colour in the spectrum. In these experiments, he discovered in the orange compartment of the spectrum, produced by the light of the fire, a bright line, which he afterwards found to exist in all spectra, and by means of which he was enabled to determine the refractive powers of the bodies which produced them.

By using prisms entirely exempt from veins,—by carefully excluding all extraneous light, and even stopping those rays which formed the coloured spaces that he wished to examine, he discovered that the spectrum was intersected by a great number of black lines parallel to one another, and perpendicular to its length.* In the spectra formed by all solid and fluid bodies, he not only discovered the same lines, (of which he has reckoned 590 in all,) but he found that they had fixed positions, and that the distances between them in different spectra afforded precise measures of the action of the prism on the rays which formed the corresponding coloured spaces. The valuable Memoir in which these discoveries are consigned, was published in the fifth volume of the *Memoirs of the Academy of Munich* for 1814 and 1815, and also in a separate pamphlet entitled *Bestimmung des Brechungs, und Farbenzerstreuungs, Vermogens verschiedener Glasarten.* The writer of this notice had the satisfaction of first translating this memoir into English, and of publishing an abstract of its results in the article *Optics* in the EDINBURGH ENCYCLOPÆDIA.

About this time, in 1817, Fraunhofer was elected a Member of the Academy of Bavaria, of which he was an active supporter.

In speculating on the cause of the dark lines of the spectrum, our author was led to consider them as arising from the interference of the rays, and he was induced to make a complete series of experiments on the inflexion of light. These experiments he published in the eighth volume of the *Memoirs of the Academy of Munich*, under the title of *Neue Modefikation des Lichtes durch gegenseilige Einwirkung und Beugung der Strahlen und gesetze derselben.* In these experiments, of which we have given a full account in the article *Optics* in the EDINBURGH ENCYCLOPÆDIA, Fraunhofer employed a heliostate for giving a fixed direction to the solar ray, and he examined all the phenomena through a telescope mounted upon a large theodolite, by means of which he measured the deviation of the inflected light. The object-glass was twenty lines in diameter; its focal length was 16.9 inches, and its magnifying power from 30 to 110. The heliostate was placed 38 feet 7½ inches French measure from the centre of the theodo-

* Above twenty years ago, lines were discovered in the spectrum by Dr Wollaston. See *Phil. Trans.* 1802.

lite. The diameters of the apertures were measured by a micrometer microscope, which showed distinctly the *two hundred thousandth part of an inch,* and sometimes even half that quantity. All the phenomena which he thus observed and measured, he considered to be perfectly explicable on the undulating system, with certain modifications; and upon these principles, he afterwards constructed a general analytical formula, to express these new laws of light. From this formula, it followed that these phenomena would be modified in a manner not only singular, but apparently extremely complicated, if a number of parallel lines could be made so fine, that 8000 of them were contained in one inch. After another set of experiments, he invented a machine, by means of which he could construct these systems of lines with that accuracy which the theory required. The details of these experiments were read before the Academy of Munich on the 14th June 1823, and will be found in this and the subsequent number of this *Journal.*

M. Fraunhofer likewise applied himself to the study of various atmospheric phenomena, such as halos, parhelia, &c. which he published in Professor Shumacher's *Astronomische Abhandlungen,* and of which we have given a notice in the last number of this *Journal,* p. 348.

Such is a brief sketch of the scientific researches of Fraunhofer, but, valuable though they be, they are in no respect to be compared with his practical labours as an optician. His minor inventions are a new *Heliometer,* a *repeating wire Micrometer,* and an improved *annular Micrometer.* The principal instruments which he has made, are the great parallactic telescope, constructed for the observatory of Dorpat, and of which we have given a full description and a drawing in No. iv. p. 306 of this *Journal.* The prime cost of this instrument was L. 950. Its aperture is *nine* inches, and its focal length $13\frac{1}{3}$ feet. His next great work was another achromatic telescope, ordered by the King of Bavaria, and which has an object-glass *twelve inches* in diameter, and eight feet in focal length, but it is not yet completed. Although engaged in works of such magnitude, Fraunhofer was at the same time carrying on others on a less scale, though not of less importance to science. The Astronomical Institution of Edinburgh, in the year 1825, ordered from him a very large and complete transit instrument, with a telescope eight feet and a half in focal length, and six inches aperture. Upon the receipt of this order, he constructed three object-glasses of these dimensions, one for the Royal Observatory of Edinburgh, another for a heliometer for M. Bessel, and a third as a spare one in case M. Bessel's object-glass should meet with any accident in the bisection; and, fortunately for science, these object-glasses are all completed.

In the year 1820, when M. Reichenbach left the copartnery, MM. Utzschneider and Fraunhofer entered into a new contract for continuing their optical establishment. The former presented to Fraunhofer a share in the concern, equal to about 24,000 francs, so that, from having several other sources of income, he was now comfortable and independent. Inspired by his success and good fortune, all the activity of his mind was called forth, and he took the establishment entirely under his direction. Since 1817 it had been transferred to Munich, and the business had increased to such a degree, that *fifty* workmen are at present employed.

In 1823 M. Fraunhofer was appointed keeper of the physical cabinet of the academy of Munich, a situation to which a pension was attached. In 1824 after the public exhibition of the great telescope of Dorpat, the King of Bavaria honoured him with the rank of a chevalier of the order of Civil Merit. He was also elected a member of several foreign societies, among which we may mention the Society of Arts in our own city. The university of Erlangen also conferred upon him the title of Doctor in Philosophy.

Thus honoured and respected both at home and abroad, Fraunhofer was enjoying all the happiness which character and reputation and a moderate independence never fail to yield. His mind was occupied with great views of scientific ambition which he could not have failed to realize, and such was the perfection to which he had brought his art, that he was willing to undertake an achromatic telescope, with an object-glass *eighteen inches in aperture*, and we have now before us a letter in which he fixes even the price of this stupendous instrument. But he was not destined to accomplish so great an undertaking. In October 1825 he was attacked with a pulmonary complaint, from which he never recovered. The injury which he sustained by the fall of his house seems to have left some effects behind it, and for several years he had suffered from glandular abscesses. He was, however, seldom obliged to discontinue his labours, and there is reason to think that he suffered from exposure to the heat of his furnaces. His faculties never for a moment left him; and in his few last days, his mind was occupied with the idea of a journey to France and Italy for the recovery of his health. He was cut off on the 7th June 1826, in the fortieth year of his age. A few days before this event he had received from the King of Denmark the diploma of Chevalier of the order of Dannebroga. The whole of the city of Munich took a lively interest in his disease, and felt the most sincere sorrow for his death. The magistrates of the city permitted M. Utzschneider to choose a place for his tomb, and he was interred by the side of the great mechanician M. Reichenbach, who had died a short time before.

Bavaria has thus lost one of the most distinguished of her subjects, and centuries may elapse before Munich receives within her walls an individual so highly gifted and so universally esteemed. But great as her loss is, it is not rendered more poignant by the reflection that he lived unhonoured and unrewarded. His own sovereign Maximilian Joseph was his earliest and his latest patron, and by the liberality with which he conferred civil honours and pecuniary rewards on Joseph Fraunhofer, he has immortalized his own name, and added a new lustre to the Bavarian crown. In thus noticing the honours which a grateful sovereign had conferred on the distinguished improver of the achromatic telescope, it is impossible to subdue the mortifying recollection, that no wreath of British gratitude has yet adorned the *inventor* of that noble instrument. England may well blush when she hears the name of Dollond pronounced without any appendage of honour, and without any association of gratitude. Even that monumental fame which she used to dispense so freely to the poets whom she starved, has been denied to this benefactor of science, and Westminster

Abbey has not opened her hallowed recesses to the remains of a man who will ever be deemed one of the finest geniuses of his age, and who had exalted that genius by learning and piety of no ordinary kind.

Thus neglected and mortified, it is not a matter of surprise that this branch of science and of art should seek for shelter in a more hospitable land, and that the pre-eminence which England had so long enjoyed in the manufacture of the achromatic telescope should be transferred to a foreign country. The loss of Fraunhofer holds out to us an opportunity of recovering what we have lost, and we earnestly hope that the Royal Society of London and the Board of Longitude will not allow it to pass. Great Britain has hitherto left the sciences and the arts to the care of individual enterprise, and to the patronage of commercial speculation ; but now, when all Europe has become our rivals, when every sovereign, like the Ptolemies of old, is collecting round his throne, the wisdom even of foreign states, is it not time that she should start from her lethargy, and endeavour to secure what is yet left ? The British minister who shall first establish a system of effectual patronage for our arts and sciences, and who shall deliver them from the fatal incubus of our patent laws, will be regarded as the Colbert of his age, and will secure to himself a more glorious renown than he could ever obtain from the highest achievements in legislation or in politics.

Art. II.—*Remarks on Mount Vesuvius.* Communicated by a Correspondent.

Having recently performed two excursions to the summit of Mount Vesuvius, it occurs to me that some of the particulars which I observed may possibly not be very generally known, and consequently thought worthy of a place in the *Edinburgh Journal of Science*. I shall therefore give an account of my second expedition, adding any particulars which I find in my notes on the first. We left Naples about eleven A. M. and having arrived at Resina found Salvatore ready to accompany us, we mounted asses, and after a long ride during torrents of rain reached the hermitage on the side of the hill at one o'clock. The road so far is very rugged, with many detached rocks and fragments of lava, but the great bed of the latter is now resuming marks of slight verdure. The habitation of the monks itself is placed on a projection from the mountain of tufa rock formed in the year 1779 by the eruption, and lies so towards the crater, that, though the lava flows on both sides, the eminence itself is left untouched. When we arrived here the weather appeared to be clearing, and, as we had plenty of time to ascend and see the sun set from the top, we remained some time with the holy fathers, and the afternoon answered our expectations. When almost fair we set off and pursued our way on asses towards the cone. Our road (if such it could be called) lay over an extensive bed of lava, partly formed in 1822. A more desolate scene can scarcely be conceived; rugged rising grounds, with craggy convulsed dells between, all formed of this hard, black, monotonous, and frightfully romantic lava; the very Tartarus on earth, whether we imagine it burning with sheets of liquid fire, unquenchable by human means, and rolling down its dread resistless tide, or whether we see its wide convulsed remains, its indescribably horrid, desolate, uninhabitable aspect. It seems as if the elements of nature were exposed to light, and one chaotic spot left amidst the richness of creation. Passing this dreary tract, we reached the bottom of the cone at half-past two, where we left our beasts and ascended on foot. It is composed of productions of the volcano itself, and the exterior is quite coated with loose cinders, which renders the ascent very laborious, as you often sink back till you are above the ancle in these loose materials. I ascended it in forty minutes. When we reached the brink of the crater we found it full of smoke and fumes, while the strongest sulphureous smells prevailed. We rested and refreshed ourselves for some time in a hot crevice, where we left several eggs to roast, and then advanced round the south brink of the abyss, and had a tolerably easy walk for about half its circumference, during which we heard occasionally noises like thunder proceeding from rocks every now and then giving way from the sides in vast masses, whose fall is reverberated and renewed by the echoes of the vast cavern.

At length the edge of the crater grew much lower, forming a gap in the side of the cone next to Pompeii, which we first descended, and then scrambled inwards towards the centre of the mountain, being a fall on the whole of 1000 feet.

In this gulf nature presented herself under a new form, and all was unlike the common state of things. We were, in truth, in the bowels of the earth, where her internal riches are displayed in the wildest manner. The steep we had descended was composed of minerals of the most singular yet beautiful description. The heavy morning rains were rising in steam in all directions, and had already awakened each sulphureous crevice, while almost every chink in the ground was so hot that it was impossible to keep the hand the least time upon it. But this sensation was in unison with the objects around; the great crater of the volcano opening its convulsed jaws before you, where the rude lava was piled in every varied form, in alternate layers with pozzulana and cinders. Below us the newly formed crater * was pouring forth its steamy clouds, and at every growl which labouring nature gave from below these volumes burst forth with renewed fury. At our feet, and on every side, were deep beds of yellow sulphur, varying in colour from the deepest red orange, occasioned by ferruginous mixture, to the palest straw-colour, where alum predominated, and beside these, white depositions of great extent and depth, which are lava decomposed by heat, and in a state of great softness. Contrasted with these productions of beauty, we find the sterner formations of black and purple porphyry, which occasionally assume the scarlet hue from the extreme action of heat; add to this the sombre grey lava, and that of a green colour glittering throughout with micaceous particles, with the deep brown volcanic ashes, and you will have a combination which, for grandeur and singularity, must be almost unparalleled. It is singular enough, that, among so many sulphureous fires, we should have suffered from pinching cold. At the lowest point to which we went the thermometer stood at $43\frac{1}{2}^{\circ}$. We employed ourselves for a considera-

* A small crater burst out in the bottom of the large one on the morning of the 18th. This excursion was on the 21st November.

ble time in collecting the finest specimens we could obtain of the above mentioned minerals. We then retraced our steps in this descent, which proved considerably laborious, and after gaining the top visited a crevice a little way down on the outside of the cone, opened within the last forty days, which, though about one finger broad, and not much longer, admits a current of air so tremendously heated, that, on laying a bunch of ferns quite wet with the morning's rain upon it, they speedily were in a blaze. Resuming the edge on the summit, we returned the way we came to the top of the descending path, and on our way saw the sun set in a very splendid manner, illuminating the distant islands of Ischia and Procida, the point of Misenum, and the bay of Baiæ, with his last rays. Having eaten our eggs, we descended the cone; being rather dark I made no particular haste; but on a former occasion I went down the cone with great satisfaction in four minutes. Had there been fewer stones I could easily have gone quicker. We left the top about half-past five, and having taken our cold dinner at the hermitage, we descended to Resina by torch light, and reached Naples safely at half-past eight o'clock.

Before 1822 the mountain was 4250 feet high; but in the tremendous eruption of that year above 800 feet of the cone were thrown completely off, and landed in the sea. The ascent is therefore now much shorter, and the figure of the hill entirely changed. Formerly the crater was only 5600 feet, or little more than a mile in circumference, and comparatively shallow, but now it is three miles and a third round, and 1500 feet deep from the lowest, 2000 from the highest part of the summit. I descended to within 500 feet of the bottom. As much interest was excited in ourselves and other visitors, by the prospect of a speedy eruption which was very generally expected, I was at pains to hear the opinion of our much experienced and very intelligent guide Salvatore. The substance of his information was, that the present crater being so very deep, and the new hole opened being in the *bottom* of it, he conceives it impossible that lava can ever come over the edge, and does not think that the mountain can have force to open another mouth in the side; but should it do so it will be at the hot crevice before described. Since the eruption of 1822, the mountain has never smoked from the *bottom* of the crater till now. Occasionally for some time the mountain has discharged stones at certain intervals, but not having sufficient force to throw them to a distance, they fall in again. Fire is seen most nights in the crater. From these data it is presumed that an eruption of stones will probably take place, but that we can scarcely look for any lava, especially as the mountain has in a great measure disgorged itself in the tremendous explosion of 1822, when all the magnificence of former occasions has been united, and of which Salvatore himself never speaks without enthusiasm.

All the internal resources of the earth seem to participate in the convulsions of Vesuvius, and the very skies to be shaken above. The slumbering fires of Ætna and Hecla are awakened, while Solfaterra, and the neighbouring sulphurous emissaries are drained of their borrowed lights. At eruptions in general, and the last one in particular, the most terrific thunder and lightning ever remembered by our guide and his father took place, and gave additional force to the scene. The sea regularly retires to a great extent from his troubled bed, while shells in calcareous masses are thrown from the volcano. The weight of the air diminishes by whole inches of mercury; and I am informed that the mountain is most brilliant in snowy weather, and under the influence of the full moon.* Here is a mass of unison and sympathy of all the

* I cannot help mentioning a very extraordinary circumstance recounted in Mrs Stark's well known work on the Continent, which may serve partly to determine a much disputed point in natural philosophy. On June 14, 1794, the day after the destruction of the town of Torre del Greco, by Vesuvius, Professor Santi, then residing at Pienza, a town near Siena, (who related the circumstance to Mrs S.) observed a dense cloud coming from the south-east, the direction of Vesuvius, (200 horizontal miles distant,) which discharged noises like cannon, then burst into flames, and a shower of stones fell on the country for seven or eight miles round. These stones were found to consist of grey lava, exactly such as is found on Vesuvius. At this moment the mountain was producing one of the most tremendous eruptions ever witnessed.—See Stark's *Directions,* 5th Ed. p. 265.

powers residing in the earth, and of those most especially affecting its constitution, derived from the heavens. Electricity, and consequently magnetism, the equilibrium of the atmosphere, the level of the ocean, the effects of weather, the resources of internal fire in all parts of the globe, are all employed, affected by, or subservient to, this vast production of the mechanism of nature. Surely it is not too much to say, that some indissoluble bond unites these various agencies, which perhaps it is the lot of this age to discover. This idea, which I have long entertained, has been well stated by Mr Playfair as his opinion at the end, (I think,) of the first volume of his *Outlines of Natural Philosophy*. If such connection exists, and should the latent principle be discovered, it is impossible to foresee how great may be the extension of human intellect, how deep our insight into the physical economy of all that surrounds us.

As rational hopes may yet be entertained of a considerable eruption of Vesuvius in a short time, I subjoin the following diary of the appearance of the mountain from Naples, which, should the event take place, may perhaps be curious. I must premise that, my residence being on the Chiaja, I had not constant opportunities of observing the hill, as it cannot be seen from that place.

Nov. 14th.—Covered with clouds in the morning; afterwards smoking more and more towards night.

15th and 16th.—Almost entirely covered by clouds from bad weather, but at intervals when I saw it, irregular clouds of smoke, white or dark, were issuing.

17th.—Being a fine day, I frequently observed the mountain; sometimes it was without any smoke, and then irregular clouds, light-coloured or quite white, rose in considerable quantity.

18th.—Ascended Vesuvius. From the report of Salvatore junior, I understood that, till yesterday, they did not look for an eruption, as the smoke proceeded chiefly or entirely from the sides of the crater; but that a new aperture opened in the bottom at three this morning, and fire and ashes with a stone, were thrown up.* On the way down I saw prodigious clouds of smoke flying with the wind.

19th.—The mountain was much clouded; but in the forenoon I had a view of whole volumes of smoke issuing from the crater, and flying southward; and also observed that it descended considerably on the south side.

20th.—Great regular and dense clouds of smoke appeared to be rising the whole day, and of the entire breadth of the crater. There is said to have been fire seen on the night of the 18th.

21st.—Ascended the mountain again. There had been much rain, and from the outside of the cone, as well as the interior sides, a great deal of steam was rising. The new crater threw out immense clouds of smoke, which filled the whole of it. Salvatore says that the mountain has been disgorging stones every two days.

22d.—The smoke to-day was irregular; for, on going out to ride in the afternoon, Vesuvius emitted smoke to the whole extent of the crater; but in about a quarter of an hour, not a trace was to be seen, and shortly after the fumes were renewed.

23d.—Saw very little of the mountain. It seemed to be smoking considerably.

24th.—Saw little of the mountain. Low clouds.

25th.—Saw little of the hill; but it continues to smoke.

26th.—Saw nothing of Vesuvius till the afternoon, when one large cloud covered the whole upper part down nearly to the hermitage. The cloud exactly resembled, and appeared to me to be, smoke, in which I was confirmed from an elevated sort of cone nearly above the crater, which very frequently and quickly changed its appearance.

27th.—Numerous dense clouds, apparently of smoke, covered all the upper portion of the hill with exceedingly changeable aspect.

28th.—Considerable quantity of smoke filling the crater in the afternoon, but with little peculiarity.

29th.—In the afternoon, almost no smoke, but only little occasional puffs rising in the most beautiful manner against

* Similar stones fell on the 11th, and, I think, the 14th November.

a perfectly azure sky. Snow lying on the north side of the cone.

Nov. 30th, Dec. 1st, 2d, 3d, and 4th.—Saw little of the mountain. On one day very little smoke, and throughout variable.

Dec. 5th.—Did not see the hill, but heard that there was much snow on the cool side, and little smoke.

6th.—No smoke at all when I saw it, and a great deal of snow, especially on the cone, the north side being completely white.

7th.—Cloudy all day, and did not see the mountain.

8th.—Little smoke.

9th.—The hill clouded till afternoon, when there was a great mass of smoke adhering to the south side of the cone, which seemed unable to rise.

10th.—Much adhering smoke.

11th.—In general no smoke, but now and then very slight puffs.

12th.—The appearance of the mountain towards afternoon was very remarkable, the smoke rising upright in great quantity from the crater, and then spreading horizontally into a light-coloured cloud. Much dense smoke and steam appeared to rise from the north side, which has usually been very quiet; and whitish vapours from the edges appeared to me to indicate the formation of a new crater, and that some of the interior sides were giving way. The afternoon being very clear and cold the mountain was extremely distinct.

13th.—Both the cone and Monte Somma were almost entirely concealed by lateral beds, either of clouds or smoke, but from watching their motion, it seemed rather to be the latter. Δ

Rome, *January* 9, 1827.

Art. III.—*On Mesole.* By William Haidinger, Esq. F. R. S. E. &c. Communicated by the Author.

Several years have elapsed since Berzelius gave the analysis of Mesole, *—a species which he established from specimens

* *Edin. Phil. Journ.* vol. vii. p. 7.

sent him by Dr Brewster, the results of his analysis being such as would not allow him to comprise the mixture of the new mineral within any one of the chemical formulæ designed to express the mixture of other species. The varieties sent had not been selected for the purpose of analyzing this mineral, which was not then thought to be anything new, but for the apophyllite, which is often found associated with it; and it is not surprising, therefore, that the natural-historical properties of the mesole, as well as of the mesoline, as far as they could be ascertained in those specimens, were not sufficient for removing every doubt respecting their existence as species independent of others.

In my translation of the *Treatise* of Mohs, * I hinted at the probable identity of mesoline with a particular kind of chabasie, which I had seen in many of the specimens of Mr Allan's cabinet, accompanying mesole, stilbite, and apophyllite. Berzelius himself arrived at the same conclusion by chemical arguments. † The description of mesole was given partly from Berzelius' paper, partly from some specimens of the same variety in Mr Allan's cabinet. But only very few of its properties were ascertained, and the knowledge of the species itself is therefore so imperfect, that from the mere description it could not be distinguished from many varieties of other species, and must be then comprised in the appendix.

Though even now I cannot pretend to offer a perfect description, the more accurate indication of the regular forms still being a desideratum, yet the new varieties which I have lately had an opportunity of examining are such, that the place of the species of mesole in the system of Mohs may be fixed with precision. These varieties show a very great resemblance to certain kinds of apophyllite, so much so, that Sir Charles Giesecke, who discovered them in the island of Disco, in Greenland, was induced to consider them as a particular subspecies of it, the *micaceous* apophyllite. There are several specimens of the same mineral in Mr Allan's cabinet. These I had placed two years ago in the genus Kouphone-spar, without, however, referring them to any particular spe-

* Vol. iii. p. 127.

† *Årsberättelse* for 1825, p. 211.

cies. Sir Charles Giesecke likewise favoured me with some of them, and with the exact indication of their locality, when I had the pleasure of seeing him in Dublin in December last. On comparing these varieties with those of Mr Allan's cabinet, I was struck with the similarity of the surface of the reniform masses with those of mesole, and a more accurate examination of their other properties finally proved them to be the same species.

Since this is not so much the establishment of a new species, as an enlargement by several new varieties hitherto not noticed of one already existing, I shall dispense with giving a general description, but in its place shortly enumerate the specimens forming the suite of mesole in the cabinet of Mr Allan, which, I trust, will not be found uninteresting for the comparative novelty of the species altogether, and particularly so in regard to its natural-historical properties. At the same time this case may serve as an instance of the correct application of the method of *mediate determination*, as explained by Professor Mohs.* The differences occurring here are only in the size of the individuals; but this difference is very important, and has often led to the establishment of erroneous species, particularly among the older mineralogists.

1. A reniform mass on basalt. Colour greyish-white; composition distinctly diverging from the centres of the single globular groups which yield a radiated fracture. This is the variety analyzed by Berzelius. Mr Allan brought it from Nalsoe, one of the Faroe islands. It occurs near the western shore of that island in soft amygdaloid, disposed on the roof of a large cavern, which has an opening of about two hundred feet in length, but is nearly closed up in front with debris, which gradually slope into it, so that in many places the cavern is quite low. It is associated with stilbite, chabasie, and also, though more sparingly, with apophyllite.† In a specimen of this variety of mesole, which Mr Allan had sent to Mr Mohs, I found the specific gravity = 2.370.

2. Single globular masses, of a pale greyish-white, disposed

* *Transl.* vol. i. p. 388.

† *Trans. Roy. Soc. Edin.* vol. vii. p. 233.

within a cavity in basalt, lined with small crystals of chabasie. The disposition of small tabular crystals, of which the globules consist, is here distinctly visible, resembling certain longish globules of heavy spar, only in the latter the tabular crystals are disposed parallel to the long diameter of the globular shape, while in mesole they lie in an opposite direction.

3. In the three specimens comprised under this number, the crystals are not joined in their whole length, but show distinctly a four-sided tabular form belonging to the prismatic system. Parallel to their broad face cleavage takes place with great facility; the laminæ are slightly flexible, but, on account of their minuteness, they easily yield to a slight pressure and break. These crystals are joined on one end with their broad faces in crest-like aggregations, which, if they were filled up by a farther increase of the individuals, would produce globules as in the preceding variety.

4. Reniform variety of a yellowish-grey colour on red decomposed amygdaloid. The single globular masses consist of larger individuals than those in No. I. so that the bright cleavage may be easily discovered. The surface of the specimen is strewed with thin rectangular plates, which are crystals of mesole.

5. Individuals, resembling the last in size and colour, aggregated in stalactitic shapes. All these, like the first, are from Nalsoe.

6. The individuals forming reniform groups are here similar to those of var. 4. but larger, about one-eighth of an inch in diameter, of a pale yellowish-grey. The single cleavage appears very bright. This variety was discovered by Sir Charles Giesecke at Nia Kornak, in the island of Disco, Greenland, where it occurs in the vesicular cavities of a basaltic rock, associated chiefly with apophyllite and mesotype. In another specimen in Mr Allan's cabinet there is likewise chabasie and levyne in very small crystals. I found the specific gravity of this variety of mesole = 2.382.

7. The size of the plates is here between a quarter of an inch and half an inch. They have a bright pearly lustre on their cleavage planes, and the whole aggregate resembles in no small degree the crystallized spermaceti. The colour of this

variety is white, slightly yellowish. It forms part of the inside of a geode detached from one of the vesicular cavities of basalt. It is from Karartut, near Godhavn, in the island of Disco.

8. Large individuals aggregated, and coarsely forming reniform shapes. The surface is dark yellowish-grey; the colour on the cleavage planes almost straw-yellow; the whole apparently decomposed. Cleavage is very easily obtained, and the laminæ show some elasticity when we attempt to separate them. This specimen is a native of Nia Kornak in the Omenaksfiord, like the preceding in the island of Disco.

The perfect single cleavage, with a considerable deal of pearly lustre, at once distinguishes mesole from mesotype and other similar bodies, with which it was sometimes confounded. Its specific gravity being above 2.3, is much more considerable than that of either stilbite or heulandite, which hardly ever exceed the limit of 2.2, an immense difference in species, whose specific gravity is at the same time so inconsiderable and so constant as in the genus Kouphone-spar. In this property it nearly agrees with apophyllite, but is readily distinguished by the traces of its prismatic forms, which are always visible, while the forms can be likewise made out to be pyramidal in the other species. Its crest or fan-like aggregations, the like of which never occur in apophyllite, yield also a good empirical mark, which may assist us in ascertaining the prismatic form of the species, although the crystals hitherto observed are too small, or rather too thin, to allow of an exact determination. In allusion to these aggregated groups, and the kind of fracture depending upon it, I propose the *Flabelliform Kouphone-spar* as the systematic denomination of the species, the first varieties of which were described by Berzelius under the name of *Mesole*.

It is worth noticing, that this species, when it is associated with stilbite or apophyllite, will always form the lowest stratum immediately adjoining the basaltic or amygdaloidal support, in the cavities of which it is deposited.

Beside Faroe and Disco, where mesole occurs in many places, it is likewise found in Iceland and in Sweden. In the former it occurs at Skagastrand, in the northern part of the island, in a dark brown amygdaloid, and is associated with levyne and heulandite. It was discovered by Hisinger,* in the cavities of a kind of lava at Annaklef, near Röstanga, in Scania. The analysis of the Swedish variety by Hisinger slightly differs from that of the Faroe variety by Berzelius. The results obtained were,

	Swedish Variety.	Faroe Variety.
Silica, -	42.17	42.60
Alumina,	27.00	28.00
Lime, -	9.00	11.43
Soda, -	10.19	5.63
Water, -	11.79	12.70
	100.15	100.36

The chemical formulæ, of course, will deviate in consequence of the results from which they are calculated.

Art. IV.—*Some Account of a Society lately established in Germany, of which the object is to send out Botanical Collectors to the most interesting parts of Europe; together with a recommendation to the Naturalists of other Countries, and especially those of Great Britain, to unite with it.* Communicated by W. Jackson Hooker, LL. D. F. R. S. F. L. S. F. A. S. and Regius Professor of Botany in the University of Glasgow.

Linnæus has observed "*Herbarium præstat omni icone, necessarium omni Botanico;*" and the truth of this remark no one acquainted with the subject will, I think, be disposed to deny. There exists, notwithstanding, on the part of the student of botany in this country, an almost unconquerable antipathy to the operation of gathering and drying plants, simple as that process actually is; insomuch that I have often heard foreigners express their astonishment at the meagre collections of native plants which are found in the Herbaria of Great Britain; and when the continental naturalists ask us for specimens of some of the vegetable productions peculiar to

* Berzelius, *Årsberättelse* for 1825, p. 211.

our country, there are perhaps but few who have it in their power to supply a stranger with them in a well-preserved state.

The French and the Germans far excel us in this important department of a botanist's pursuits. So that by a visit to half a dozen of his correspondents in those two countries the British naturalist will be enabled, through their friendly assistance, to return with almost a complete Flora of those vast empires. In Germany, especially, the art of preserving plants is carried to a very high degree of perfection; and the advantage which the student derives from examining such specimens is incalculable, almost equal to that of doing so in the living state. Among many others, MM. Hoppe, Hornschuch, Funck, and Sieber, have combined a great love of botany with a happy tact in all that concerns the preparation and drying of specimens; and, possessing also a deep and scientific knowledge of the plants themselves, these naturalists have given to the world collections which excel every figure, and are necessary to every student. The trifling labour attending the manual operation is amply compensated by the beautiful scenery into which the travelling botanist is sure to be transported; by the impressions, (almost never to be effaced,) which the very circumstance of his discovering and gathering such and such a plant in a state of nature are sure to make upon him; and by the gratification in prospect of distributing to persons of a kindred mind with himself those vegetables, from the acquisition of which he has already derived so much pleasure.

It is in Germany that the Institution has arisen of which I am about to give an account; and of which, I believe, the origin is due to Professor Hochstetter and Dr Steudel of Esslingen, both of them well known for their attachment to natural history, and the latter especially, by his laborious and learned work the *Nomenclator Botanicus*. These gentlemen, in conjunction with a few other German botanists, were at the expence of sending out M. Fleischer, an excellent botanist and apothecary of Esslingen, together with an assistant, to explore the vegetable riches of the Southern Tyrol in 1825. The success with which the expedition was crowned gave them the idea of extending still further their views; but before I proceed to state these, I will make some extracts from the *Botanische Zeitung* for February 1826, where the nature and produce of the journey is more fully described.

On the 3d of May M. Fleischer, with his assistant, left Esslingen, and hastened through Ulm and Meiningen, in the neighbourhood of which latter town he considered it a happy omen that he met with some of the rarest German *Cyperaceæ*, even before quitting the Bavarian dominions. The Reverend M. Koeberlein of Grünenbach conducted the traveller to the moory grounds in that vicinity, where many sedges, and among them *Carex capitata* and *C. chordorhiza* were already in full flower. It was in the month of May 1825 that Germany was visited by an almost unprecedented degree of cold and frost, so that the botanists were glad to proceed as quickly as possible to Southern Tyrol, and soon reached the shores of Lake Garda, and a country warmed by a genial Italian sky. Here the Tyrolean mountains presented M. Fleischer with *Carex baldensis*, *Avena sempervirens*, *Scabiosa graminea*, *Horminum pyrenaicum*, *Spartium radiatum*, and many other rarities. The environs of Torbele proved still richer in scarce vegetable productions, and the foot of Mount Baldo in the Tyrol, likewise on the Italian side, yielding *Spartium junceum*, *Cytisus argenteus*, *Carpinus orientalis*, *Quercus ilex*, *Coriandrum testiculatum*, and *Lathyrus setifolius*. At Roveredo M. Fleischer received much kindness from M. Christofori, an apothecary, and warm admirer of botany, who took him to the stations of *Plantago carinata* of Schrader, (*P. Wulfenii*, Sturm,) *Dianthus atro-rubens*, *Cytisus sessilifolius*, &c. Col-Santo was ascended from Roveredo, a mountain whereon were found the *Aira montana* of the Norwegian Alps, (a plant new to the south of Europe,) *Pæderota cærulea*, *Anemone baldensis*, *Horminum pyrenaicum*, *Geranium argenteum*, *Rhamnus pumilus*, and many other rare alpine productions. On another adjacent mountain grew *Daphne striata*, and the curious *Saxifraga Vandellii*. The environs of Bolzano, the Seisser Alps, and the Schlehern, together with Orteles, in which countries M. Fleischer passed a good part of his time, and perhaps at the most favourable season, yielded the amplest harvest.

The plants of Bolzano are almost entirely those of southern regions, such as *Pistacia terebinthus*, *Celtis australis*, *Ostrya vulgaris*, *Jasminum officinale*, *Ziziphus vulgaris*, *Andropogon Allionii*, *Molina serotina*, *Onosma stellulatum*, *Selinum venatum*, *Antirrhinum italicum* of Treviranus, *Achillea tomentosa*, and *Acrostichum maranta*. In the Val di Non the rare *Lotus hirsutus* was gathered. The Schlehern and Seisser Alps are a chain of one and the same range; and they afforded many grasses and other alpine plants, but they are mostly peculiar to the southern Alps, such as *Avena argentea*, *Valeriana elongata*, and *V. supina*, *Scabiosa longifolia*, *Phyteuma comosum*, and *P. Sieberi* of Sprengel, (probably the *P. cordifolium* of Villars,) *Arenaria alpina*, (with a very broad leaf, and quite different in appearance from what grows upon our Scotch Alps,) *Juncus arcticus*, *Cherleria octandra*, the beautiful *Potentilla nitida*, *Ranunculus rutæfolius*, *Hieracium parviflorum* of Schleicher, (perhaps a variety of *H. præmorsum*,) *Arnica Wulfeniana* of Pollich, (*Doronicum caucasicum*, Bieb.) *Polypodium*, (*Woodsia*, Br.) *hyperboreum*, *Centaurea uniflora*, and *C. ambigua*. The Ortoles is known to be the loftiest mountain of the Tyrol, and it might naturally be expected to prove rich in alpine vegetation. Here, consequently, was found a new *Epilobium*, (*E. Fleischeri* of Dr Hochstetter,) allied to *E. rosmarinifolium*; and among others I shall only mention *Aira subspicata*, *Kochleria hirsuta*, *Festuca roethica*, *Alchemilla pentaphylla*, *Aretia pennina*, *Phyteuma globulariæfolium*, *Sibbaldia procumbens*, *Cerastium trigynum*, *Pedicularis asplenifolia*, *Achillea nana*, together with many lichens and mosses in very fine states of fructification; among the former *Parmelia speciosa*, *Lecanora alphoplaca*, *chlorophana*, *chrysoleuca*, &c.

In the whole, M. Fleischer returned from his Tyrolean excursion with a collection of 400 species of Phænogamous, and 200 species of Cryptogamic plants, altogether 15,000 specimens, in a very beautiful state of preservation.

The success which attended this first mission, as already remarked, has induced the conductors of it to enlarge their plan, and to invite naturalists in all countries to contribute towards so laudable an object, and to share in the results of the different excursions. During last year a prospectus was issued in German and Latin.

The professed aim of the institution is to employ zealous and properly educated botanists in Germany and other European nations to collect rare plants, both in a living and dried state, and seeds. The different, and especially little explored provinces of Germany, as the higher part of the Black Forest in Wurtemberg, and the Alps of that vicinity, those of Carinthia, Carniola, &c. will be the objects of particular investigation. For these countries, botanists residing in their neighbourhood will be engaged; for they may be sure of meeting with naturalists, whose partiality for such pursuits will induce them to undertake the excursions, provided that they are only remunerated for their expences. On the other hand, botanists will be sent out expressly to the more remote countries, which abound in a greater degree with novelty; as to Istria, Sardinia, Siebenburgen, Greece, Portugal, the Pyrenees, the Lapland Alps, &c. Two or more collectors will be employed annually; but their number must be regulated by the means of the establishment.

The members of the Society will constitute two classes; 1st, Honorary Members; that is such as give it their support by voluntary contributions, arising from a desire of promoting its views. To these will be granted the privilege of selecting from the annual collections, (of which a public account will be always given,) rare seeds, or living plants, for their gardens, or splendid specimens for their herbaria; and they will be allowed to give directions in regard to other objects of natural history which they may desire; but they will not share in the regular annual distributions. 2dly, There will be Ordinary Members, who will divide among themselves, according to the amount of their subscriptions, the collections, after the honorary members have received their portions; and the subscribers are particularly requested to specify whether they prefer dried plants, living plants, or seeds.

The annual contribution is fifteen florins Rhenish, (the Louis d'or being reckoned as eleven florins,) and the sum must be forwarded at the beginning of each year. Persons subscribing to twice or thrice that amount will receive plants in proportion, and will have more of the rarest kinds, of which only a few may have been gathered. The directors bind themselves to the continuance of the establishment for five years to come.

With a view to give greater weight and respectability to the institution, which is called the *Travelling Union*, the previously established society at Stuttgard, entitled the "*Central Prefecture of the Rural Society of Wurtemberg*," has allowed it to constitute a part of the society; and to it communications are to be addressed, free of expence, in German, "*Centralstelle der landwirthshaftlichen Vereins, in Stuttgard*." If such communications be attended with difficulty to the botanists of this country, the writer of this article will readily be the means of forwarding them, as will a gentleman in London, whose active services in promoting the cause of science both in Great Britain and on the Continent, are known to almost every naturalist, "*John Hunnemann, Esq.* 9, *Queen Street, Soho*." Through the same channels the annual returns can be received.

To those who reside at a great distance, the question will naturally arise, "what security have we, not being able to look into the affairs of the society, that we shall have our fair portion of the plants discovered?" To this I can only say, that the principal promoters and directors of the establishment are men of the most honourable minds, and holding public situations; and what is still more to the purpose, that, being entitled to two shares in the produce of the first excursion, I am actually in possession of a collection, which, for the number, rarity, and beauty of the specimens, has much exceeded my most sanguine expectations, and such as, but for this valuable institution, *no money could have purchased;* all are correctly named with printed labels. The Cryptogamic plants, especially the mosses, are equally rare and well preserved with the Phænogamous plants. The estimate, judging from the first collection, was, that each member would receive 200 species for a single annual subscription; but I calculate from appearance, for I have not counted mine, that the number exceeds that proportion.

The result of the last year's travels in *Istria* and the *Alps of Germany*, and the *shores of the Adriatic*, has arrived at Stuttgard, and it will soon be divided. The indefatigable M. Fleischer has been sent to *Smyrna*, where he will remain till May of the present year, so that he will have collected a whole year's Flora in that interesting country. He will then employ the rest of the summer in *Carniola*, where he will identify many of Scopoli's plants.

M. Müller is gone to *Sardinia*, and it is hoped that the means will be afforded of sending him a co-operator. Indeed, the society looks for assistance to England, and I hope it will not look in vain, when the nature of the institution shall be more generally made known. "Perhaps," says Dr Steudel in a letter to a friend in this country, "the subscription of fifteen florins is thought in England very trifling, but we are obliged to consider our German poverty, and indeed any one who considers it no great sacrifice is at liberty to take as many shares as he thinks proper. Scrupulous exactness in the distribution we look upon as one of our first duties, so as to insure by equal rights, and strict impartiality, the success of this infant establishment. If we should meet with sufficient support, we shall, in this case, send a third traveller to the southern parts of Hungary, and to the mountains of Transylvania, where many new and rare plants are likely to be found. Perhaps you are surprised that so much can be done with such small means, but this problem is solved by the circumstance, that we employ young men, who ask for no other reward than the gratification which they derive from their travels. Were it possible to obtain English subscribers for several successive years, it would give us the advantage, while sure of the means, of arranging the necessary preparations for future expeditions with greater effect."

I trust that this appeal to that love of botany which exists in Britain will not be ineffectual.

Art. V.—*Views of the Process in Nature by which, under particular circumstances, vegetables grow on the bodies of Living Animals.* By Dr Samuel L. Mitchill of New York, F. R. S. E. &c. With remarks by a Correspondent.

In the 12th volume of Professor Silliman's *Journal*, Dr Mitchill has inserted a Letter written by him to Professor Decandolle of Geneva, on the growth of vegetables on the bodies of living animals. As the subject is a curious one, and the occurrence, if the observations be correct, anomalous, we shall transcribe his own words.

"My attention was called to these curious appearances in the year 1808, when my friend, William A. Burwell, Esq. brought me, from his own plantation, in Virginia, the larva of an insect, upon which a vegetable had fixed itself, and grown to a considerable size. He had found several others of the same kind, and in a similar condition. From the long and semi-cylindric figure, the wrinkled and whitish surface, marked by rings, the scaly head and strong jaws, the numerous feet, and the arched or curved attitude, I was induced to consider it as belonging to the species of *Melolontha*, or May-bug, whose grub is destructive, at times, to the roots of grass in meadows and pastures. The vegetable was single, and had been somewhat injured by handling and transportation; yet the lower part of the stem and the point of attachment were very distinct. My informant assured me, that, when picked up, the vegetables were complete in this and various other specimens. But there was no more than one on each.

"Some years afterwards, another vegetating insect was presented to me by the late William M. Ross, M. D. who obtained it in the Island of Jamaica during his residence there. It was a full-grown individual of a *Sphynx* or Hawk-moth, whose whole body had been covered with a vegetable crop, issuing thick from the thorax and abdomen.

"Another Sphynx, with its body covered with a harvest of parasitical vegetables, has since been exhibited to me by

J. B. Ricord Maddiana, M. D. who brought it from the Island of Guadaloupe.

"The same gentleman, distinguished for his researches in different departments of natural science, gave me several vegetating wasps *(vespæ)* procured by himself in the same place, where he resided several years. A fortunate incident brought very interesting facts to his knowledge at Bay-Mahant, near the small river *du Coin*. On the 16th June 1823, as he was on a botanizing excursion, he saw, lying on the ground, a wasp's nest, which had, by means unknown to him, been separated from a branch of the *Laurus persea*, *(avocatier,)* near which it had fallen. The creatures were in a strange condition after this disaster to their dwelling. Some were flitting about over the cells, and by the softness of their wings, and the faintness of their colours, were easily known to have been hatched but a short time. Many others were lying *dead* on the ground. On examining these he instantly perceived vegetables proceeding from their bodies, and this uniformly from the anterior part of the sternum, or thorax. He collected about fifty of these vegetating wasps. On inspecting the nest, he found a considerable proportion of the cells empty. This, however, was not the case with them all; for there were still some that contained young wasps in the state of larvæ, and which had not reached the last stage of their metamorphosis. He drew them from their cells, and satisfied himself that there was an incipient vegetation; and moreover, that its progress had kept pace with the growth of the chrysalis.

"After these observations, he satisfied himself in a very rational way, wherefore the vegetable parasite was situated on the fore part of the body. It was remarked, that rarely or never was there more than one vegetable on a single wasp.

"Botanists have pronounced this parasitical production to be a species of *Sphæria*, belonging to the natural order of the Fungi. Upon the supposition that it is propagated by seeds in the ordinary mode, it plainly appears that these seeds would, on being wafted through the air, alight upon the most exposed part of the unhatched insect, that was accommodated for its reception. This would, of course, be near the head.

Being fixed there, it would increase with the enlargement of the animal; and drawing nourishment from its body, would continue to grow, even after it had attained its last and perfect state, until the *Sphæria* destroyed the life of the wasp.

"If the declaration that a vegetable of any sort could take a root, or sustain itself upon a living animal, rested upon a solitary occurrence, it might be suspected there was a mistake in the matter. But, in the present instance, there is no room left for such an objection, inasmuch as the vegetating wasps collected on the spot, and carried away in complete preservation, put the fact beyond all doubt, that, under particular circumstances, the body of an insect, while yet alive, becomes the soil or base upon which vegetables fasten themselves, and from which they derive support.

"Three occurrences in this country deserve to be mentioned. Stephen W. Williams, in a letter to me, dated Deerfield, Mass. March 29, 1824, describes a remarkable production of the kind. He states, on the authority of several most respectable citizens, that they have repeatedly seen a vegetable growing from the body of the common grub, (*melolontha ?*) They have observed them so many times, and in so many places, rising to the height of several inches, that some of the witnesses were inclined to believe the product was the tall blackberry, *(Rubus villosus.)* The grub he means is found in wood-yards, around the stumps of dead trees, and often in sward-ground; in which latter it has been known to do extensive damage, by devouring the roots of grass, and sometimes every plant in its way. In 1822, these devastators not only killed the herbage of large tracts, but also preyed upon the maize and potatoes.

"Addison Phillco, M. D. has sent me several specimens of larvæ or grubs bearing plants, though there was no more than a single vegetable on one animal. In his letter, dated at Sangamon, Illinois, May 4, 1826, he writes that his neighbour, Capt. Hathaway, ploughed up a number of them in some old ground where turnips had been raised the preceding fall. The excrescences were invariably near the head of the creature, and in some instances sprouted into three divisions like leaves."

From these facts Dr Mitchill draws the following inferences: 1. That this species of vegetation is not confined to a single species of insect, but obtains in several. 2. That the bodies of insects nourish more than one species of vegetable; and 3. That a part at least of this order of parasitic vegetables begin their work of annoyance "in the body of the living insect, and continue it until the creature is killed by its destructive inroads."

With regard to the first two of these conclusions, there seems sufficient ground from recorded observation to grant their probability, if not their absolute certainty. But the third, or that which asserts the growth of parasitic vegetables on the living insect, seems more than doubtful, and not warranted by any facts which have come to our knowledge,—not even by the communication of Dr Mitchill itself.

So long ago as 1763, Dr Watson published in the *Philosophical Transactions* an account of the insect called the vegetable Fly, brought from the island of Dominica by Mr Newman, an officer in the army, who, adopting the popular belief of the residents in that island, stated that the fly, in the month of May, "buries itself in the earth and begins to vegetate. By the latter end of July," he adds, "the tree is arrived at its full growth, and resembles a coral branch; and is about three inches high, and bears several little pods, which, dropping off, become worms, and from thence flies like the English caterpillar." A similar account was given to Dr Huxham by Captain Gascoign; but specimens being procured, they were submitted to the examination of Dr Hill, and the result of his and Dr Watson's observations laid before the Royal Society. Dr Hill found on examination that a particular species of fungus, of the genus *Clavaria*, which grows upon dead and putrid animal bodies, had sprung from the dead insect. "The Cicada is common in Martinique," (says he) "and in its nympha state, in which the old authors call it Tettigometra, it buries itself under dead leaves to wait its change; and when the season is unfavourable many perish. The seeds of the Clavaria find a proper bed on this dead insect, and grow. The Tettigometra is among the Cicadæ in the British Museum; the clavaria is just now known. This, you may be assured, is the fact, and all the fact; though the untaught inhabitants suppose a fly to vegetate; and though there exists a Spanish drawing of the plant's growing into a trifoliate tree; and it has been figured with the creature flying with this tree on its back. So wild are the imaginations of man: so chaste and uniform is nature!"

Dr Mitchill, from his reference to Dr Watson's paper, to the figures of Edwards in his *Gleanings of Natural History*, and to M. Fougereau's paper in the *Memoirs of the French Academy of Sciences* for 1769, seems to be perfectly aware of the opinions entertained on this subject; and we were therefore much surprised, that in his Letter he was not more particular in ascertaining whether the animals he examined were really *alive*. The whole value of his observations turns on this point; for the finding specimens of dead or decomposing insects or larvæ in Virginia, with clavariæ growing from them, similar to what are found on animals of the same class in the West Indian Islands, only proves that similar causes produce similar effects in both countries. In his account of the specimen of a *Melolontha* from Mr Burwell, it is not mentioned that the animal was alive: Dr Ross's specimen of a *Sphynx* from Jamaica must evidently have been dead; and the same remark applies to the West Indian *Sphynx* of Dr Maddiana. The other fact communicated by this latter gentlemen, regarding the wasp's nest, is of the same nature. It was in wasps "*lying dead* on the ground" alone that he perceived the marks of vegetation; and though he "satisfied himself" that in the larvæ contained in the cells "there was an incipient vegetation," yet, from his omitting to say that they were really alive, the presumption is, that in these also life was extinct, and that they were in a state of decomposition.

In Mr Jacob Cist's notice of the *Melolontha*, in the eighth volume of Dr Silliman's *Journal*, also referred to by Dr Mitchill, that gentleman states, from personal examination of numbers of the larvæ of this insect in Pennsylvania, that "in every instance the grub is not only dead, but in a state of decay, and the sprout rising about the ground indicates where they may be found." Mr Cist's figures accompanying his notice show evidently that the plant is a Clavaria; and his theory for its production is, that the "seed is taken internally by the worm, and causes its death; and that in the following spring it vegetates, finding a suitable bed or soil in the decayed worm."

As to the circumstance of the fungous vegetation proceeding from the mouth or from the anterior part of the sternum, it may be remarked that this is the most likely place, from its being the commencement of the intestinal canal, and in the neighbourhood of soft parts, for decomposition to commence, and vegetation, of course, to take its rise. Neither does it favour the hypothesis of Dr Mitchill, that, in some specimens, the fungous vegetation was found on the larvæ, and in others on the perfect insect; as it does not necessarily follow from this circumstance that the minute seeds of these vegetable productions, sown by the winds (according to Dr Mitchill) on the body of the larvæ, should survive its metamorphosis, and decorate the body of the winged insect with a crop of foliage. Deprivation of life and incipient decomposition would, in both cases, produce the same result; and this is further confirmed by the fact that the vegetable production is not larger in the fly than in the larva, though it ought to be so on the reverse supposition. Dr Mitchill must likewise be aware of the speedy, the almost instantaneous growth of many species of fungi; and this circumstance is sufficient to account for the appearance of the plant in the same state on the bodies of full grown wasps and their larvæ, both, probably, in Dr Maddiana's instance, deprived of life by the same accident.

The facts of the case not being established, it is not necessary to follow out the author's reflections on the "fungous tribes of cryptogamic vegetables" being "the destroyers of the insect race;" or to enter into questions regarding the balance of power between the insect or vegetable republics in their mutual "ravages" and "reprisals."

Dr Mitchill's presumptions from analogous processes in other departments of nature have no application. Living vegetables have been long known to support parasitic living vegetables; dead vegetable and animal matter is a fertile source of cryptogamic vegetation; and the instances of parasitic animals on other animals are so numerous, as almost to have become a general law among animated beings. The shells of marine and fresh water Molluscæ are frequently found covered, the first, not only with sea plants, but with lepades and serpulæ, and the second, with its coating of vegetable green, without either of these impeding the necessary motions, or disturbing the vital functions of the contained animals. But none of these instances apply to the case of Dr Mitchill's insects, where the growth is from a part of the body that must necessarily preclude the animal from exercising the functions essential to life; and the size and weight of the productions are besides such as to root it permanently to the spot. The presumption to be drawn from analogous facts seems rather to heighten the value of the proof which has been afforded by observation, that the death of the insect must have taken place prior to the commencement of the fungous vegetation.

"Des personnes peu éclairées" (says an eminent naturalist when writing on the same subject) "en ont voulu conclure que des animaux pouvoient se transformer immediatement en vegetaux; mais l'on sait que telle est la nature de certains champignons, notamment de cette clavaire, de ne pouvoir croître que sur des substances animales déterminées. Si le temps n'est pas favorable, il périt plusieurs de ces nymphes de cigales qui vivent dans la terre, sous les feuilles mortes. La semence de la clavaire s'y attache et s'y développe; voila tout le merveilleux." *

Art VI.—*On the Dew-Point Hygrometer formerly described in this Journal*, vol. iv. p. 127. By Mr John Foggo, Junr. Communicated by the Author.

I have inserted in a former Number of this work a brief notice of a method of taking the dew-point by means of a simple thermometer. Since that notice was published, I have had occasion to give a very extensive trial to this method, the result of which has satisfied me of the accuracy and facility with which observations may be made with it. Its utility has, however, been strenuously denied by an authority so high as that of Mr Daniell; and in replying to his objections, I shall embrace

* Bosc, in *Nouv. Dict. d'Hist. Nat.* tom. xxi. p. 445.

the present opportunity of making some remarks on dew-point instruments in general.

The superiority of these instruments over *hygroscopic* substances is derived from the circumstance, that they are not liable to deterioration from use or time, and they possess the further advantage, that their indications are strictly comparable, being independent of every change in the condition of the atmosphere, excepting those alone which they themselves are employed to detect.

The idea of ascertaining the hygrometric state of the air by cooling a portion of it till its moisture was rendered visible, appears to be the oldest as well as the simplest, and was perhaps suggested by observation of phenomena upon the great scale of nature.

The Florentine Academicians employed a glass vessel of the form of an inverted cone, which they filled with ice; and they estimated the degree of dryness or humidity by the frequency of the drops formed by the trickling down of the dew deposited from the chilled air in contact with the sides of the glass. Their experiments, however, were made at the very dawn of the sciences; and the other branches of natural knowledge were too little advanced to assist them in drawing any useful consequences from them. We now know from the laws which regulate the condition of vapour, that the frequency of the drops would indicate only the changes in the density of the vapour as it varies in warm and cold seasons, and not the relative dryness or humidity of the atmosphere at the time of the experiment. M. le Roi adopted a method susceptible of more precision, though even in his time the relations which his results bore to the actual quantity of moisture in the atmosphere were not understood. He filled a glass vessel with water, and lowered its temperature by stirring bits of ice in it till the cold was sufficient to condense the moisture. He then noted the temperature at which the precipitation first began, and judged of the degree of humidity by the difference of this temperature and that of the air. Since his time Mr Dalton has made many thousand observations nearly in the same manner, but by cooling the water by an artificial saline mixture instead of ice. He uses a cylindrical glass jar, dry on the outside, which he fills with cold spring water fresh from the well. If dew be immediately formed, the water is poured out and allowed to stand some time, in order to acquire heat, and is then replaced into the jar, after the outside has been well dried with a linen cloth. This operation is to be repeated till dew ceases to be formed, and the temperature of the water is to be observed. It was found that spring water generally answered the purpose during the three hottest months of the year, but in the other months it was necessary to employ a cooling mixture. Mr Dalton can thus ascertain the dew-point to one-fifth of a degree of Fahrenheit's scale. I may observe, that it is more convenient to have two or more small cylinders of polished metal; (about two inches deep and one inch in diameter;) one of these is to be filled with cold water, and, if dew be formed, the water is to be poured from one to the other, the warmth of the hand soon raising the temperature sufficiently to drive off the dew; or if it be necessary to use a saline frigorific solution, a small quantity of a mixture of equal parts nitrate of potash and muriate of ammonia may be thrown into it, and after the experiment the salts may be recovered by evaporation. Mr Dalton was the first who could deduce any important conclusions from observations of this kind. Having previously determined, by a series of admirable experiments, the elastic force of vapour for a long range of temperature, he was thus enabled to discover how much of the pressure of the whole aerial column was to be attributed to the presence of the moisture blended with it. This was a great step in the advance of hygrometry; and being followed shortly afterwards by the investigations of Gay-Lussac on the expansion of gases and the density of vapours, the whole theory of this science has been established by the mathematical demonstrations of Biot. It has been shown, that, to ascertain the condition of the atmosphere with respect to moisture, it is necessary only to know its temperature, and that of its dew-point, or the temperature at which its moisture begins to be condensed. But the methods I have described of obtaining this last term is evidently so troublesome, that it has never been introduced to any extent. In the meantime, meteorologists have had recourse to the principle of evaporation proposed by Dr Hutton, or to the hygrometers of Saussure and

De Luc, the performance of all of which has only rendered more striking the value of some convenient and effective plan of reducing M. le Roi's method to practice.

The manner in which Mr Daniell has resolved this problem by an elegant application of the principle of the cryophorus is too well known to require any description in this place. By this contrivance, and still more by his popular exposition of its principles and uses in many important researches, Mr Daniell has given to the science of hygrometry an almost unhoped for degree of precision, and has certainly inspired fresh energy into the study of almost every other branch of meteorology. I willingly add my tribute to the applause bestowed on this ingenious adaptation of a beautiful philosophical principle to the purposes of practical science, which, however, forms only a small part of Mr Daniell's very successful and meritorious labours. I think very few will call in question Mr Daniell's opinion, that he has thus introduced a mode of ascertaining the required *data*, so easy and nice of application as to leave no excuse for those who, at the expence of candour and professional honour, intrude on the public the abortions of their own dreamy lucubrations. By introducing the frigorific power of vaporization from a volatile liquid, I conceive that Mr Daniell has secured almost all the credit likely to be acquired from the subject; and having acknowledged this much, I may enter with more freedom into the discussion of the merits of some suggested improvements upon his instrument.

Mr Daniell thinks he has *demonstrated* that his hygrometer is susceptible of no improvement. Without stopping to inquire on what the demonstration is founded, I shall quote some remarks on his *perfect* instrument from a correspondent* who unites a thorough knowledge of meteorological science to a profound acquaintance with every other branch of natural history. "It is a beautiful result, that, by applying ether at one ball, such a degree of cold is produced as to effect a depression of 30° or 40° in the other, notwithstanding that the vapour, in passing from one to the other through a long tube which remains of the temperature of the air, will be heated up to this tem-

* The Reverend Mr John Macvicar, Dundee.

perature perhaps, and have all this heat to part with before it is condensed. But what is the use of this long tube, unless because there is such a one in the cryophorus? The reason for being long in that instrument is obvious, but the objects of both instruments are diametrically opposite. Dr Wollaston wished to effect freezing in the most disadvantageous circumstances, in order to show the force of the principle, but in the hygrometer the purpose manifestly is to produce cold most advantageously and economically. The principle of this hygrometer is beautiful, but the execution is not very happy. It is uselessly large. The only efficient parts are the two balls and the included thermometer, which, though the case must be larger than an octavo volume, is much too small for accurate observation. There is a great waste of ether, which at the end of the year must be no small quantity spent. There is a great loss of power in cooling a large body of ether, none of which, except the superficial film, is allowed to act. The principle of producing the cold by distillation in vacuo may be successfully given up altogether. Since the evaporation from the covered ball is able to depress the thermometer in the sentient ball a considerable number of degrees, a much more intense effect might be produced were the same quantity of ether suffered to evaporate from the surface of the ether at once; or, in other words, the same effects might be produced by a much smaller quantity lost. To accomplish this, all that is necessary is to expose the surface of the ether at once to the action of the atmosphere, to surround the bulb of the thermometer by a cup, into which pour ether, and, having observed the dew-point on the surface of that, return the ether to the phial. Here every drop of ether evaporated would be employed in producing the requisite degree of cold. The flat bottomed-cup I propose should have a lid to prevent or modify evaporation when the dew-point comes out speedily. The cup also slips off, and leaves the thermometer fit for ascertaining the temperature of the air, and entirely supersedes the use of two thermometers in making a hygrometrical observation." On these hints, the hygrometer which I formerly described was constructed by Mr Coldstream, and used by us in our observations made at Leith, and published in the *Edinburgh*

Philosophical Journal, (vol. xxiv. and xxv.) before it was known that a similar method had been adopted by Mr Jones, and long before we had learnt from Mr Daniell's remarks upon the instrument of this last gentleman that it had likewise been used in Germany. Mr Daniell has observed, that, as the bulb is only partially exposed to the cooling effect of the ether, we cannot thus obtain the true term of deposition, since the thermometer is graduated on the supposition that the whole of the mercury is of the same temperature. In short, he wishes us to believe that the two halves of the thermometer have different temperatures. It would be easy to oppose these theoretical objections by others more sound, if it were not absurd to try a question of this kind by any thing but experience; and a description of the manner of experimenting will enable every one to judge for himself on the subject in dispute. I use a thermometer with a ball of an oval shape, blown of black enamel; three-fourths of its surface are covered with muslin; a ring of silver or brass separates the covered part from that on which the dew is deposited. Having taken the temperature of the air, ether is dropped slowly on the muslin, the evaporation from which cools the mercury slowly and equably at the rate of one degree in 7″ or 8″. Hence, the contraction of the mercury is so very gradual that every portion of it has time to acquire the same temperature. If it be thought it may be otherwise, the instrument itself can detect the possible error; for, after the dew-point has been thus taken, and its approximate temperature known, the dew may be wiped off, and by cautious management the heat of the bulb may be kept steadily for any length of time a little above the exact point necessary to precipitate the moisture. Then, all the mercury having had full time to acquire the same degree of heat, when it is allowed to fall, and the dew-point again taken, if there has been any error in the first observation it will now be apparent. I have often verified my observations in this manner, but I always found it unnecessary. In Mr Daniell's hygrometer the evaporation of the ether in the sentient ball is extremely rapid, sometimes like an explosion, and in damp weather, when the dew-point differs little from the temperature of the air, the deposition is instantaneous. Besides, granting that the incipient deposition has been observed, what is the evidence that the exact temperature of this coincides with that read on the thermometer? The dew forms principally in a ring parallel to the surface of the ether, because that is the line of greatest cold, its constituent temperature, therefore, is that of the superficial plane, while the bulb is plunged below this into the body of the ether, which will have a considerable influence in modifying its temperature. The objections to the simple form thus recoil with increased effect upon the original; and if Mr Daniell is still incredulous, he is doubtless prepared to explain the discriminating faculty enjoyed by Newman's thermometers.

I do not wish to prejudice any one by these observations against Mr Daniell's hygrometer, the value of which is established by extensive experience, and by high scientific authority. I only claim for the other the attention to which it is entitled, and to show that in this case, as in every other, the merits of a scientific question are to be decided by facts only, not by cavilling on theoretical grounds, or by misapplied ridicule. My conviction of the utility of this instrument is founded on repeated trials of its performance made in company with its inventor; and since the publication of Mr Daniell's opinion of the London and German instruments, I have taken every opportunity of putting it to the test.

As an infallible standard by which to judge of it, I compared it with the results obtained by Dalton's method described above; and, at the same time, I used hygrometers of various sizes and forms, but the agreement of them all was complete; and, excepting their superior delicacy, I could never discover the most trifling discrepancy between them and the standard of comparison. In the course of these examinations the temperature has varied from 80° to 20°, the degree of dryness ranging between saturation and a thermometric difference of 25° or 30°, and I frequently exposed the hygrometers to the sun till they had risen 50 or 60 degrees above the temperature of the air, but the application of the ether always brought out the same dew-point. The construction I find most convenient is a straight thermometer, carrying 15 degrees to one inch on its scale, the bulb projecting beyond the scale, and made of black enamel blown so thin that in a strong light the mercury appears through it, of an elongated shape, about one-third of an inch in diameter, and three-fourths in length. The bulb is covered with muslin, leaving the black enamel exposed at the part next to the scale. The exposed part should be as small as consistent with facility of observation. The use of the ring is to confine the ether to the covered surface. This instrument, therefore, is as easy of construction as a common thermometer; it is very portable; and its sensibility is unlimited.

I have subjoined the tables to be used with the dew-point instruments. I cannot here enter into any account of the principles on which they are constructed. These will be found detailed in Mr Anderson's *Essay on Hygrometry* in the *Edinburgh Encyclopædia*, (vol. xi.) or in Mr Daniell's *Meteorological Essays*. In my *Elements of Meteorology* I shall give my reasons for preferring Mr Dalton's elastic forces to those given by Dr Ure.

Problem.—The temperature of the atmosphere and of the dew-point being given, to find the quantity of vapour in a cubic foot of air.

If the temperature of the air and the dew-point be coincident, then in the first table opposite to the temperature will be found the corresponding elastic force, and in the third column is the weight of a cubic foot of vapour expressed in grains. Let the temperature of the air be 70°, and the dew-point the same, then from the first table we find the elastic force corresponding to this temperature $=.726$, and the weight of a cubic foot 8.082. But if the temperature of the air be different from the dew-point, a correction is necessary to find the exact weight. Suppose the dew-point to be 70° as before, but the temperature to be 80°, then the vapour has suffered an expansion due to an excess of 10°. We find in the second table the correction for 10° is 1.0208, and 8.082 divided by this $= 7.917$. To find the relation of these conditions on the natural scale of humidity, the weight of vapour at the dew-point being divided by the weight at the temperature of the air, the quotient gives in parts of 1.000 the degree of saturation, thus $\frac{8.082}{10.993} = .735$.

These tables contain all the temperatures likely to occur in this climate.

Table of the force of Vapour, and weight in grains of a cubic foot of Vapour at different Temperatures, from 5° to 80° Fahr.

Temp.	Force.	Weight.	Temp.	Force.	Weight.	Temp.	Force.	Weight.
5	0.074	0.912	30	0.185	2.204	55	0.442	5.052
6	.076	0.945	31	.192	2.280	56	.457	5.216
7	.079	0.980	32	.199	2.360	57	.473	5.390
8	.082	1.016	33	.206	2.442	58	.489	5.563
9	.086	1.054	34	.214	2.526	59	.506	5.748
10	.089	1.092	35	.221	2.613	60	.523	5.921
11	.092	1.132	36	.229	2.703	61	.540	6.114
12	.096	1.173	37	.237	2.796	62	.559	6.319
13	.099	1.216	38	.246	2.891	63	.577	6.514
14	.103	1.260	39	.255	2.990	64	.597	6.727
15	.107	1.307	40	.264	3.092	65	.617	6.942
16	.111	1.352	41	.273	3.202	66	.637	7.156
17	.115	1.401	42	.283	3.305	67	.659	7.390
18	.120	1.451	43	.293	3.417	68	.681	7.612
19	.124	1.503	44	.303	3.532	69	.703	7.857
20	.129	1.556	45	.314	3.651	70	.726	8.082
21	.134	1.612	46	.325	3.773	71	.750	8.357
22	.139	1.669	47	.336	3.889	72	.775	8.622
23	.144	1.729	48	.348	4.021	73	.800	8.886
24	.149	1.789	49	.360	4.154	74	.827	9.151
25	.155	1.854	50	.373	4.297	75	.854	9.455
26	.160	1.917	51	.386	4.437	76	.881	9.722
27	.166	1.985	52	.400	4.594	77	.910	10.042
28	.172	2.054	53	.413	4.736	78	.939	10.345
29	.179	2.192	54	.427	4.888	79	.970	10.670

Table of Corrections to be used when the term of deposition differs from the temperature of the air.

Diff. of Temp.	Correction.	Diff. of Temp.	Correction.	Diff. of Temp.	Correction.	Diff. of Temp.	Correction.
1	÷1.0020	11	÷1.0229	21	÷1.0437	31	÷1.0646
2	1.0041	12	1.0250	22	1.0458	32	1.0667
3	1.0062	13	1.0271	23	1.0479	33	1.6880
4	1.0083	14	1.0291	24	1.0500	34	1.0708
5	1.0104	15	1.0312	25	1.0521	35	1.0729
6	1.0125	16	1.0333	26	1.0542	36	1.0750
7	1.0145	17	1.0354	27	1.0562	37	1.0771
8	1.0166	18	1.0375	28	1.0583	38	1.0792
9	1.0187	19	1.0396	29	1.0604	39	1.0813
10	1.0208	20	1.0417	30	1.0625	40	1.0834

ART. VII.—*Description of a Plant of the order of Guttiferæ, which Dr Roxburgh called Garcinia pedunculata.* By FRANCIS HAMILTON, M. D. F. R. S. and F. A. S. Lond. and Edin. Communicated by the Author.

IN an account of Asam, which I published in the *Annals of Oriental Literature*, (244,) I have mentioned a fruit, which is exported from that country to Bengal to be used as an acid seasoning, and which is called Thaikol. This is of two kinds, Bara and Kuji, or great and little. The latter is the tree of which I am now about to give an account, that of Dr Roxburgh having not yet appeared.

With the *Garcinia* of Linnæus, Dr Roxburgh united the genus *Oxycarpus* of Loureiro, which M. Petit Thouars, for better reasons than usual with his innovations, has called *Brindonia;* and this arrangement, having been adopted by M. Choisy, is followed by Decandolle. If the genus *Garcinia* thus constituted be good, as, even including the *Cambogia* of Linnæus, it contains only thirteen species, (Decand. *Prodr.* i. 560,) why has it been divided into two sections, *Mangostana* and *Brindonia.* Had it indeed contained a hundred species such a division may have been useful in facilitating the investigation of an unknown plant; but the small number of species renders this unnecessary. If, on the contrary, the *Brindonia* differs essentially from the *Mangostana*, why not at once form them into two genera?

The Thaikol, although in flower it agrees entirely with the character of *Brindonia* or *Oxycarpus*, differs essentially in wanting the pulpy arillus round each seed; and its general appearance differs a good deal from all the species of *Garcinia* that I have seen. Although I found it pretty generally diffused through the gardens of the Rungpur district, where it had been introduced from Asam, I never saw the male plant; but this may have been merely accidental. I here confine my description to the hermaphrodite. The specimens sent to the India-House are marked by the name which Dr Roxburgh used.

Arbor mediocris ramulis compressus glabris. Folia opposita, crassa, rigida, glabra, integerrima, obovata, costata, obsolete venosa. Petiolus compressiusculus, marginatus, glaber, brevissimus, annulo ramum cingens, non stipulaceus.

Pedunculus solitarius geminus vel ternus, terminalis, crassus, rigidus, tubum floris mentiens, utrinque apicem versus infra calycis foliola interiora bisulcus, annulo carnoso quasi disco cinctus. Intra discum bracteæ duæ partiales parvæ, ovatæ, adpressæ; extra discum bracteæ communes duæ foliaceæ, parvæ, patulæ. Flores lutei, rigidi, gummiferi.

Calycis quadriphylli foliola subrotunda, concava, patula, duobus interioribus dorso carinatis. Petala quatuor oblonga, obtusa, crassa, ungui lato hypogyna, calyce longiora. Filamenta quatuor basi unita, petalis alterna, germine breviora, hypogyna, carnosa, apice septem s. octo-dentata. Antheræ minutæ, singulis filamentorum denticulis insidentes. Germen magnum, superum, obsolete tetragonum. Stylus nullus. Stigma planum, peltatum octolobum.

Fructus circumferentia pedali depressus, lævis, flavus, utrinque umbilicatus, calyci parvo tetraphyllo insidens, stigmate persistente coronatus. Parietes unciam crassæ, succo acido plenæ, carnosæ, sed succo expresso duriusculæ, flavæ, epidermide tenuissimo tectæ.

Loculi circiter octo obsoleti, septis membranaceis aliquando fere evanidis e centro carnoso ad parietes radiatim decurrentibus divisi, intus farcti pulpa aurantii coloris molliore, dulciore, sapore nonnihil Mangostani, fibrillis intermixta, facile e parietibus separabili, semini arctissime adnata. Ossiculum in singulis loculis solitarium, oblongum, compressum, margine interiore compressiore, uniloculare, monospermum, lignoso-coriaceum. Semen forma ossiculi medio lateris interioris emarginatum, funiculo e ossiculo enato suspensum. Integumenta membranacea, gemina. Interiora amygdalina absque partium distinctione visibili in corpus solidum conferruminata. See Plate I. Fig. 1.

Art. VIII.—*Contributions to Physical Geography.*

1. *Description of the Cavern of Adelsberg in Carniola.*

The village of Adelsberg stands at the bottom of an inconsiderable rocky eminence. At the western extremity of the eminence the rock gapes into two large apertures. The one reaches nearly from its summit to the level of the plane, and has an irregular, jagged, cleft-like shape; the other is rather more to the eastward, about fifty feet higher in the rock, and in a much more regular vaulted form. The river Poick comes winding along the valley from the south, flows under the eminence, reaches its western extremity, throws its whole body into the lower of the two openings, which it entirely fills, and disappears. The higher opening runs a short way into the mountain, forming a regular and spacious gallery. The partition of rock that separates it from the lower one, through which the river holds its course, is broken through in several places, and furnishes here and there a glimpse of the dark waters fretting along in their subterranean channel. But as you advance, their murmurings and the distant gleams of day-light die away together, and the silence and darkness of ancient night reign all around.

The guides now lighted their lamps, and, in a short time, the distant sound of water was again heard. It became louder and louder. The passage seemed to widen, and at length opened out into an immense cavern which the eye could not measure, for the lights were altogether insufficient to penetrate to any distance the darkness that was above, and around, and below; they were just sufficient to show where we stood. It was a ledge of rock which, running across the cavern like a natural partition, but not rising to the roof, divides it into two caverns.

From that on the left of the partition, on whose summit we stood, rose amid the darkness the furious dashing of the river, which has thus far found its way through the mountain, and, announcing by its noise the obstacles it encounters, seems to throw itself in despair against the opposing partition, which threatens to prevent its course into the more ample division of the cavern on the right. On this latter side, the rocky partition sinks down absolutely precipitous; the cavern, likewise, is much deeper than that on the left, and impenetrable darkness broods over it. Leaning over the precipice, the ear, after it has become accustomed to the raging of the stream on the other side, hears that its waters far below have pierced the partition, and made their way into the deeper and more ample hall of the cavern. It is, in fact, a natural bridge. The impression, however, on this side is more striking; for the river is heard eddying along with that dull, heavy, and indistinct sound, which, particularly in such circumstances, among subterranean precipices, and in subterranean darkness, always gives the idea of great depth. The guides lighted a few bundles of straw, and threw them into the abyss. They gleamed faintly, as they descended, on the projecting points of the rock; blazed for a few seconds on the surface of the water, showing its slow, heavy motion, and illuminating, through a small circle, the darkness of the cavern, left its gloom, by their extinction, more oppressive and impenetrable.

"From this spot," says Sartori, "it is not allowed to the boldest of mortals to proceed farther;" and he said so, because, towards the greater division of the cavern into which the river has thus forced its way, the partition is too precipitous to admit of descent. But mortals not at all bold now go a great deal farther. Towards the smaller division, the partition is not so precipitous, and the cavern itself is not so deep. A flight of steps was cut out on this side, down to the bottom. The partition itself was then pierced in the direction of the greater cavern. When the workmen had got through it, they found themselves still considerably above the bottom of the greater, but the rocky wall was now more sloping, and, by hewing in it a flight of steps, the bottom was reached in safety. The great object was to know what became of the river. We had not advanced many yards along the rocky floor, which owes much of its comparative smoothness to art, when the river was again heard in front, and the lights of the guides glimmered on its waters. It flows right across the cavern;

it has lost its noise and rapidity; it eddies slowly along, in a well defined bed, and having reached the opposite wall of this immense vault, the solid mountain itself, it again dives into the bowels of the earth. Its course can be followed no farther, and it is still doubtful whether, or where, it again appears on earth.

This, imposing as it is, is but the vestibule to the most magnificent of all the temples which nature has built for herself in the regions of night. A slight wooden bridge leads across the river, and after advancing a little way the terminating wall of the cavern opposes you. This was always held to be the *ne plus ultra*. But, about five years ago, some young fellow took it into his head to try, with the help of his companions, how far he could clamber up the wall by means of the projecting points of rock. When he had mounted about forty feet, he found that the wall terminated, and a spacious opening intervened between its top, and the roof of the cavern which was still far above. A flight of steps was immediately hewn in the rock, and the aperture being explored, was found to be the entrance to a long succession of the most gigantic stalactite caverns that imagination can conceive.

From a large rugged, and unequal grotto, they branch off in two suites. That to the left is the more extensive, and ample, and majestic; that to the right, though smaller, is richer in varied and fantastic forms. Neither the one nor the other consists merely of a single cavern, but a succession of them, all different in size, and form, and ornament, connected by passages which are sometimes low and bare, sometimes spacious and lofty, supported by pillars, and fretted with cornices of the purest stalactite. It would be in vain to attempt to describe the magnificence and variety of this natural architecture. The columns are sometimes uniform in their mass, and singularly placed; sometimes they are so regularly arranged, and consist of smaller pillars so nicely clustered together, that one believes he is walking up the nave of a Gothic Cathedral. Many of these columns, which are entirely insulated, have a diameter of three, four, and even five feet. Frequently the pillar is interrupted as it were in the middle, losing its columnar form, and twisting, dividing, or spreading itself out into innumerable shapes. Sometimes it dilates into a broad thin plate, almost transparent in the light of a lamp; sometimes this plate curves itself round in a circular form; sometimes the descending part tapers to a point, which rests on the broad surface of the ascending stalagmite. The walls are entirely coated with the same substance, and, in the smaller grottoes, it is so pure, that travellers have covered it with names written in pencil, some of which have already resisted the moisture five or six years. The other division is more spacious, and extends much farther. The caverns which compose it are wider and loftier, but not so beautifully adorned as in the other. The enormous clustered columns of stalactite that seem to support the everlasting roof from which they have only originated, often tower to such a height, that the lights do not enable you to discover their summit; but, though infinitely majestic, they are rougher, darker, and more shapeless than in the smaller suite. The farther you advance, the elevations become bolder, the columns more massive, and the forms more diversified, till after running about six miles into the earth, this scene of wonderment terminates with the element with which it began, water. A small subterraneous lake, deep, clear, cold, and dead-still, prevents all farther progress. It has not been passed; it would therefore be too much to say that nothing lies beyond.

Throughout these caverns, not a sound is heard, except the occasional plashing of the dew-drop from a half-formed pillar. No living thing, no trace of vegetation enlivens the cold rock, or the pale freezing stalactites. A solitary bat, fast asleep, on a brittle white pinnacle, was the only inhabitant of this gorgeous palace. When I took him from his resting-place, he uttered a chirping plaintive sound, as if murmuring that our lights had disturbed his repose, or that human feet should intrude into the dark and silent sanctuary of his race. When replaced on his pinnacle, he folded up his wings, ceased to chirp and murmur, and, in a moment, was as sound asleep as ever.

Yet these abodes are not always so still and deserted. About the middle of the more extensive of the two ranges, the passage which, though not low, has for a while been rough and confined, opens into one of the most spacious and regular of all the caverns. It is oval, about sixty feet long, and forty broad; the walls rise in a more regularly vaulted form than in any of the others; the roof was beyond the eye. The walls are coated with stalactite; but, excepting this, nature has been very sparing of her ornaments. The floor has been made perfectly smooth. In addition to the stone-seats which the rock itself supplies, wooden benches have been disposed round the circumference, as well as a few rustic chandeliers, formed of a wooden cross, fixed horizontally on the top of a pole. Once a-year, on the festival of their patron saint, the peasantry of Adelsberg, and the neighbourhood, assemble in this cavern to a ball. Here, many hundred feet beneath the surface of the earth, and a mile from the light of day, the rude music of the Carniolian resounds through more magnificent halls than were ever built for monarchs. The flame of the uncouth chandeliers is reflected from the stalactite walls in a blaze of ever-changing light; and, amid its dancing refulgence, the village swains, and village beauties, wheel round in the waltz, as if the dreams of the Rosicrucians had at length found their fulfilment, and Gnomes and Kobolds really lived and revelled in the bowels of our globe.—*Russel's Tour in Germany.*

2. *Account of the Subterraneous Sounds heard at Nakous in Arabia Petræa.* By M. Seetzen.

In our last Number, we gave a short account by Mr Gray of Oxford, of these singular sounds, and made a reference to the account given of them by Mr Seetzen; but, as the description of the same phenomenon by this last traveller, is very interesting, we think it will be agreeable to our readers to be put in possession of it.

"Near Tor is a mountain, which, in a physical point of view, is perhaps one of the most remarkable, not only in Arabia Petræa, but in the whole world. It is called *El Nakous*, and is situated three leagues to the north of Tor. No European traveller has yet visited it. For two years I have heard it spoken of by the Greeks, first at the convent of Sinai, and afterwards at Suez, but the account which was given me of it was accompanied with so many fabulous recitals, that I was led to suppose it an invention of the merchants. When I obtained farther information at *Wody el Nachel*, it not only confirmed these first accounts, but added to them new prodigies. Under the mountain there existed a Greek convent; and the subterranean noise was that of the *Nakous*, that is, the call to prayers. (*Nakous* is a sort of long narrow rule, suspended in a horizontal position, which the priest strikes in time with a hammer, and the sound of which is heard at a distance. There are only a few places in the East where the Christians are permitted to have clocks.) It was also stated, that a Greek, who had been dead for some time, had seen the mountain open, and had descended into the subterranean convent, where he found fine gardens, and delicious water; and in order to give proof of his descent, he had brought to the upper world some fragments of consecrated bread which he had received.

" Accompanied by a Greek Christian, and some Bedouins, I set off on the 17th June at five o'clock in the morning. After a quarter of an hour's walking, we reached the foot of a majestic rock of hard sandstone. The mountain was quite bare, and entirely composed of it. I found inscribed upon it several Greek and Arabic names, and also some Koptic characters, which showed that this place had been visited for centuries. At noon we reached the part of these mountains called *Nakous*. There, at the foot of the ridge, we beheld an isolated peaked rock. Upon two sides this mountain presented two surfaces, so inclined, that the white and slightly adhering sand which covers it scarcely supports itself, and slides down with the smallest motion, or when the burning rays of the sun completes the destruction of its feeble cohesion. These two sandy declivities are about 150 feet high. They unite behind the insulated rock, and forming an acute angle, they are covered, like the adjacent surfaces, with steep rocks, which are mostly composed of a white and friable freestone.

" The first sound was heard at an hour and a quarter after noon. We climbed with great difficulty as far as the sandy declivity, a height of seventy or eighty feet, and we stopped under the rocks where the pilgrims are in the habit of placing themselves to listen.

"In climbing, I heard the sound from beneath my knees, and this made me think that the sliding of the sand was the cause, and not the effect of the sonorous motion. At three o'clock the sound was heard louder, and it lasted six minutes, when, having ceased for ten minutes, it began again. It appeared to me to have the greatest analogy to the humming top; it rose and fell like the sound of an Eolian harp. To ascertain the truth of my discovery, I climbed with the utmost difficulty to the highest rocks, and I slid down as fast as I could, and endeavoured, with the help of my hands and feet, to set the sand in motion.

"This produced an effect so great, and the sand in rolling under me made so loud a noise, that the earth seemed to tremble, and I should certainly have been afraid, had I been ignorant of the cause.

"But how can the motion of the sand produce so striking an effect, and which is, I believe, observed nowhere else? Does the rolling layer of sand act like the fiddle-bow, which, on being rubbed upon a plate of glass, raises and distributes into determinate figures the dust with which the plate is covered? Does the adherent and fixed layer of sand perform here the part of the plate of glass, and the neighbouring rocks that of the sounding body? Philosophers must decide this. My journal contains a more detailed account of this phenomenon, and a rough draught of the rocks of Nakous. I have in my mineralogical collection specimens of the sandstone, as well as the moveable sand which is found at this place."—*Monatliche Correspondenz*, October 1812, p. 393.

3. *Account of the Granite Quarries at Assuan.* By the Honourable C. L. Irby, and James Mangles, Esq. Commanders in the Navy.

"On our arrival at Assuan, we proceeded to visit the ancient granite quarries in the neighbourhood. Our principal object was to examine the column which is there, and which has an inscription in Latin not devoid of interest. Our guide lost his way at first, and took us to another part of the quarry, where we found an immense granite basin, seventeen feet long, by seven wide, and three deep. It is hewn out in the rough, and is narrower at the bottom than the top; we were at a loss to imagine for what purpose such an immense basin could be intended, unless it was for a bath. The whole of this quarry was highly interesting; here we had an opportunity of noticing the manner in which the ancients used to cut the prodigious masses which one meets with throughout Egypt. It appears that, when they wanted to detach a mass, they cut niches in a right line throughout the piece they intended removing; these niches were about two feet apart, five or six inches long, and about three deep, by two and a half broad. As soon as they were finished the block was separated by some violent blow or concussion. We met in all directions specimens of the progress of their work; some masses were but half-detached, others wholly separated; here we saw an obelisk in the rough, and there a column; the whole was an interesting scene. The ancient road regularly paved with granite is still plainly to be seen, though the sand covers a great part; in the vacancies between the hills are causeways, some of considerable length, to connect the elevated parts one with the other, and thus keep a communication open with the several quarries, all these roads leading to two principal ones, which conduct to Assuan. We now searched for the column with the inscriptions, and at last found it. The pillar is small, not being more than ten feet in length, by about three feet diameter; the inscription is tolerably perfect. An Arab, acquainted with Mr Belzoni, told him of it, and it was seen for the first time by a traveller last year. As Mr B. had copied the writing, we did not think it worth while to copy it. Its purport is as follows:—'To Jupiter Ammon, Kneephis Bona, (the good spirit,) and to Juno the Queen, under whose protection is this mountain, in which were discovered nine quarries near Philæ, during the happy age of the Roman Empire, under the most pious Emperors Severus and Caracalla, and —— —— and Julia Domna his august mother; and a vast number of statues, and large columns, were taken out of these quarries by Aquila, Prefect of Egypt. '*Cura magens opera,*' which Mr Salt interprets, 'under his directions

Aurelius Helogabalus ordered this stone to be erected in the calends of March.' The vacant space before Julia Domna the mother, is where the name of 'Geta, the other brother, was erased; Caracalla having murdered him, ordered his name to be blotted out of every inscription where it was inserted. Mr Salt tells us that there is one instance of this at Rome, and he has met another on an inscription discovered at the late excavation of the Sphinx. I should like to have sent the original Latin to you, but as it was not to be got, I must be content with what I have. You will observe the inscription says, that the Romans *discovered* the nine quarries, *not that they made them.* One must therefore infer that they were first worked by the Egyptians; and as they were so numerous, and of such magnitude, they must have been of great consequence, and doubtless one of the most remote antiquity. I confess I was much perplexed to think how the Egyptians could have cut, hollowed out, and polished such immense blocks of the hardest stone, without the use of iron, a metal which they are said to be wholly ignorant of; the niches therefore, which I mentioned above, if not with iron, must have been cut with brass.

4. *Account of Hot Springs, and Volcanic Appearances in the Himalaya Mountains.*

In the eighth Number of this *Journal*, p. 209, we published a very interesting account of the appearance of a volcano in the Himalaya mountains, transmitted to us by a correspondent in India. In confirmation of this curious fact, he has sent us the following extract of a report on Kemaons, by the Commissioner Mr Traill.

"If volcanic appearances are ever discovered, it will no doubt be in the Himalaya range. A few hot springs are to be met with in the passes through it. The heat of them vary. One at Buddreenaut, where it issues from the ground, shows a heat of 138° of Fahrenheit.

The inhabitants residing at the base of the range in question state that smoke is occasionally seen to rise from the interior. The frequent occurrence of earthquakes renders it possible that some volcano is situated there; but the inaccessible nature of the interior of the Himalaya must ever render it impossible to ascertain its existence by actual inspection.

5. *Account of the Brahma Kund.** By Captain Bedford.

After some ineffectual attempts to open a passage to the supposed head of the river, the Deo Panee, or Brahma Kund. the divine water, or well of Brahma, which it was known was not remote, and after some unsuccessful efforts to reach the villages, the smoke of which was perceptible on the neighbouring hills, a communication was at last effected with the Meeseemees of Dillee, a village about a day's journey from the left bank, as well as with the Gaum or Tikla, the head man of the Brahma Kund village, in whose company a visit was paid to the reservoir on the 4th of April. This celebrated reservoir is on the left bank of the river: it is formed by a projecting rock, which runs up the river nearly parallel to the bank, and forms a good sized pool, that receives two or three small rills from the hills immediately above it. When seen from the land side, by which it is approached, the rock has much the appearance of an old Gothic ruin, and a chasm about half way up, which resembles a carved window, assists the similitude. At the foot of the rock is a rude stone seat; the ascent is narrow and choked with jungle: half way up is another kind of seat, in a niche or fissure, where offerings are made; still higher up, from a tabular ledge of the rock, a fine view is obtained of the Kund, the river and the neighbouring hills: Access to the summit, which resembles Gothic pinnacles and spires, is utterly impracticable: the summit is called the Deo Baree, or dwelling of the deity. From the rock the descent leads across a kind of glen, in the bottom of which is the large reservoir, to the opposite mainland, in the ascent of which is a small reservoir about three feet in diameter, which is fed by a rill of beautifully clear water, and then pours its surplus into its more extensive neighbour below. The large Kund is about seventy feet long, by thirty feet wide. Besides Brahma Kund and Deo Panee, the place is also termed Purbut Kathar, in allusion to the legend of Parasurama hav-

* See this *Journal*, No. viii. p. 302. It is now certain that this reservoir is not the origin of the Bramapooter.

ing opened a passage for the Brahmaputra, through the hills, with a blow of his Kat'har or axe. The offerings made at this holy spot are very miscellaneous, and many of them very incompatible with the ordinary Hindu belief, as fowls and cows. Whatever, indeed, is eaten by the minister, is supposed acceptable to the deity, and the Meeseemees of this part of the country have no prejudices in the article of food, eating beef and pork, and every variety of flesh and fowl. The visitors to the reservoir do not seem to be numerous or opulent.

6. *Notice of the Phoonga Caves in Junk Ceylon.* By Captain Low.

The pyramidal rocks of Phoonga occupy a line of about ten miles, running nearly north and south—the northern extremity lies behind the town of Phoonga on the Peninsula; the southern stops about four miles from the sea shore. They rise from the sea perpendicularly to various heights between 200 and 500 feet. The most majestic present a columnar appearance at a distance, but, on approaching them, this appearance is found owing to the decomposition of the most friable parts, and the alternate reddish, grey, or bluish and white stripes left upon the surface, by the water which has filtrated through the rock, depositing such substances as it held in solution.

About six feet above high water mark runs a series of natural excavations: the roof is about ten feet high, supported by stalactitic columns of various shapes and dimensions. The sides and compartments of the grottoes are of similar formation. Adjoining to the range of excavations is a rock, which is completely perforated, and it forms a stately and elegant arch, about twenty feet high, from the roof of which depend clusters of stalactites of the most massive and grotesque description. The Phoonga rocks are evidently connected with those of Trang, and as similar formations occur in Martaban, it seems likely that the chain extended formerly up to that province. In Tavai, however, granite and schistus are predominant.

Specimens of the stalactites, and other specimens of carbonate of lime from these caves, have been presented by Captain Low to the Museum of the Asiatic Society of Calcutta.

7. *Notice of the Cavern of the Sagat Rock, upon the Sagat Strait of the Sanloon or main river of Martaban.*

The squall abating, we pushed up past the strait, which is formed by the high rock *Sagataung* on the west, and *Krooklataung* on the east. The river being confined rushes with impetuosity, and forms many eddies, especially on the west side, where it is turned off by the foot of the *Sagat* rock. An appearance of an inscription in large characters, on the face of the rock, offered itself to notice, but on landing it was found to arise from a number of small baked and partially gilded earthen images, so arranged in tables and niches as to look like letters: several small Pagodas crown those sharp spires of the rock which overhang the bed of the river, and greatly add to the grandeur of the approach to this curious place.

The disappointment in not finding any inscription upon the Sagat rock was, in some measure, compensated by the discovery of a cave to the left of the tables, containing the diminutive gods alluded to. It is two hundred and forty feet in depth, by an average breadth of fifty feet, and the height may be rated throughout from twenty-five to thirty feet. It forms a sort of natural arch, quite unsupported by pillars. The rock is composed of limestone in various stages, and the cave has been formed by the gradual decay of the softest part. It was found to be dry, but the interior quite insupportable above a minute, owing to the want of a free circulation of air, and to the smell arising from the dung of the large bats and vampires which here shelter themselves, and which lies nearly twelve inches thick under foot.

Many massive concretions of sparry carbonate of lime were observed in the crevices of the rock, or attached to the sides of the cave. The Booddhists of Martaban had consecrated this cave to their religion previous to their falling under the Burman yoke. Many marble images, plain and gilded, and in good preservation, stand in rows on the same places on which they had been arranged perhaps several centuries since, and several wooden ones, quite decayed by time, lay scattered about. Two rather colossal images of the great teacher, Buddha, guard the entrance; that on the right is of brick, covered with stucco, and is in a sitting attitude with the legs crossed. In this cave we find no marks of the rude yet grand conceptions which produced the sculptures to be found scattered over India; instead of drawing forth, with a bold hand, the statue from the living marble, those who dedicated this cave filled it with gaudily painted and gilded alabaster images, which do not harmonize with the bold outline of the rock, or the gloomy grandeur of the interior. In this country no fluted columns or graceful pillars adorn the plain, or add dignity to the approach to the shrine of the Burman Idol.

8. *Account of the Floating Island of Newbury Port.* By Mr Amos Pettingall Jun. From Dr Silliman's *Journal*, No. xxv. p. 122.

That a few floating reeds, upon a pond, should collect together, and adhere with sufficient compactness to sustain small pieces of earth and decayed shrubs and plants, and thereby exhibit small clumps of vegetables moving on the water, is not surprising; but that islands of any magnitude should be found in this vagrant state, has ever been considered a subject of considerable curiosity. Passing over the mythological fiction of the floating *Delos*, as founded upon questionable evidence, and the island of Chemmis, with those called the Cyanean, reported as floating, by the less doubtful testimony of Herodotus, the first of which history gives a minute and circumstantial account, are those in Lake Vadimon, near Rome, (now called *Lago de Bassanello*,) described by Pliny major and Seneca. Pliny the younger, in the 20th Letter of his 8th Book, gives a very interesting description of the same, in which he mentions the circumstance of sheep, which, while grazing, imperceptibly fell upon some of these islands, lying on the borders of the lake, and were carried off by the wind, and borne to the opposite shore. It is also asserted by Boethius, that in *Loch Lomond* there were floating islands upon which cattle graze. A few small ones, of the same description, are said to exist in a lake in the province of Honduras in America.

The island which I am about to describe is situated nearly one mile south of the market-house in Newburyport, about two stones' cast from what is called Old-Town meeting-house, in a pond in the rear of the adjoining burying-ground. Its length averages about 140 feet, and its breadth 120, containing nearly half an acre. Its surface is thickly studded with dog-wood, although not a bush of it is found beyond the limits of the island, as though it were an enemy to the water that surrounds it. There are upon it six large trees, two of which measure in girth three feet and upwards, besides several clusters of willow trees of small growth. These rise and fall with the island. The pond is usually dry during the summer months, and at these seasons the island has been found so low that you would descend, *perceptibly*, in passing to it from the dry bed of the pond. I visited it yesterday, and found it elevated about eighteen inches above the level of the pond's bottom, owing to the rains that have recently fallen.

The customary rise of the pond in the fall and spring is about eight feet, although it has been known to rise twelve: the island preserves the same elevation above the surface of the water in the different periods of its rise. I have been told to-day, by a man of unequivocal veracity, that he has forced a pole, ten feet in length, down through the centre of the island, and with this, as far as he could extend it with his arm, has been unable to meet with a solid and permanent bottom. He also informed me, that, when the pond was very high, these large trees standing upon the margin of the island overhang the water with considerable obliquity, owing, probably, to the roots being brought to a great degree of tension, and preventing the exterior part of the island from rising with the centre. It is not entirely detached from the bed of the pond, but seems to be a kind of a stratum peeled off from the solid parts below. In passing across its surface, the whole island is considerably agitated, and presents a waving appearance, like the sea; you are toiling continually to ascend, as though it were a surface of flexible ice.

Art. IX.—*Notice respecting the Vanderon Monkey, or the* Guenon à face pourpre *of Buffon.* By Francis Hamilton, M. D. F. R. S. and F. A. S. Lond. and Edin. Communicated by the Author.

The most common monkey in the vicinity of Point du Galle in Ceylon, and therefore called Vanderon, seems to be that called *Guenon à face pourpre* by Buffon; but the name is highly improper, as the purple of the face is merely accidental, and the common colour of the face, hands, and ears, or naked parts is black. The proper distinguishing mark of the species is a triangular white beard, pointed towards the chin, and turned up over each eye towards the temple. So far as I observed, the animal has no cheek-pouches, at least I have seen it often eating, without putting anything into its pouches, if it has any. The crown of the head is brown; the remainder of the hair is grey, consisting of black and white, but in general the black is by far the most predominant, except on the rump, buttocks, and tail, which are whitish. The tail is considerably longer than the body and head, or than the hinder legs. It is cylindrical, and, although the hair towards the point is very long, it is so thin that it does not form a tuft, like that at the end of a cow's tail, although such is said to be the case in the animal described by Buffon. The place, however, where the animal is found, and the name, leave no room to doubt that the animals are the same. It is a mild inoffensive creature, not at all so restless and mischievous as monkies usually are; and more resembles in its manners the black long-armed ape. It is very impatient of cold.

Point de Galle,
April 3, 1815.

Art. X.—*Description of a New Safety-Tube for Chemical Apparatus.* By James King, Esq. Communicated by the Author.

Sir,

The straight safety-tube commonly employed in Woolf's apparatus, and others of that description, cannot be conveniently ground air-tight into the bottle, and must necessarily be luted; and when considerable pressure is required, its length must be such as to render it very unwieldy. Besides, when it is placed into the first bottle of the series which is only intended to collect the condensable part of the product, a quantity of liquid must also be introduced, which, being in the best possible situation to be impregnated with the gas, readily absorbs it, but is rendered useless by the admixture of foreign ingredients from the retort. This inconvenience, however, is obviated by the safety-tube of Welther, which is also objectionable from its necessarily delicate construction, and its unmanageable length, even when a moderate degree of pressure is required. Various plans have from time to time been adopted to overcome these inconveniences. The most successful is that proposed by the late Dr Murray, who suggested the formation of a globe on the long leg of each tube of communication, a little above their insertion into the bottles. This plan, too, has its defects. The bent tube cannot with safety be made to dip among more fluid than is barely sufficient to fill the small globe on its leg. A greater number of bottles is therefore necessary to bring the same quantity of liquid in contact with the gas. There is also considerable waste of the aeriform fluid in the spaces of the bottles not occupied by the liquid; an increased number of bottles multiply the luted joints, and the risk of leakage is consequently augmented.

By the use of the safety-tube, of which I have sent you a drawing, any degree of pressure may be applied that the bottles can resist, and which may be regulated at pleasure without altering its length. Neither is it necessary for its action that the first bottle contain liquid; the others may be filled almost completely; it may be ground with ease air-tight without lute; it is not liable to derangement; is easily adjusted; allows egress of the gas, when necessary, to prevent explosion, and ingress of air in the event of a partial vacuum being formed at the conclusion of the process. Such are the advantages of this little piece of apparatus, the construction of which occurred to me some little time ago; and I have since, on trial, found it very useful. As I have not seen the same on record, I now transmit you this notice, which, through the medium of your widely circulated *Journal*, may be of advantage to the manufacturers of muriatic acid, &c. or to the experimental chemists in Europe. I got it made at the extensive flint-glass manufactory of Messrs Bailey and Company, Edinburgh, whose facilities for the manufacture of all glass-articles are the best in Scotland. I ought to have written you this before I left Dundee in September last, being now on a voyage on board the ship City of Edinburgh for New South Wales; from thence you may expect to hear from me. I leave this letter with the British Consul, who is kind enough to forward it to you.

A, Plate I. Fig. 2. is a glass tube of the form of a syphon; the long leg is ground into the neck of the bottle I. B is a conical valve opening outwards. C a metallic wire fixed into the moveable plug, on which the weights D, E, or more, may be placed, so as to increase the weight of the valve, and thereby restrain the escape of the gas when a greater pressure is required. In the short leg of the syphon-shaped tube A is formed a valve opening inwards. F is a bit of tube introduced tight into the tube A, which is only intended to preserve the moveable part of the valve in its proper position. G is another piece of tube ground air-tight into the tube A, and a space about half an inch is left between the tube F and G, so as to allow the disc H to rise and fall. The inner end of the tube G, and the under side of the disc H, are ground perfectly flat, so that when they are in close contact the upper orifice of the tube G is air-tight. The upper side of the disc, or the under end of the tube F, may be natched. It will be seen from this arrangement that the advantages mentioned in my letter will be realized. I am, Sir, your most obedient servant,

James King.

Laying at anchor off the Island of St Jago, one of the Cape De Verd's, 15*th Nov.* 1826.

To Dr Brewster.

Art. XI.—*Abstract of the Journal of the Proceedings of Lieutenant Wilcox, now engaged in a Survey of the North-east of Assam.* Communicated by a Correspondent in India.

Lieutenant Wilcox proceeded up the Tenga Panee, till, having passed the Mora, Tenga, Marbar, and Deesovee, he found the stream reduced in breadth to eight or ten yards, and the navigation stopped by numerous trees fallen in and across it. Like all the rivers east of Suddeeya, it abounds in rapids, and, from the great inclination of its bed, the banks, though low, are not liable to inundation. The whole tract through which it flows is said to be highly favourable to cultivation, and was in the time of the Deka Rajah thickly peopled. Particular names are still preserved to each bend and strong island.

Luttuo and Simieu are now the only villages immediately on the banks of the river, near its source in the hills in a direction south-east from Marbar, Mookh, and Luttoru, Undong and Lissoo, which were removed here from their former sites, after the Assamese captives were forcibly liberated last year. The cultivation is at present insufficient for support; and some of the Singfoh chiefs are even reduced to the necessity of guiding the plough with their own hands. A nearly impenetrable tree jungle extends without interruption. The soil is loam with pebbles. Near a low part of the Duedam Hills, washed by the river, is found a peculiar black clay, useful to potters.

During an excursion to the Meeseemee Hills, I received the information which has enabled me to trace a route to the "Lama" country. I remained three days confined by stormy weather at Thethong, a village of three or four houses, situated near the crest of a hill, which is climbed with great labour, and high enough to afford a view of seventy or eighty miles to the extremity of the vale across the great river. It was my purpose to visit the Taeen chief's village (the third on the route) to gather information, and to examine a hill producing fine garnets and large cubes of iron pyrites, but I was prevented from proceeding by the heavy rains. The Meeseemees sometimes reach Taeen Gong from Challa in one day, by a path passing the Brahma Kund, and skirting the rocks on the river's edge; but, when carrying a load, they are obliged to make the circuit; and for men of the plains this path is said to be too difficult.

Sitti, on the frontier of the Lama country, is but eight days' journey beyond Taeen, and one day on this side of the point of conflux of the Tulooka and Tulooding, the north and east branches forming the Burrumpooter.

Having crossed the river by a cane suspension-bridge at Taeen, the worst part of the road is passed, and thence cattle may travel by a circuitous path without difficulty. Bameyah, the seventh stage by the ordinary road, is on an immense hill, partly ascended with the aid of ropes.

Primhso, a Meeseemee Gam, was my chief informant. He has repeatedly made the journey, and even acquired a respectable knowledge of the Thibet language. From his description "Lama Des" is a remote hilly part of a fine plain country, spreading in the north from east to west, studded with stone built towns, and intersected with rivers, which have their courses towards other regions. He had travelled farther than his brother merchants, and had visited the towns here enumerated, * the list of which I procured for comparison with Du Halde's maps. The Taishoo, of less magnitude than the Burrampooter, is the largest river he had seen ; its course he knew nothing of. The Tulooka branch of the Burrampooter is the smaller, and its water is impure; it skirts the hills, which run off northward, and its banks are thinly peopled. The Talooding has villages on both banks, its source is in a snowy mountain, (the Khana Deba's country,) whence on the opposite side issues the Irrawaddy.

The Meeseemees purchase large copper vessels, pipes for smoking, straight swords, dyed woollens, beads, rock-salt, and chowr-tailed cows, for which they give musk, various skins, a bitter medicinal root, some ivory, &c. They formerly took slaves captured in Assam. The Jamees (Chinese) trade with the Lamas, carrying away grain on horses. On the smoking-pipes I have observed the Chinese character neatly engraved. The swords and beads are probably also manufactured by them. The houses of the Meeseemee villages which I visited are built longitudinally on the face of the hill, the rafters of the floor resting on the rock, and having their outer ends sup-

* Singoo,	Keewang,	Khra,	Dong,
Seme,	Wowkoo	Kumthong,	Mischa,
Timtsoam,	Mowgo,	Thaling,	Kingé,
Sapoeon,	Hulloo,	Tchillee,	Waloong,
Munchachooa,	Roee,	Reemah,	Praka,
Gri,	Utchasakoo,	Tungoo,	Gulle.
lhi,	Wouriresa,	Sumsee,	
Tailung,	Choutseejung,	Kooning,	

ported on posts, thus forming a spacious ground floor, which is given up to hogs and fowls.

The Meeseemees feed on Indian corn, and a small grain termed bubissia; they also cultivate in small quantities a fine white rice. They wear a thick coarse cloth of cotton, but have no idea of either shaping, or sewing together a garment; and all their better articles of clothing are from Thibet or from Assam.

They work rudely in iron and brass. They are excessively dirty, not being at all in the habit, I understood, of using water for ablution.

The men of rank (wealth) have stalled up for eating the chowr-tailed ox of Thibet, their own hill cattle Mithoous, hogs, and small cattle of Assam, procured in barter for copper. Young dogs are also esteemed. A continual round of feasting is kept up by the chiefs, each slaying a beast every ten or twelve days, and inviting his neighbours. They blacken, and hang in rows to ornament the interior of their houses, the skulls of those slain in battle; and on the death of the head of a family, these trophies of his last wealth are heaped upon his grave, and enclosed in with stakes.

A deep soil covered the hill, and the strata could not be observed. I found fragments of gneiss near the summit; and in the water-ways and nullahs, below a variety of standstones, quartz, rock, and a porphyry, having felspar imbedded. The hills are clothed with noble forest trees and some brushwood.

It is said that the fir is found in plenty on the Deebong, also on the Langtan range. I have not met with it.

The south-eastern portion of the Langtan snowy mountains is occasionally visible from Suddeeya; and I have taken bearings on some of the peaks, but their immense distance and their direction preclude the possibility of ascertaining their exact position by means of any base hitherto measured. After the south-easterly bend, in which the range nearly reaches the Irrawaddy, it turns again to the south, and is the Koongmoongboom of the Singfohs, running parallel with that river nearly to Rhanmoh.

Bor Khamtee is a province of Moonkong, (Magnon,) and, while governed by a native Rajah, pays tribute to the Burhman Phokun at that place. It is accessible from the south by the banks of the Irrawaddy, but the river cannot be navigated so high. A range of snowy mountains divides it on the north from the Lamas; on the east from part of China. The Khunoong Meeseemees, inhabitants of the range, trade with both countries. They find large quantities of silver in the north-east, and iron in the south-east parts of their mountains.

The Khunoongs manufacture the ("Khamtee") das, held here in high estimation.

Some very remarkable sculpture is spoken of as existing on the banks of the Irrawaddy, partly immersed in the water. It consists of a cow and calf, and a canoe, too-well executed to be attributed even to the Chinese, who are considered great artists.

Tradition says the Khamtees, as well as the ancient conquerors of Assam, are from that part of Sham, situated east, or south-east of Moguon.

I have little information to throw light on the nature of the country north-east beyond the snowy ranges, but conjecture that the distance to the Lama country is rather less in that direction than by the route of the Burumpooter. I understand that Meeseemees, situated on the heads of the Deebong, traffic with that country, as well as other tribes of their numerous and scattered race on the left bank of the Deehong.

With regard to the source of this great branch of the Lohit, I have lately received information from the Bor Abors, confidently given, that it is from the west, and that a lake through, or from which it issues gives rise to the Soobunsheeree also. It is nevertheless asserted, that, in the north-westerly route to the Lama country, the Deehong is crossed from east to west at the twelfth stage and left.

I have received also from the Abors a singular account of an immense river running from east to west, and having no connection with the Deebong. It is luckily distant but five days' journey from their first villages; and therefore, if I am successful in negotiating with them, the foundation of this story may be traced; but it appears to me a doubtful version of a vague tale current amongst the Assamese, which is frequently told with many circumstances of wonder and exaggeration, of a broad river rolling with an impetuous course beyond the mountains north of the whole Abor and Meeseemee countries, and named the Sree Lohit; but my Meeseemee informants and the Laory Gohoyn, a Khamtee of extensive acquaintance with their chiefs and knowledge of their traditions, have not pretended that any such river exists. The Sree Lohit is only *known* in Assam as a river crossed by the descendants of Koonling and Koonlace in their progress to assume the sovereignty of Assam, near the Moongree Moongram Hills, which are always placed in the direction of, or rather beyond Mageron. It is probably the Irrawaddy.

We cannot refuse credit to the assertion of both Khamtees and Meeseemees, that the Irrawaddy rises in the neighbourhood of the heads of the Burrumpooter.

I am not aware whether it is the opinion of the Pundits of Hindoostan, that the Burrumpooter has its rise in the Lake Munsorowar, but having had the Shastra Trita Koomoodee examined, I find it therein stated, that the Dikurubakhinee, or copper temple east of Suddeeya, is on its north bank.

On the 29th March, I took with great care a section of the Burrumpooter opposite the station of Suddeeya, which gave the discharge 33,900 feet per second. On the following day I took with equal care a section of the great river below the junction, considering that accuracy would be more easily attainable in a convenient spot here, than by attempting to measure the several rapid streams of the Deebong. The result was a discharge of 120,200 feet per second, deducting the value of the Burrumpooter, and 12,000 feet assumed as the outside discharge of the Deebong, we have 74,300 per second for the discharge of the large branch. The river had risen at the time a few feet above the level of the cold season.

Art. XII.—*Notice of the Barometrical Measurements of Vesuvius, and the New Cone which was formed in the Eruption of February* 1822, *taken by the* Right Hon. the Earl of Minto.

The recent changes which have taken place in the form and altitude of Mount Vesuvius, and the importance which is now attached by the philosophical geologist to the study of the volcanic phenomena, give a peculiar value to accurate determinations of the height of this interesting mountain.

The formation of a new cone no less than 200 feet high in the eruption of February 1822 is a most remarkable fact in the natural history of this mountain; and as it was entirely carried away by the eruption in October of the same year, * it is fortunate for science that the particulars respecting its position and its altitude have been so well ascertained.

Under these circumstances, our readers cannot fail to partake in our gratification in perusing the following account of the barometrical observations made by the Earl of Minto, which he has, at our request, permitted us to use.

Barometrical Measurement of Vesuvius, 17*th March* 1822.

H. M.	Station.	B.	A.	D.
A. M.		Inch.		
10 30	Naples, in my room, 21 feet above the sea, - -	30.554	16°.6	14°.5
P. M.				
1 30	Hermitage of St Salvadore on Vesuvius, - -	28.436	13 .5	11 .5
4 20	4½ feet below the old Palo summit of Vesuvius, -	26.405	9 .1	8 .
5 35	Hermitage of St Salvadore on Vesuvius, -	28.435	11 .6	11 .4
6	Hermitage of St Salvadore on Vesuvius, -	28.433	11 .	10 .5
9 15	Naples, in my room, 21 feet above the sea, - -	30.524	16 .5	12 .1

The above observations were made with an excellent barometer of old Cary's. On the same day I measured the new cone formed by the eruption of February 1822. But on account of the intense heat and acid exhalations from the crater, I could not venture to employ the same instrument, and was obliged to use an Englefield barometer, made by Gourdon of

* This eruption blew the whole summit of the mountain into the air, and replaced the convex plane which formed that summit, by a vast chasm or crater, nearly a mile in diameter, and 800 feet deep. See p. 14.

Geneva, which gave the following observations. Its division is also in English inches and decimals.

P. M.		B. Inch.	A.	D.
3 30	Edge of the crater from whence the lava flowed in the eruption 1822,	26.424	16°.2	8°.5
	Summit of the new cone formed by that eruption, - -	26.290	19. 5	8. 5
4	Four feet below the old Palo summit,	26.476	17.	8.
4 10	Four feet below the old Palo summit,	26.440	9.	8.

N. B. This barometer of Gourdon's requires that a correction of $\frac{1}{53}$ should be added to the differences, or to the results calculated, the capacity of the tube being to that of the cistern as 1 to 53.

B = barometer in English inches and decimals.

A = temperature of mercury, centigrade.

D = temperature of air, centigrade.

Daniel's hygrometer observed at Naples at 10 h. 30 m. A. M. gave temperature of air = 58° Fahrenheit. Dew-point = 38° Fahrenheit.

17th March 1822 *continued.*

Adie's Sympiezometer observed at Naples.

h. m.	h. m.	h. m.	h. m.	h. m.
At 10 0 A. M.	11 20 A. M.	1 20 P. M.	6 5 P. M.	10 0 P. M.
30.73	30.70	30.66	30.68	30.66.

17th March.

Temperature of the air at Naples at 1 h. 20 m. P. M. = 17°.7 centigrade.

13th April 1822.

Hour. h. m. A. M.		B. Inch.	A.	D.
7 25	Naples, at my house, twenty-one feet above the sea, -	30.200	17°.7	
8 30	Naples, do. do.	30.202	18 .8	17°.
10 40	Portici, three feet above the sea,	30.246	24 .5	17 .8
10 50	Portici, do. do.	30.238	21 .6	17 .8
P. M.				
12 45	Hermitage of St Salvadore on Vesuvius, -	28 173	18 6	17 .3

P. M.		B. Inch.	A.	D.
2 40	Three feet below the old Palo summit of Vesuvius, -	26.198	16°.8	13°.3
3 15	Do. do. do.	26.190	16 .8*	13 .
3 35	Do. do. do.	26.187	15 .8	12 .8
4 45	Do. do. do.	26.175	13 .	11 .5
5 55	Hermitage of St Salvadore on Vesuvius, - -	28.153	17 .	16 .2
9 30	Naples, at my house, twenty-one feet above the sea, -	30.192	18 .8	16 .5
10 30	Naples, do. do.	30.191	18 .5	16 .
11 45	Naples, do. do.	30.193	18 .	

Daniel's hygrometer observed at Naples at 8 h. 30 m. A. M. gave temperature of air = 62.8. Dew-point = 50.

Sympiezometer and Thermometer observed at Naples.

	h. m.	h m.	h. m.	h. m.	h. m.	h. m.
Hour, -	7 0 A. M.	8 30	9 25	11 0	6 5 P. M.	10 30
Sympiezometer,	30.34	30.36	30.38	30.36	30.34	30.35
Thermometer,		62.8	64.	68.	68.	61.

When I was formerly at Naples in 1817, what I call the *Old Palo Summit* was the most elevated part of the great cone of Vesuvius, upon which a post had been erected, from whence it derived its name of Palo. Upon my return in 1822, I found this summit unchanged, and the pile of stones in which the post had been planted remained as I had seen it in 1817. But it was no longer the highest part of the mountain, the late eruptions having raised a cone of greater height by its side. As the Palo, however, appeared less liable to change than any other part of the summit of the great cone, and also because the soil there was cool, and the situation convenient, I selected it for my upper station, thinking, that, if the elevation of the Palo summit above the sea was accurately known, we should have obtained a fixed point, to which the frequent changes in its neighbourhood could easily be referred.

The summit of *the new cone*, the height of which above

* The temperature of the mercury is uncertain in this observation.

the Palo I measured on the 17th March, was a very narrow ridge, scarcely affording us sufficient footing to stand upon, being all that remained of a small cone thrown up by the eruption of February 1822, immediately over the crater from which the lava issued on that occasion; for in that eruption the lava did not burst through the side, but overflowed from the crater itself.

The following are the heights as estimated by me:—

	Feet.
The Hermitage of St Salvadore above the sea, -	1963
Palo summit of Vesuvius above the Hermitage, -	2000
Palo summit of Vesuvius above the sea, - -	3963
N.B.—This was the height of Vesuvius above the sea in 1817.	
Edge of the crater from whence the lava flowed in February 1822, above the Palo summit, - -	45
Summit of *the New Cone*, or ridge, above the edge of the crater, - - - - -	157
Highest point of Vesuvius in March and April 1822, above the sea, - - - -	4.165

The mountain had therefore added 202 feet to its height since I had seen it in 1817. But, as a great part of the ridge which I have called the New Cone was composed of loose materials, I have no doubt that it must have crumbled down considerably since I measured it in 1822.

In 1817 I also made two barometrical measurements of Vesuvius in company with the late Mr Playfair and his nephew; but as our observations were only made in ascending, and from various accidents could not be repeated in our descent, I have not referred to them, although they agree within a few feet with these observations of 1822, which were made under much more favourable circumstances, and with every attention to insure their accuracy.

MINTO, *6th April* 1827.

Art. XIII.—*Account of the Habits of the Sea Elephant.** By M. Peron.

King's Island abounds with sea elephants, *(Phoca proboscidea,)* particularly a bay where the vessel *Le Geographe* cast anchor, and which is called the *Bay of Elephants.* This gigantic animal is from twenty to twenty-five, and even thirty feet in length, and fifteen and eighteen feet in circumference. The male is distinguished by a prolongation of the nostril, which is pendulous and flat when in a state of repose; but when the animal is irritated, it assumes a tubular form when it wishes to attack or to defend. The length of this organ is about one foot. These animals are known only in the southern hemisphere, where they inhabit a zone of 20° from 35° to 55° of latitude. Equally averse to heat and to cold in summer and winter, they emigrate to those countries where the temperature suits them. They move in large herds, and frequent particular seas in preference to others of the same latitude and temperature; and there are many extensive shores where they are perfectly unknown. In the middle of June they leave the south, and swim to the north. It is then that they resort to King's Island. "About a month after their arrival the females begin to bring forth their young. Assembled altogether upon a particular point of the sea-shore, they are surrounded by the males, who do not allow them to return again to the sea, nor do the males themselves return to it not only when the females are delivered of their young, but even during the whole period of the suckling. Whenever the mothers attempt to leave their young ones, the males bite them, and force them back. The time of their delivery does not last more than five or six minutes, during which the females appear to suffer a great deal, and at certain times they cry in the most dismal manner. During this painful operation the males, extended all round them, look on with perfect indifference."

The suckling, which lasts seven or eight weeks, is a period

* From an Analysis of Freycinet's "*Voyage de Decouverte aux terres Australes,* from 1800—1804," in the *Revue Enyclopedique* for January 1827, a periodical work of great merit, which cannot be too strongly recommended.

of fasting both for father and mother. The growth of the nursling is very rapid, and is promoted entirely at the expence of the mother, who visibly grows leaner. "They have even been seen to die, but it is difficult to say whether they had sunk from exhaustion, or some particular illness had caused their deaths." When the young ones appear strong enough they lead them to the sea. The herd swim in regular order, and if any little one lingers behind, it is immediately seized and bit, and brought back to its family. This exercise continues for three weeks, during which time the males and the females recruit their strength which had been exhausted by their long abstinence; the little ones grow accustomed to the food which is to support them all their lives, and the whole family return to the shore.

Then the bloody battles begin between the males disputing for the possession of the females. All their friendships are broken, until the conquerors have made their choice, and left to their rivals the females they have rejected. These ferocious amours of the sea elephant do not indicate a high degree of instinct, although, in their ordinary state, these animals are of social habits, and live together in large herds, watch in turn for the common safety, and appear even to be capable of a sort of education. The cry of the female and of the young male is something like the bellowing of a vigorous ox, but in the full grown males the tubular prolongation of the nostril produces such a modulation of the voice, that the cry of the latter has a great resemblance to the noise which a man makes when he is gargling. This hoarse and singular cry is heard at a great distance; it has something wild and singular in it, and frequently, when in the middle of the tempestuous nights we were awakened out of our sleep by the confused howlings of great numbers of these colossal animals which covered the shore in the neighbourhood of our tents, we could scarcely help feeling a sensation of fear, which nothing but the certainty of the real weakness of the animal could dispel.

Although these animals herd together, they have in no instance been seen to defend one another; probably this arises from the slowness of their motions, which renders each individual incapable of resisting an enemy active and provided with means of defence. The whole species are extremely gentle; but the females are particularly remarkable for this quality. They oppose nothing but their tears to the attack of the hunters, and to the brutality of the males.

The English fishermen calculate that the sea elephants live about thirty years. They find every year great numbers dead from old age or disease. The storms frequently dash them against the rocks. Our naturalists were witness to a wreck of this sort one night, when Le Geographe lost her anchors and her sloop, and encountered the greatest perils.

Other dangers attend them at the bottom of the sea. Upon some occasions the fishermen report they have seen them unexpectedly come from the bosom of the deep, apparently much frightened, and many of them covered with enormous wounds. They lose a great quantity of blood, and their terror and their wounds prove evidently that they have been chased by one, or several most formidable enemies. What can these terrible adversaries be? The fishermen unanimously agree that no known animal could inflict wounds so large and so deep. They can only suppose that these monsters live far from the shore, and dwell in the depths of the sea, as they have never been able to discover the smallest trace of them.

They add, that they have no doubt it is to preserve their young from these enemies that the trumpet-seal hinders them with so much anxiety from going far from the shore, or to dive too deep, as we have often observed.

ART. XIV.—*Magnetical Observations on the Variation and Dip of the Needle, made during the Voyage of the Coquille from Toulon to Port Jackson, in* 1822, 3, *and* 4. By M. DUPERREY, Commander of the Expedition. Communicated by SIR THOMAS MAKDOUGALL BRISBANE, K. C. B. F. R. S. London and Edinburgh. (Concluded from No. xii. p. 257.)

THE following observations on the variation and dip of the needle were made in the voyage from Bayta to Tahiti, one of the Society's Isles, from the 24th March to the 21st April 1823.

Lat.			Long.			Variation.			Dip.	
6°	18′	0′ S.	83°	25′	45″ W.	10°	48′	30″ N.E.	— 0°	51′.3
7	29	54	84	52	21	10	47	42	— 3	50.7
18	8	52	47	39	45	8	10	0	— 27	36.3
17	36	12	102	8	40	7	6	12	— 27	14
17	16	29	105	57	45	6	15	42	— 27	46.9
16	51	0	113	23	54	5	23	0	— 27	29.8
16	51	0	122	59	45	5	38	0	— 27	35.8
16	52	22	129	37	45	5	50	0	— 27	42.7
18	38	41	135	25	15	4	51	42	— 30	12.5

At Matavai, in the north of the Isle of Tahiti, in May 1823, and in lat. 17° 29′ 35″ S. and lat. 149° 30′ 15″ W. the variation was 6° 40′ 24″ N.E. and the dip —30° 1′,8.

At Bozabora, to which the expedition went from Tahiti, the latitude of the observatory was 16° 30′ 2″ S., the long. 151° 47′ 24″ W. and the variation 6° 21′ 22″ N.E.

In the voyage from Bozabora to Port Praslin, in New Ireland, the following observations were taken.

Lat.			Long.			Variation.			Dip.	
19°	18′	0″ S.	170°	21′	45″ W.	10°	19′	0″ N.E.	— 37°	18′.2
22	35	39	176	55	15	8	24	30	— 40	57.5
20	42	0	168	9	45 E.	8	47	0	— 40	45.2
12	3	0	162	50	45	10	21	0	— 24	29.7
10	22	0	159	54	45	7	12	0	— 25	34.4
7	50	0	154	34	45	7	38	54	— 21	55.9
5	16	40	151	8	45	6	36	24	— 20	8.2

At Port Praslin in August 1823, the definitive variation was 6° 48′ 27″ N.E. and the mean dip of all the needles—20° 41′.7. The longitude of the observatory was 147° 8′ 15″ W. and its lat. 4° 50′ 37″.8 S.

The following observations were made in the passage from Port Praslin to Offak.

Lat.			Long.			Variation.			Dip.	
3°	27′	40″ S.	146°	13′	26″ E.	5°	0′	0″ N. E	— 17°	28′.1
3	5	0	146	26	35	5	12	0	— 17	57.1
1	37	16	135	35	19	2	10	0	— 16	16.6
0	18	0	133	49	45	2	0	0	— 12	41.5
0	4	36 N.	131	26	45	1	0	0	— 12	21.1
0	2	30	128	51	45	2	50	0	— 13	50.4

At Offak, on the north coast of Waigiou, in long. 126° 0′ 50″ E. and lat. 0° 1′ 59″ S. the definitive variation was 1° 1′ 44″, and the mean dip — 13° 41′.6 in September 1823.

At Cayeli, on Bouzu, one of the Molucca Isles, in long. 122° 21′ 41″ E. and lat. 3° 21′ 8″ S. the variation was 0° 31′ 48″ N. E. and the dip — 20° 8′ 4″.

At Amboyna, one of the Molucca Isles, in October 1823, and in long. 123° 25′ 43″ E. and lat. 3° 41′ 41″ S. the variation was 0° 28′ 3″ N. E. and the mean dip — 20° 32′.3.

During the passage from Amboyna to Port Jackson, the following observations were taken.

Lat.	Long.	Variation.	Dip.
13° 30′ 53″ S.	108° 23′ 35″ E.	10° 0′ N. E.	— 37° 53′.3
24 34 29	91 18 18	10	— 52 58
46 8 0	136 54 45	10 0	— 73 8.2
43 44 0	146 39 45	10 0	— 70 25.7

At Fort Macquarie, in Sydney, New South Wales, in lat. 33° 51′ 41″, the variation was 8° 55′ 57″ N. E., and the mean inclination — 62° 17′.4. The variation obtained by Sir Thomas Brisbane's needle was 9° 8′ 8″ N. E. and the mean of the two 9° 2′ 2″.5.

M. Duperrey made the following observations on the magnetic intensity with a needle five decimetres long.

In September 1823, at Offak, on the north side of Waigiou, under the equator, the needle performed ten oscillations in 139″.52 of time.

At Port Jackson in January 1824, ten oscillations were performed in 165″.443.

The same needle observed in March 1823, at Bayta, on the coast of Peru; and at a small distance from the equator, gave the same results as at Offak.

Art. XV.—*On the Remarkable Comet which revolves within the Orbit of Jupiter.* * By M. Damoiseau.

On the evening of the 27th February 1826, M. Biela, residing at Josephstadt in Bohemia, observed in Aries a small

* M. Damoiseau's Memoir was read before the Academy of Sciences on the 9th April 1827. The above abstract is from *Le Globe,* Avril 14, 1827.

round nebulosity, whose position he fixed by estimation. On the day following he was convinced that he had discovered a comet whose nucleus had advanced since the night before a degree to the east, and appeared to have increased in lustre and magnitude. He compared the comet with the star, No. 28 of Bode's *Catalogue*, to determine its position. He observed it also on the 3d and the 12th March.

M. Gambard discovered this comet at Marseilles on the 9th March, and continued to observe it on the following days. The news of this discovery having spread, the comet was observed on the 10th March at Gottingen by M. Harding, at Altona by M. Clausen, and successively in all the observatories of Europe, and in the beginning of May it disappeared. By calculating the first observations on the hypothesis of a parabolic orbit, it was evident that the elements of the new comet had a great resemblance to those of 1772 and 1806. The hypothesis, however, of this being the same comet, deviated greatly from observation, as it might have been expected to do; but MM. Clausen and Gambard, after some trials, have found, without any communication, an ellipse which represents the observation with such accuracy as to leave no doubt of the perfect identity of the three comets.

M. Damoiseau first gives the ellipse of M. Clausen computed from M. Biela's observations of the 28th February, M. Harding's observations of the 14th March, and M. Clausen's of the 28th March. He next gives two ellipses calculated by M. Gambard, the one for 1826, and the other for 1806.

He then shows that the difference of some days which exists between the observations and the calculations is explained by the changes upon the motion of the comet by the action of Jupiter, who passed very near it in 1782 and 1799.

This identity being admitted, it is necessary, previous to announcing the next return of the comet, to take into account the perturbations due to the action of the planet in the interval between its passage of the perihelion from 1806 to 1826, and in the interval between its last passage and that of 1832, a year which will be remarkable by the reappearance of two comets with elliptical orbits and short periods, viz. that of Encke and that of Biela.

After making the investigations alluded to, M. Damoiseau finds, that, by supposing the comet to have passed its perihelion in 1826 on March 18th. 9688, its return to its next perihelion will take place in 1832 on November 27. 4808, being a period of *five years* and 112½ days.

Setting out, then, from the elements of 1826, he has computed, by the aid of the variations with which the calculus has furnished him for the actual revolution, the following elements:

	D.
Passage of perihelion 1832,	Nov. 27. 4808
Mean time of Paris, reckoned from midnight,	
Longitude of the perihelion, -	109°56′ 45″
Longitude of the ascending node, -	248 12 24
Inclination, - -	13 13 13
Eccentricity, - -	0.751748
Half the greater axis, - -	3.53683

In order to assist astronomers in finding this remarkable body at its return in 1832, M. Damoiseau has computed the following ephemeris.

Mean Time Paris from Midnight. D.	Right Ascension.	Declination North.	Distance of Comet from Earth.	Distance of Comet from Sun.
1832, Aug. 4. 648	35° 46′	28° 44′	1.533	1.828
21. 260	46 50	32 28	1.235	1.657
Sept. 5. 308	60 0	35 25	0.990	1.500
18. 934	76 2	36 49	0.798	1.359
Oct. 1. 291	95 0	35 26	0.659	1.234
12. 542	109 12	30 54	0.573	1.127
22. 858	110 50	25 51	0.537	1.038
Nov. 1. 416	112 1	20 37	0.546	0.969
10. 403	114 26	15 58	0.586	0.918
19. 006	118 29	12 4	0.645	0.888
27. 415	124 2	8 44	0.715	0.878

ART. XVI.—*Account of the Discovery of an almost entire Skeleton of the Fossil Mastodon.** By JEREMIAH VAN RENSSELAER, M. D. of New York.

WE were induced to search for these remains, from having seen lately exhibited at the Lyceum of Natural History, a tooth, which proved upon examination, to belong to this interesting genus, and which was said to have been found near Long Branch.

About three miles west of that watering place, is situated the farm of Poplar, occupied by William Croxson, Esq. and who, nearly six years ago, began to reclaim a marsh about a quarter of a mile from the house. This marsh was usually covered by about two feet of water, which was much increased, however, in wet seasons. The water was easily drained off, when the moisture having evaporated, and the earthy particles consolidated, the surface sunk very gradually between two and three feet below its former level, except in those places where extensive beds of bog-iron-ore had been formed. These afforded an opportunity of judging pretty accurately of the subsidence of the present surface.

Last year, in crossing this field formed by the reclaimed marsh, the attention of the proprietor was attracted by something sticking out of the ground, which proved to be a tooth. He then searched a little, and found part of the head of a large animal partially exposed, being covered by grass only. With the assistance of a spade he found other bones, which he took up and had removed to his house.

Visiting New York this spring, he brought with him the tooth, which led us to inquire for the remaining portions of the skeleton.

Mr Croxson had the kindness to conduct us to the spot, where we soon found sufficient inducement to dig, and in a short time our hopes were fully realized, and our most sanguine expectations surpassed. In the course of that and the

* From Dr Silliman's *Journal*, vol. xi. No. ii. p. 245. For a full account of the history of this fossil animal, see the *Edinburgh Encyclopædia*, Art. ORGANIC REMAINS, vol. xv. p. 721.

following day, we recovered all the bones of the skeleton that Mr C. had left, with the exception of two or three unimportant bones of a foot—unimportant, because we have the corresponding bones of the other foot. We now possess very nearly a perfect skeleton from this locality, viz.—

The head much injured, and without tusks, but with two teeth.

Twenty-two vertebræ, more or less perfect, commencing with the atlas, and terminating with the os sacrum.

Eleven ribs nearly perfect, and many imperfect.

Two claviculæ.

Two scapulæ.

Half of the pelvis perfect.

The bones of the extremities, with the exception of three small bones of the right foot, viz.—

Of the fore extremities.	*Of the hind extremities.*
Two ossa humeri.	Two ossa femoris.
Two radii.	Two patellæ.
Two ulnæ.	Two tibiæ.
Sixteen carpal, and	Two fibulæ.
Ten metacarpal bones.	Fourteen tarsal, and
Twenty-eight phalanges.	Ten metatarsal bones.
	Four sessamoidea.

Recapitulation.

Of the trunk.		
Vertebræ, - -	22	
Ribs, - -	11	
Pelvis, - -		
		—35
Of the fore extremities,		64
Of the hind,		59
		158

Part of the head and two teeth.

It is to be observed that our skeleton was found much nearer to the ocean than any yet discovered, and is perhaps to be considered as one of the most perfect that we possess of that immense animal. The bones near the surface of the field, and within the influence of frost, have all suffered more or less; but as we proceeded down, they became more sound, and the bones of the legs and feet are perfectly solid, and in excellent preservation. Many of them had small quantities of the phosphates of iron, and of lime, and small crystals of sulphate of lime adhering to them.

Its position, corresponding with that of the skeleton found on the Wabash, was vertical, the feet resting on a stratum of sand and gravel, (mostly rolled quartz,) and the head to the west-south-west. There is every reason for supposing that the animal was mired in that situation, but at what period we have no data even to conjecture. But we have authority for believing that the mastodon was one of the last animals that has become extinct. Zoologists, particularly zoological geologists, consider the doctrine as established, that the successive generations of organized beings that have dwelt upon the exterior of our globe differ from the present generations, in proportion as their remains are more or less distant from the present surface; or, in other words, as the time in which they existed is remote from the present day. Now, according to this, the mastodon differs but little from some one of the living generations, (which we know to be the case,) and the deduction is fair, that if the living animal be not found, of which there seems now very little probability, its race has not long since perished, comparatively speaking. This conclusion is confirmed in my own mind by our researches after these very interesting remains.

Immediately under the surface, we found bog-iron-ore loosely disseminated; in other places in the field it existed in abundance. A soft, black, damp earth, containing vegetable fibres, (what the Germans call *geest*,) continued down four feet from the surface. Beneath this we found a yellowish clay, tinged perhaps from animal decomposition. Below, thin and alternate layers of sand and black earth continued, until we met a small stratum of rolled quartz pebbles covering sand, on which rested the feet of the animal, about eight and a half feet below the surface. These layers resemble those occurring frequently in Europe, and compose the greater part of our sea-coast, from Long Island to the Mississippi. They form part of the newer or tertiary formations, and are evidences of the last geological changes that the surface of our globe has experienced, always excepting volcanic and alluvial still in daily operation.

Of the genus mastodon there are two distinct species, viz. the *M. giganteum*, and the *M. angustidens*, distinguished, as the names imply, by the size and by the configuration of the teeth. Our animal belongs to the former species, of which portions of many individuals have been found on our continent, and a few comparatively in Europe. The beauty and value of these organic remains induced us to present them to the Lyceum of Natural History of New York; and we have the satisfaction of knowing that they constitute an important addition to the fine collection of fossils in the cabinet of that valuable institution.

ART. XVII.—*Observations on the Minimum and Maximum of the Barometer, made during a period of twenty-nine years at Malmanger, and Ullensvang in Norway.* By PROVOST HERTZBERG of Ullensvang. *

THE following series of valuable observations of the minimum and maximum of the barometer were taken by Mr Hertzberg, Provost of Hardanger, and Pastor of Kingsverig, in Norway, in the diocese of Bergen. They include a period of twenty-nine years, from 1798 to 1827. From 1798 to 1807, the observations were made at Malmanger, in the diocese of Bergen, in lat. 60° north, and at the height of 66 Rhinland feet above the level of the sea. From 1807 to 1827, the observations were made at Ullensvang, in the same diocese, in the latitude of 60° 19′, and at the height of 32 Rhinland feet above the level of the sea. The height of the barometer, which is given in French feet, is reduced to the temperature of 0° of Reaumur's scale. The temperature in Reaumur's scale is added, and also the state of the weather.

* This excellent observer has also communicated to us a valuable set of hourly observations made at Ullensvang on the 15th January 1827.—ED.

Year.	Barom. Minim.	Therm.	Weather.
1798, Nov. 27.	26 8 4	+12° 5	Rain and storm from S. W.
1799, Apr. 11.	27 1 7	+10	Do. and calm.
1800, Nov. 26.	26 8	+ 4	Do. and storm from S. E.
1801, Jan. 5.	26 7 3	+ 5	Do. and storm from S.W.
1802, Dec. 10.	26 8	+ 5	Shower, and strong S. W. wind.
1803, Feb. 15.	26 6	— 2	Snow 10 inches. Storm from SE.
1804, Mar. 31.	27 3	+ 4	Rains. Strong wind from E.
1805, Dec. 21.	26 6	+ 2	Rain, but calm.
1806, Dec. 25.	26 3 8	+ 4	Rain, great storm.
1807, Nov. 21.	26 10 8	+ 0 .4	Snowy, and calm.
1808, Jan. 28.	26 8 4	+ 1 .5	Cloudy. Slight wind from S.
1809, Dec. 10.	26 8 9	+ 7	Rain. Wind strong from S. Snow 19 inches.
1810, Feb. 25.	26 7 8	+ 1 .5	Calm.
1811, Jan. 17.	26 10	+ 3 .5	Rainy, snow, and violent N wind.
1812, Oct 20.	26 8 5	+ 7 .5	Storm from East.
1813, Nov. 15.	26 8 9	+ 5 .2	Storm from S. E.
1814, Dec. 18.	26 7 8	+ 1	Rain. Storm from S. W.
1815, Nov. 14.	26 7 3	+ 3	Calm.
1816, Dec. 29.	26 10	+ 2	Rain. Snow. Calm.
1817, Feb. 15.	26 9 2	+ 1 .5	Snow. Calm.
1818, Mar. 8.	26 6	+ 3 .4	Calm. Cloudy.
1819, Jan. 17.	26 10 8	+ 4 .2	Rain. Storm from S.
1820, Mar. 1.	26 11	— 1 .4	Slight snow. Calm.
1821, Dec. 23.	26 6	+ 3 .2	Rain. Storm from S. E.
1822, Feb. 3.	26 3 8	+ 2	Rain. Snow. Storm from N. W.
1823, Mar. 7.	26 6 5	+ 2	Breeze from East.
1824, Dec. 25.	26 4 8	+ 4 .2	Snow 10 inches. Storm from S.
1825, Nov. 6.	26 3 6	+ 2	Rain. Snow. Storm from S.
1826, Feb. 7.	27 2 6	+ 3 .5	Rain. High wind from W.
Mean,	26 8 2	+ 3°.4	

Year.	Barom. Max.	Therm.	Weather.
1798, Dec. 29.	29 1	— 8°	Clear and calm.
1799, Jan. 1.	28 9 2	— 3 .5	Id.
1800, Dec. 15.	28 6	— 0 .2	Id.
1801, Mar. 30.	28 7 2	+ 1	Id. with N. wind.
1802, May 22.	28 8 1	+ 9	Clear and calm.
1803, Mar. 8.	28 8 7	— 3	Id.
1804, Dec. 18.	28 9	— 3	Id.
1805, Nov. 11.	28 8 6	+ 3	Cloudy, and calm.
1806, Feb. 24.	28 9 8	+ 4	Storm from S.W. Rain, and loud thunder.
1807, Mar. 23.	28 11 3	+ 0 .2	Clear and calm.
1808, Mar. 26.	28 10 6	— 1	Clear, breeze from E.
1809, Apr. 24.	28 8 6	+ 5 .5	Clear and calm.
1810, Jan. 14.	28 8 9	— 8 .5	Clear, and storm from East.
1811, Mar. 14.	28 8 3	+ 1 .5	Clear and calm.
1812, Dec. 6.	28 9	— 7	Id.
1813, Mar. 12.	28 9	— 4	Id.
1814, Mar. 16.	28 8	+ 1 .5	Id.
1815, Jan. 19.	28 9 7	— 3	Clear, but high wind from N.E.
1816, Dec. 20.	28 7 6	— 2 .5	Clear and calm.
1817, April 6.	28 9 1	+ 5 .5	Id.

Year.	Barom. Max.	Therm.	Weather.
1818, Dec. 28.	28 8	+ 0 .2	Slight snow breeze from N.
1819, Dec. 7.	29 3	— 1 .3	Clear and calm.
1820, Jan. 8.	29 1 3	—10	Id.
1821, Jan. 23.	28 9 7	+ 3 .2	Id.
1822, Dec. 12.	28 9	+ 3 .2	Id.
1823, Jan. 5.	28 9 3	— 2 .6	Storm from N. E.
1824, April 5.	28 8 4	+ 4 .8	Clear and calm.
1825, Mar. 17.	28 9 5	— 1 .6	Id.
1826, Mar. 12.	28 10	+ 4 .2	Id.
Mean,	28 9 28	—0°,72	

Art. XVIII.—*Account of the death of Mr Drake by the bite of a Rattlesnake.*

At the meeting of the Academy of Sciences of France on the 9th April last, some documents were presented by M. Dumeril, connected with the death of Mr Drake by the bite of a rattlesnake, forming part of a collection of reptiles which that person had exhibited at London, and had taken to France for the same purpose. These documents were transmitted to the Academy by the Minister of the Interior; and seem to have excited fears in some of the members, lest, the climate of France being favourable, some of these dangerous reptiles might escape and propagate.

From these documents it appears, that Mr Drake arrived at an inn in Rouen on the 8th February with three live rattlesnakes and some young crocodiles, and that, notwithstanding his care to preserve them from cold on the road, he saw with grief on his arrival that the finest of the three was dead. The dead animal was removed from the cage, and the cage itself, with the other two, were taken into the dining-room, and placed near the stove. Here Mr Drake endeavoured to rouse them with a stick; but, perceiving that one of the two gave no signs of animation, he opened the cage, took the serpent by the head and tail, and approaching a window to ascertain by handling if life was extinct, the animal turned its head half round, and fixed one of its fangs in the posterior external part of the left hand. Mr Drake shrieked, pronounced some words in English, according to the reports, and was replacing the serpent in the cage, when it again bit him on the palm of the same hand. Mr Drake now run out into the court calling eagerly for a surgeon; and, not finding water readily, rubbed his hand upon the ice, which he found at the door. Two minutes after, having procured a cord, he himself made a ligature on the arm above the hand. Notwithstanding of these precautions, his agitation from the fear of the consequences continued to increase till the arrival of Dr Pihorel. The presence of this gentleman somewhat composed the feelings of Mr Drake; and he saw with eager joy the chafing-dish and irons arrive, with which the wounds were to be cauterized. This operation was instantly performed, and the patient took internally half a glassful of olive oil. Drake seemed now to have resumed his tranquillity. But in a few minutes more symptoms made their appearance which rendered the case hopeless, and he died in $8\frac{3}{4}$ hours after the bites.

The body was afterwards opened. The internal organs appeared healthy; the brain and spinal chord were unaltered. The membrane which covered these parts, however, was observed to have a reddish tinge. The veins presented no trace of inflammation: and the only appearance of derangement in the system consisted in the veins of the affected side having the blood curdled or clotted.

The physicians of Rouen, where the accident happened, and who examined the body, recommended that, in future, exhibitors of dangerous serpents should be obliged to extract the poison fangs, and be constantly provided with cupping-glasses and instruments for cauterization; and the commission of the Academy coincide in that opinion. But it was remarked, that the successive growth of these teeth would require them to be removed every two or three months, or as soon as they were reproduced. The commission recommended suction of the wound as one of the most efficacious measures for the extraction of poison; and state that this, even when done by the mouth, is attended with no danger to the operator, provided the mouth which sucks be sound. The ligature of a place above the wound, imperfectly done in Mr Drake's case, was strongly recommended by Dr Magendie.

The melancholy termination of this case induced many of the members of the Academy to propose the absolute interdiction of the exhibition of poisonous animals for the gratification of public curiosity. M. Geoffroy, to demonstrate the virulence of the poison of the rattlesnake, mentioned that the body of the reptile which had bitten Mr Drake had been sent to the Museum of Natural History; and that, eight days after its dissection, one of the assistants having punctured his hand with the scalpel employed in this operation, the slight wound was followed by nearly serious consequences. The hand swelled, and severe pain in the axilla supervened; symptoms similar to what occur in this country from scratches and punctures received in dissection, without any reference to a specific poison.

M. Dumeril remarked, that the effects of the bite of the rattlesnake in America was much less sudden and less fatal than in the case which had unfortunately happened at Rouen; and M. Bosc stated, that of all venomous animals the rattlesnake was the most gentle, and never attempted to bite where flight was possible. He had seen, he said, more than thirty persons bitten by rattlesnakes, none of whom died. A horse, however, which had been bitten on the tongue, fell a victim to the poison.

The discrepancy in the result of the cases may perhaps be accounted for, by supposing that the virulence of the poison in the rattlesnake may not be the same at all periods of the year, or of the animal's life. In some cases, however, and Mr Drake's is one of them, the poison seems to act speedily and fatally. In a curious Memoir on the habits of the rattlesnake, read lately by Mr Audubon at the Wernerian Society, that gentleman mentioned a circumstance which tends to show that the poisonous fangs of this reptile, even when withdrawn from the animal, retain their virulence for years. A person had been bitten by a rattlesnake in the woods through a strong boot. He died without the cause of his death being properly investigated. The boots descended to his son, who, after putting them on, was taken suddenly ill, and also died. The effects of this last were brought to sale; and a younger brother fancying the boots, or willing to preserve some memorial of his father and brother, was the purchaser. He used them only once, when he also fell ill and died. The medical men, whom such an occurrence had led to investigate its cause, at last ripped up the fatal boot, and found, firmly fixed in the substance of the leather, the fang of the rattlesnake which had thus caused the death of three individuals. Rattlesnakes, Mr Audubon further observed, are often found coiled up and torpid when the temperature is low; and he himself once narrowly escaped from perhaps a serious accident, in trusting to their continued torpidity. He had found an excellent specimen coiled up and torpid, which he put in his knapsack along with some wild ducks he had been shooting. The motion and heat of his body, together with the additional heat afforded by a sportsman's fire at a meal in the woods, had however revived the animal; and the motions of his knapsack, observed from the outside, indicated life within. Mr Audubon at first thought that some of his ducks, imperfectly killed, had found their situation irksome, and were testifying their impatience; but the recollection of the rattlesnake flashing at once on his mind, he threw off his bag, ducks, reptile, and altogether. The removal of the animal to a colder temperature brought on again its torpidity. He carried the snake home; and the identical specimen, if we rightly understood him, is now in the Museum of the Lyceum of Natural History of New York.

Art. XIX.—*On the Systems of Double Stars which have been demonstrated to be Binary ones by the observations of* Sir W. Herschel, and Messrs Herschel and South.

We have already had occasion to direct the attention of our readers to the detailed observations on double stars, which we owe to the diligence and accuracy of Messrs South, Herschel, and Struve. Since that time, Mr South has published, in the *Philosophical Transactions* for 1826, additional observations on 458 double stars, of which about 160 have been for the first time observed by himself; and in this paper Mr Herschel has, with his usual sagacity, contrasted all the modern observations with those of Sir William Herschel, so as to exhibit the relation which the two stars have to each other in motion, in position, and in distance.

It is obvious that a great number of double stars are only so by accident, that is, the two stars have no connection with each other, but the accidental one of being nearly in the same straight line with our own planet. Some of these stars may even vary their position, and their distance in relation to each other, in consequence of their having different proper motions, without there existing any connection between them; but there are double stars, in which the one revolves round the other with such regularity, that there can be no hesitation in regarding these two stars as forming a *binary system*, corresponding to the planetary system to which our own globe belongs. That such a system is composed only of two bodies, it would be unreasonable to believe, as it may comprehend many primary and secondary planets, whose inferiority to the other two in magnitude and brilliancy may for ever prevent them from being recognized by our best telescopes. The probability, however, is so great, that each binary system will contain other stars within its sphere, that we would recommend the minute examination of them to the diligence of the practical astronomer, while we would hold out such a discovery as one of the greatest objects yet to be obtained by the improvement of the telescope.

The discovery of binary systems of stars we owe to the indefatigable labours of Sir W. Herschel, who established the existence of several by his own observations, made at distant periods; and we have no hesitation in stating, with the Marquis Laplace, that, if the labours of that eminent astronomer "had been confined to that department of the science, the discoveries he has made in it would have alone conferred upon him an imperishable name."

When astronomy embraced only the bodies of our own planetary system, the stars were observed and numbered, as if their final cause had been to decorate the blue vault of Heaven. The imagination, indeed, sometimes ventured among their unfathomable recesses, and fancied that every star was the centre of a system of worlds, in which Almighty wisdom had dispensed the blessings of life and intelligence to various orders of animated beings; but this opinion was one of those waking visions of philosophy which no fact supported, and which had no other foundation but a remote, though a captivating analogy. Truth, however, had in this case thrown her shadow before, and what she then dimly unveiled to our fancy, she has now displayed before our judgment with all the fulness of demonstration. From observations separated by an interval of twenty-five years, Sir W. Herschel discovered in more than fifty double stars a change both of position and of distance. In *Castor*, ε *Bootis*, δ *Serpentis, and* γ *Virginis* the angle of position, (or the angle which the line joining the two stars forms with the direction of their daily motion,) had suffered a very great change, while the distances of the stars remained the same; and in ζ *Hercules, the two stars had approached so near to each other, that five-eighths of the apparent diameter of the small star were actually eclipsed by the larger one.*

These curious results have been confirmed and extended by subsequent astronomers, and the tabulated observations of Mr South, upon no fewer than 838 double stars, enable us to arrange into classes the various systems which they present to our notice.

In the present communication, we shall confine ourselves to the description of the Binary Systems which are considered by Messrs Herschel and South as perfectly determined.

1. η *Cassiopeiæ*, R. A. Asc. 0° 38′. Decl. N. 56° 51.

This star is double. The largest is red, and the smallest green, and they are of the 6th and 9th magnitude.

In 1782.4, Sir W. Herschel found the angle of position of this star to be 29° 9° *n f*, and the distance of the stars 11″.1.

In 1825.78, Mr South found the angle of position to be 6° 55, and the distance 9″.9. A connection between these stars cannot be doubted, as they have a common proper motion of nearly 2″ per annum. The apparent orbit is evidently elliptic, and the period is probably 700 years.

2. 12 *Lyncis*, R. Asc. 6^h 30′. Decl. N. 59° 37.

This star is a triple one, the three stars A, B and C being of the 7th, 7½, and 9th magnitudes, and C being of a blue colour. The motion of B in 40.81 years is no less than 22°.74; and should this continue uniform, the lapse of fifty-seven years will bring the three stars into one straight line, and in

646 years a complete revolution will have been performed. It appears from late observations in 1825, that the small star B has continued its motion, and apparently *with an accelerated velocity.*

In 1825 we have

A, B, Position 64°21′ *sf.* Dist. 2″529.
A, C, Position 35 21 *np.* Dist. 9″184.

3. *Castor*, R. Asc. 7^h 23′. Decl. N. 32°17′.

This star is double, and the two are of the third and fourth magnitudes. That it forms a binary system is fully demonstrated. In consequence of an observation having been made by Dr Bradley so long ago as 1759.8, we have till 1823.11, a period of no less than 63.3 years, during which the angle of position varied 61½°, or on an average 0°.971 annually. The distance of the stars has during that period been unchanged. This indicates a circular orbit at right angles to the line of sight; but it is most probable that this orbit is elliptical, and merely projected into a circle, for the observations seem to show that the angular velocity is sensibly retarded, having been 23°.7 in the first twenty years, 21°.4 in the next twenty-three years, and only 16°.4 in the last twenty-one years.

In 1825, the position was 6° 42 *s p*, and the distance 4″.77, the angle having varied 1° 41′, since 1823.11.

4. γ *Leonis*, R. Asc. 10^h 10′. Decl. N. 20° 45′.

This is a *quadruple* star, A and B, which are both reddish, are close, and pretty unequal; A and C are extremely unequal, and A, D excessively unequal. The mean annual motion of A, B, for position is about 0°.30 direct. From 1822.44 till 1825.3 the change in the angle of position has been 2° 53′, which indicates an acceleration in the motion.

In 1825.3, the angle of position is 11° 17′ *sf*, and the distance 2″.716.

5. ξ *Ursæ Majoris* R. A 11^h 9. Decl. N. 32° 33′.

This very remarkable star is double, and the two are of the 6th and 6¼ magnitude. These two stars, undoubtedly connected in a binary system by their mutual gravitation, and *revolving round their common centre of gravity with a motion so rapid as to admit of being traced and measured from month to month*, must be allowed to be a phenomenon of no common interest, and deserving every attention from the theoretical and practical astronomer. Sir W. Herschel first pointed out its rapid change of position, and the observations of M. Struve and Messrs Herschel and South indicate a *remarkable alteration* in its velocity, which can only be accounted for by supposing the relative orbit to be one of great ellipticity. The following are the different angles of position.

	Years.	Angles of Position.
Sir W. Herschel, -	1781.97	53°.79 *sf*
	1803.08	5. 7 *sf*
Mean of Struve's 17 observations,	1820.01	7.32 *np*
Mean of Struve's 7 observations, -	1821.75	4.71 *sp*
Mean of Messsrs Herschel and South's,	1823.29	11.51 *sp*
Mean of Mr South's, -	1825.22	25.28 *sp*

The mean distance of the two stars at the last of these epochs Mr South found to be 2.″442.

" In the first interval," says Mr Herschel, " of 21.11 years 48°.72, were described, giving an annual motion of 2°.309. In the next interval of 16°.93 years, 177°.75 were described, being at the mean rate of 10°.5 in the year. In the next period of 1.74 years, the angle described was 12°.03, or 6°.914 per annum, while in the succeeding short period of 1°.54 years the motion amounted only to 4°.442. It is therefore at present rapidly decreasing, and the maximum annual motion must at some period between 1803 and 1820 have greatly exceeded 10°.5, and perhaps may have amounted to 20° or 30°. This consideration would lead us to place the perihelion of the orbit in the north preceding quadrant, between the 30th and 60th degree from the parallel, and to suppose its plane greatly inclined to the visual line in a plane not far from that passing through the eye, and the major axis of the orbit ; and this agrees well with the change of distance, which is certainly less at present than in 1782, though the estimation by diameters is necessarily very uncertain.

"In the present imperfect state of the data, it would be useless to enter into any minute investigations respecting the elements of the orbit; but when twenty or thirty years observations shall have enabled us to trace precisely the variation of the angular motion up to the aphelion, and to ascertain by direct observation the periodic time and mean motion, the principles of physical astronomy may be applied."

These are the observations in Messrs South and Herschel's memoir of 1826. After comparing the preceding observations with the latest by Mr South in 1825.22, Mr Herschel remarks:

"Nothing can be more satisfactory than the confirmation these observations afford of the rapid motion ascribed to this remarkable star. In the interval of 1.97 year since the epoch 1823.29, the motion has amounted to no less than 13°.55 in the direction *np, sf* or — 7°.025 per annum. The sudden diminution of velocity is however not confirmed. Indeed, it rested on too short an interval, and on too few observations (from four very close stars) to deserve great confidence. We cannot do better than recommend this star for the next ten or twenty years to the constant and careful measurement of astronomers; nor can we too strongly inculcate here the indispensable necessity of multiplying extremely their measures of position to eliminate those errors of judgment to which the most experienced observers are liable in measures of this sort. This done, there is no doubt of our arriving at a precise knowledge of the elements and positions of the orbit described by each about their common centre of gravity, and the question of the extension or non-extension of the Newtonian law of gravity to the sidereal heavens—the next great step which physical astronomy has yet to make—will be effectually decided."

6. γ *Virginis,* R. Asc. $12^h\ 32'$. Decl. S. $0°\ 27'$.

The two stars which compose this double star are both white, and of the 8th and $8\frac{1}{2}$ magnitude. Both the angle of position, and the distance of these stars have undergone a great change. The following are the results:—

	Position.	Annual Velocity deduced.
1756.0	54°.4 *np.*	
1781.9	40 .7	— 0°.528
1803.2	30 .3	— 0 .490
1820.2	15 .3	— 0 .882
1822.3	13 .4	— 0 .905
1825.3	6 .9	— 2 .167

Hence there is an obvious acceleration in the motion of the stars, and it would seem that the two are mutually approaching to the perihelion, or at least to their situation of greatest angular velocity.

The distances of the stars have been,

1720.31	7″.49 Cassini.
1756	6 .50 Tob. Mayer.
1780	5 .70 Sir W. Herschel.
1820	3 .56 Struve.
1822.25	3 .794 Herschel and South.
1823.19	3 .300 Amici.
1825.32	3 .263 South.

7. ε *Bootis*, R. Asc. 14^h 37′. N. Decl. 27° 51′.

The two stars are of the 2d and 4th magnitudes, the large one being yellow, and the smaller blue-green. The best measures are

1822.55	52° 59′ *np.* angle of position.
1825.34	54 26

which give an annual motion of + 9°.4378. Their distance is 3″356.

8. Star *s f μ Bootis*, R. Asc. 15^h 18′. N. Decl. 38° 1′.

This is a very close double star. In the five feet equatorial, with a power of 133, it is seen elongated, but 303 shows it decidedly double. A power of 179 applied to the seven feet achromatic shows the discs of the two stars in contact, but 273 distinctly separates them. This double star is a severe test for a telescope, and is easily found by means of μ Bootis. The two stars are of the 8th and 10th magnitudes.

The angle of position for 1825.46 is 63° 32 *np*, and the distance 1″.421. "If this double star," says Messrs Herschel and South, "be a binary sytem, of which there can be little doubt, its period is about 622 years, and the most probable mean annual motion is 0°.5783 in the direction *s p*, *nf*, or retrograde.

9. δ *Serpentis*, R. Asc. 15ʰ 26. N. decl. 11°9.

The two stars which compose this double star are both blue, and of the 8th and 9th magnitude. The following are the angles of position:—

1782.99	42° 48′ *sp*	Sir W. Herschel.
1802.10	61 27 *sp*	
1819.70	67 41 *sp*	Struve.
1820.12	71 0 *sp*	
1821.33	70 37 *sp*.	Herschel and South.
1825.46	69 49 *sp*.	South.

The distance at this last epoch was 3″.268. The mean annual motion is —0.726. But, as Mr Herschel remarks, instead of advancing 3° as it should have done since 1821, it has receded nearly 50′.

10. 49 *Serpentis*, R. Asc. 16ʰ 4′. N. decl. 14° 1′.

The two stars are of the 8th and 8½ magnitude, and both white. Its position was

1781.18	21° 33′ *np*.	Sir W. Herschel.
1820.10	46 33 *np*.	Struve.
1825.41	48 10 *np*.	South.

The distance at this last epoch was 3″.501. The mean annual angular motion is +0°.510.

11. σ *Coronæ Bor.* R. Asc. 16ʰ 8′. N. Decl. 34° 20′. The two stars are of the 6th and 8th magnitude, and the small one is blue. There is another of the 15th or 20th magnitude, 42″ distant. The angles of position are

1781.79	77° 32′ *np*	Sir W. Herschel.
1802.79	78 36 *nf*	

1821.30	24° 45′ *nf*	Herschel and South.
1822.83	18 27 *nf*	
1825.44	12 29	

The mean annual angular velocity is about + 3°. The distance is 1″.48 at the last epoch.

In 1782 the distance of the two stars was fully 1¼ diameter of the small star, with a power of 227, but Struve observed them with the same power to be only ⅓ of a diameter as under.

12. 21 *μ Draconis.* R. A. 17^h 3′. N. decl. 54° 43′.

The two stars are nearly equal, and of the 8th magnitude. The angular position in 1781.73 was 37° 38′ *sp* or *nf*, and in 1825.25, 61° 2′ *sp* or *nf*. Its distance at the last epoch was 4″.33. Its annual motion is —0° 579, and nearly uniform.

13. 70 *p Ophiuchi.* R. A. 17^h 56′. N. decl. 2° 33′.

The two stars are of the 7½ and 8½ magnitude. The largest is white, and the small one livid. The mean annual motion from 1779 to 1823 is 6° 811. Since 1820, its annual velocity has varied from —1°. 75, to —2°. 42. Mr Herschel has shown, what the laws of central forces rendered necessary, that a very considerable diminution of distance accompanied the great increase of angular velocity, some time between 1781 and 1819, and that the subsequent diminution of the velocity has also been accompanied with a corresponding increase of distance, which, in 1825.56, was 4″ 76.

14. 5 *Lyræ*, R. Asc. 18^h 38′, N. decl. 39° 27′.

The stars are nearly equal, and of the 8th magnitude. The position in 1825.53 was 69° 11′ *np* or *sf*, and the distance 3″ 34. The annual motion is —0° 325.

15. 61 *Cygni*, R. Asc. 20^h 59, N. decl. 37° 52′.

The two stars are of the 7th and 8th magnitude. The angle of position, as determined by Bradley in 1753.8, was 54° 36′, and in 1825.7 it was 3° 4′, as determined by South, and the distance 15″ 444. "The mean annual motion," says Mr Herschel, "round their common centre of gravity is 0°.730, not far short of that of the two stars of

Castor, while their apparent mutual distance is at least three times as great. This circumstance, taken in connection with the rapidity of their apparent proper motion, (which is $+5''.38$ in R. A. and $+3''.3$ in declination,) affords a presumption of their being much nearer to us, and renders 61 Cygni a fit object for the investigation of Parallax."

16. *ζ Aquarii*, R. Asc. $22^h\ 20'$. S. Decl. $0°.57$.

The two stars are of the 7th and $7\frac{1}{4}$ magnitude. In 1779.9, its position was $71°\ 5'$ *nf*, and in 1825.73, $88°\ 56'$. The mean annual motion is $0°.4484$ retrograde.

" As the proper motion of ζ Aquarii," says Messrs Herschel and South, " amounts to $0''.173$ annually, and yet the stars of which it consists still retain the same distance, and nearly the same relative situation with respect to each other, this circumstance alone amounts to a proof of their mutual connection, which their equal size corroborates, and renders it exceedingly probable that they form a binary system."

Art. XX.—*Observations on the properties of some Fish Oils, and on the utility of Chloride of Lime in destroying their putrid odour.* By William Davidson, Esq. Surgeon, Glasgow. Communicated by the Author.

Fish oils, with the exception of sperm oil, generally exhale a fetid odour, and some are so putrid that they can only be used for inferior purposes. Whale oil is generally more free of fetor than seal, cod, and dog-fish oils; and this is principally owing to the superiority of the process for procuring the first; whereas in preparing the latter putrefaction is allowed to proceed too far before the oil is separated from the other animal matters. It is no doubt an easy process to allow the animal textures which contain the oil to be softened and decomposed by the influence of the sun, but it is unquestionably inferior to the application of artificial heat for that purpose. The different kinds of fish oils, though they agree as to their general characteristics, yet are materially different in many other respects. Whale oil, procured from the blubber of the Greenland whale, is generally transparent, of a brownish colour, and not sluggish when agitated in a phial. When agitated with cold water it is rendered of a whitish colour, but the water soon separates, and it regains its former transparency. When water is boiled along with it a cloudiness is produced; and when diluted sulphuric acid is boiled with it a scanty precipitate of brownish flocculi is deposited at the bottom of the oil. Seal oil, procured from the fat of the seal by the spontaneous decomposition of the animal textures, is pale and transparent, and is generally thinner and more fluid than whale oil. When agitated with cold water it is only rendered cloudy, and very speedily regains its usual transparency. When diluted sulphuric acid is boiled in contact with it a slight cloudiness is produced, which is gradually deposited at the bottom of the oil. Cod oil, procured from the liver of the cod-fish by the spontaneous decomposition of the animal textures, is generally of a dark-brown colour, sometimes pale, and is a thicker and more tenacious oil than any of the other kinds. It generally deposits at the bottom of the casks a considerable quantity of brownish flocculi, technically called "foots" by oil-dealers. Dog-fish oil is similar in its properties to cod oil; but in general exhales a most insupportable odour. Cod oil, when heated to 212° F. or even considerably beyond that point, does not throw down any precipitate. When cold water is agitated with it, it assumes the appearance of an emulsion, and a portion of flocculi is deposited at the bottom of the oil. Water, diluted sulphuric acid, or decoction of galls boiled in contact with it, causes a large quantity of brownish flocculi to be separated, and gradually precipitated. Water which has been boiled in contact with cod oil leaves scarcely any residuum on evaporation, and gives no precipitate with tincture of galls, acetate of lead, corrosive sublimate, nitro-muriate of tin, or nitrate of silver. The flocculi are again soluble in the oil from which they were separated, in oil of turpentine, and in boiling alcohol, which latter on cooling again deposits a considerable portion of them. They seem to possess the same properties as those which are spontaneously deposited in the original oil casks. Alcohol boiled in contact with cod oil extracts the greatest proportion of this flocculent substance; for when water is afterwards boiled in contact with it, a very small deposit is obtained. And if the ebullition be first made with water, and afterwards with alcohol, there is no further deposit when water is again boiled with it. Alcohol containing this principle in solution was tested with the following reagents: An alcoholic solution of corrosive sublimate when added produced no precipitate, neither did an alcoholic tincture of galls. An alcoholic solution of acetate of lead produced a copious white curdy precipitate, and an alcoholic solution of nitrate of silver produced a greyish white precipitate. Water agitated with alcohol containing this principle in solution occasions a permanent milkiness, with the formation of white and yellowish bodies floating on the surface of the fluid. Alcohol boiled with the oil which has previously been boiled with water still indicates a precipitate with acetate of lead, and nitrate of silver, though it is not so copious as in the case where the oil has not been previously boiled with water. When the alcoholic solution derived from cod oil was evaporated by a gentle heat till it was just beginning to char, but while it was still soluble in fixed oil, oil of turpentine, and boiling alcohol, it had the following properties: It was of the consistence of crystallized honey, or soft lard, of a brownish colour, easily melted by a very gentle heat. When water is boiled with it, it assumes nearly the form of the flocculi, which are produced by boiling water with cod oil, only a shade darker. It is insoluble in nitric and muriatic acids; but when either of these acids is boiled with it, the flocculi are charred. It is soluble in a boiling solution of potass, and ammonia forms a saponaceous compound with it. Conjecture might lead us to suppose that this flocculent principle was of a gelatinous or albuminous nature, because the fishes from which the oil is procured contain a considerable portion of these principles. It is insoluble in water, and therefore is not gelatin. It is not coagulable by heat alone, and is soluble in oils and alcohol, and insoluble in water, and therefore is not albumen in any form. It may be supposed to have some of the characteristics of inspissated mucus, being precipitated by acetate of lead and nitrate of silver; but inspissated mucus is not soluble in fixed and essential oils, and does not form saponaceous compounds with alkaline substances. It possesses the properties of adipocire or spermaceti in its solubility in boiling alcohol, fixed oils, and oil of turpentine, in its liquefaction by heat, and in forming saponaceous compounds with the alkalies. It differs from pure spermaceti in its greater solubility in oils and alcohol, and in giving a much more abundant precipitate with acetate of lead. Cod oil is, from universal experience, the only fish oil which will answer all the purposes of the currier; and it is reckoned by many of them almost indispensable. This adipocirous body, combined with the oil, is probably one of the causes of its important qualities in rendering leather soft and pliant. For, being carried in a fluid state into the texture of the leather, it will be intimately combined with it, and permanently deposited there in a solid state by the influence of the moisture and the tannin producing its coagulation.

When a solution of chloride of lime is mixed with putrid fish oil, and briskly agitated for a short time, it forms a thick whitish compound, destitute of any fetor. In this state it is totally unfit for burning, or, in general, for any practical application. But if a portion of diluted sulphuric acid be added sufficient to decompose the chloride of lime, and if gentle ebullition be employed for a short time, the lime is completely separated from the oil, and is precipitated in the form of sulphate of lime, carrying the water along with it.

The following is the process which I have generally adopted for destroying the putrid odour of fish oils: Dissolve about one pound of chloride of lime in about one gallon (imp.) of water, draw off the clear solution, and mix it thoroughly with about one hundred weight of putrid oil, then add about three ounces of sulphuric acid previously diluted with sixteen or twenty parts of water, and boil, with a gentle heat, till the oil begins to drop clear from a spatula. After the ebullition is finished, draw off the oil into a cooler, and allow it to remain at rest for a few days. A vessel lined with lead is less acted on by the acid; but a copper or iron vessel will answer the purpose perfectly well. The quantity of chloride of lime must be varied according to the putridity of the oil. It may be apprehended by some that the boiling will injure the colour of the oil; but it never does so where the heat is properly applied; for if there be a sufficiency of water the temperature can never be much above 212° F. The oil in general, after going completely through this process, seems to have nearly the same properties as it formerly had, and burns in a lamp equally well; but a portion of its adipocirous contents is in general precipitated.

Glasgow, 12*th April* 1827.

Art. XXI.—*A short account of the results of recent Experiments upon the Laws of Light, and its Theory.** By M. Le Chevalier Fraunhofer, Member of the Royal Bavarian Academy of Sciences at Munich.

In a Treatise of mine, which was printed in the eighth volume of the *Memoirs of the Royal Bavarian Academy of Sciences* last year, I published new experiments on the *Inflection* of light, and on the phenomena which arise from the reciprocal action of inflected rays on each other, together with the developement of the laws which may be deduced from these experiments.

Led by the inferences which I had drawn, I have since continued these experiments; and the following is a notice of such of the results which I obtained as are suited to a short paper, assuming, however, that all that the above treatise contains on this subject is understood.†

In observing the phenomenon which takes place when the light is inflected through a *single small aperture* by means of a telescope, coloured spectra are seen, which, in respect to the order of colours, are similar to the Newtonian coloured rings;

* Read in the Mathematical and Physical class of the Academy, June 14, 1823.

As the Editor of this Work has already translated and published from the French of M. Shumacher and M. Pictet, the whole of Fraunhofer's first *Memoir on the Spectrum,* and the principal part of his second *Memoir on the Modification of Light by Inflection,* he has been anxious to put the English reader in possession of the present Memoir, which he has had translated from the original German, which appeared in Gilbert's *Journal* for 1823.—Ed.

† The substance of this Treatise will be found in the article Optics in the *Edinburgh Encyclopædia,* vol. xv. p. 556.

and their light, like that of these rings, is not homogeneous. In my Treatise I have denominated these spectra, which are seen through a single aperture, spectra of an *external kind*, in order to distinguish them from those which are produced in another manner. In future, however, I shall denote them by the appellation of *spectra of the first class*, in order to speak on this subject with greater facility. If, on the contrary, light is inflected through a *great number of small apertures* all at equal distances, then from the reciprocal action of the inflected rays on each other, when observed with a telescope, spectra of another sort are produced, of which the light is perfectly homogeneous, provided there is a sufficient number of the small apertures. And in these are perceived the same fixed lines and streaks which are seen in a spectrum produced by a prism when observed by a telescope. By this means the latter kind of spectra are peculiarly fitted for discovering the law of these modifications of light; for by observations made on these lines and stripes that law may be deduced with a high degree of accuracy. Such a system of equal small parallel intervals can be most easily procured, either by pressing thin silver or gold wire into the threads of a very fine screw, or by etching parallel lines upon a plate of glass covered with gold leaf. In these experiments the light of the sun must enter a darkened room by a vertical aperture of extremely small apparent width in the shutter, and fall upon the object-glass of a telescope, in the direction of its axis,placed at the opposite end of the room. When the observer has drawn out the eye-glass of the telescope so far that he sees the aperture in the shutter as distinctly as possible, and then places the parallel wires in such a manner before the object-glass that the threads shall run horizontally, he sees the aperture itself unaltered, as if there were no wires; but at the same time there will appear to him, at some distance from this aperture in the shutter, and in a horizontal direction, symmetrically on both sides, very intensely coloured spectra, which are repeated, and become wider in proportion to their distance from the middle (or axis,) so that the first repetition has twice the breadth, the second three times, and so forth; and in the same proportion as their distances from the axis are increased. These spectra I denominated in my Treatise *perfect mean spectra*, but in future I shall call them *spectra of the second class.* On the contrary, I name these latter spectra *imperfect ones* if their light be not homogeneous; and that is always the case when only a few reflected rays act upon each other at *equal* distances.

In this paper the capital letters B, C... H will denote *coloured rays* of different kinds; B is a red ray, which lies towards the extremity of the spectrum; C is deeper in the red; D orange; E green; F blue; G indigo; and H violet. In every spectrum from solar light that consists of *perfect homogeneous* rays fixed lines or streaks are found, which distinguish themselves either by their strength, or their position, from the other numerous fixed lines of the spectrum.*

* In the meanwhile, it must not be assumed that the spectrum which is obtained, when the light refracted through a prism is received on a wall, or on a white surface, consists of *homogeneous* light. Such a spectrum would consist of perfectly homogeneous colours if the surface on which it is received were at an infinite distance from the prism, or if an exceedingly small prism could be employed. In both cases, however, the light would be extremely weak, and therefore no spectrum could be seen. If, for instance, the prism is two inches wide, then the extreme red rays in the received spectrum must likewise be spread into a space of about two inches. The next red ones must occupy an equally large space, and they must, for the most part, fall into the former ones. The same must take place with the various tints of the other coloured rays. This is the reason why all the coloured rays through such a prism necessarily must appear mingled together, the less so, however, the further from the prism the spectrum is received, or the smaller the prism, but never in so small a quantity that they could present homogeneous colours which have still intensity enough to be perceived. The colours of the spectrum are, according to this, so much less developed the nearer we approach the white surface to the prism; and here we see at the same time the cause why we obtain entirely white light when this surface is nearest to the prism, viz. because then the extreme violet rays fall into the extreme red ones, and the various coloured rays are throughout intermixed. Should the white light falling upon the prism proceed from a luminous *surface*, then the colours for the same reasons could not be homogeneous, even if they were produced by an infinitely small prism, or received at a very considerable distance. The apparent diameter of the aperture, or that of the object from which the white rays proceed, must be exceedingly small. Thus, for instance, the apparent diameter of the sun is far too considerable for the colours of the rainbow to be perfectly homogeneous. If, on the contrary, the white rays fall under a certain angle of inclination, and all together under the same

I denote the angles at which the rays B, C... of light, modified by the parallel wires, diverge from the axis in the *first* spectrum which is nearest to the axis, with B', C'..., in the *second* spectrum with B'', C''..., in the *third* spectrum from the axis with B''', C'''... and so on.

From the experiments which are described in detail in my second Treatise, it results, that, if we denote the width of single intervals in the wires with γ, and the thickness of the single wires with δ, expressed in parts of an inch (Paris measure,) we find with all the systems of wires that the arcs of these circles are as follows, supposing the radius $= 1$:—

$$B' = \frac{0{,}00002541}{\gamma + \delta} \qquad C' = \frac{0.00002425}{\gamma + \delta}$$

And further:

$$B'' = 2B' \qquad C'' = 2C'$$

angle upon a prism, then the extreme red ones, after the refraction in the whole width of the prism, likewise diverge all under one and the same angle; and this must be the case with each of the succeeding kinds of coloured rays. But a perfect object-glass has the property of uniting in one point all the rays which fall parallel to each other under any angle in the focus; and hence such a prismatic spectrum in a perfect telescope must consist of perfectly homogeneous colours, provided that the white rays proceed from an object of which the apparent diameter is exceedingly small. These circumstances, which in themselves contain nothing mysterious, and very simply follow from the nature of the subject, are often in optical experiments too little, or not at all observed; thus frequent deceptions have occurred in these experiments which have led to erroneous conclusions. What has been here said applies not only to the phenomena of refraction, but also to those of inflexion, and the mutual action of bent rays on each other, and is the cause why, when the light modified through parallel wires is received on a white surface, nothing is seen of those phenomena which are observed in it by means of a telescope. It will be easily seen that a lens cannot supply the office of a telescope. If we wish on a wall or white surface to have a spectrum, the colours of which should consist of perfectly homogeneous light, it would be requisite to receive the light proceeding under a proper angle from a very good prism, with a very good object-glass of long focus, and to place the white surface accurately in its focus. In such a spectrum the fixed lines or streaks would be likewise visible; the prism and the object-glass, however, must not be small, in order to have sufficient clearness, while the coloured light is sent forth from the white surface in all directions, and only a small part of it can strike the observer's eye.

$$D' = \frac{0,00002175}{\gamma + \delta}$$

$$E = \frac{0.00001943}{\gamma + \delta}$$

$$F' = \frac{0.00001789}{\gamma + \delta} \qquad B''' = 3C'$$

$$C''' = 3B'$$

$$G' = \frac{0,00001585}{\gamma + \delta}$$

$$H' = \frac{0.00001451}{\gamma + \delta}$$

The numerator in these general expressions for every distinct coloured ray, though a different absolute number, yet, however different the cases may be, is an invariable number, which, as will be easily perceived, relates here to a distinct and absolute measure, the Parisian inch. If this number is generally marked, for every coloured ray, with ω, and the angle of deviation of one and the same coloured ray in the first spectrum with ϑ', in the second with ϑ'', in the third with ϑ''', and so forth, there is generally

$$\vartheta' = \frac{\omega}{\gamma + \delta} : \vartheta'' = \frac{\omega}{\gamma + \delta} \text{ \&c.}$$

And consequently, if ν stands for the number which indicates to what spectrum in the order the value belongs, (since ν is for the axis $= 0$, for the first spectrum $= 1$, for the second $= 2$, &c. and can never be a fraction;) and if, for the sake of shortness, the sum of the breadth of an interval and a wire, or $\gamma + \delta$, $= \varepsilon$, then we have generally

$$\text{(I.)} \quad \vartheta^{(\nu)} = \frac{\nu\omega}{\varepsilon}$$

The results of the above-mentioned experiments, and also the common expression (I.) thence derived, show that the angles of deviation of the same coloured rays, in the series of spectra as they deviate from their axis through the wires, are as the numbers, 0, 1, 2, 3, &c. But the experiments from which these results are derived, gave angles so small, that their sines, tangents, and arcs, are nearly in the same proportion. In my first system of wires, where $\varepsilon = 0,001952$ of an inch D' is $= 38'\ 19{,}3''$. Upon reflection it will probably appear that in larger angles, that is with finer systems of wires, not the arcs, but perhaps one of the trigonometrical lines of these angles, may have the proportion under consideration. According to the theory, which will be treated of hereafter, with the light falling vertically upon the system of wires, the *sines* of the angles will have the said proportion. Partly in order to be able to confirm this directly by experiments, partly because the laws of this theory of the modification of light can be better inferred from larger spectra, it appeared to me, that, if it were possible to produce them, much finer systems of wires than those which I had employed in my earlier experiments would be desirable; but in such fine systems the spaces between the threads or wires must be equal, and a high degree of accuracy is necessary, in order that the fixed lines of the spectra should appear, without which the distances of the colours from the axis could not be measured.

To produce a considerably finer screw than that of which I made use in my earlier experiments will not easily be thought possible by those who are acquainted with the difficulties of this kind of work. By means of a peculiar arrangement I was enabled to trace upon a plate of glass, thinly coated with leaf gold, parallel lines at such intervals, that $\varepsilon = 0{,}00114$ of an inch. If it is required to trace lines at very small distances from each other, no gold remains on the glass, and consequently no intervals appear. The spectra obtained through such a system of lines, where $\varepsilon = 0{,}00114$ are, however, considerably larger than those formerly obtained, and the fixed lines are very distinctly seen in them; but the results which could be obtained by them were still far from affording any conclusion on the subject under inquiry.

In a system of lines, which is employed in these experiments, it is immaterial whether the lines of which it consists are opaque, pellucid, or transparent. A system of spun glass threads, for instance, produces the same phenomena as one of metallic wires. I therefore laid on one side of a good plate of glass such a thin coat of fat that it could with difficulty be discovered with the naked eye. In this substance I traced parallel lines, which had intervals of only half the size of those that were traced on the finest leaf gold. Through these systems of lines spectra were produced in which the fixed lines could be very distinctly perceived, and which are therefore well adapted for accurately measuring their distances from the axis.

It is impossible to trace in any layer of fat, or varnish, parallel lines more accurately at equal distances.

It was only by means of a diamond that I obtained still finer systems of lines, when I was enabled by a machine, constructed for this purpose, to trace parallel lines with a diamond point, in the greatest perfection, immediately on the surface of the plate of glass. If, by good fortune, a very good diamond point is procured, by the help of this machine lines may be traced so fine that they cannot be perceived by the most powerful compound microscope. It is, however, not sufficient to be able to trace a very considerable number of lines within a given space that shall leave interstices between them, but it is requisite that these lines should be at distances in so high a degree equal to each other that the greatest number of them shall not be nearer to each other, or farther, than the hundredth part of this small distance. With the help of my machine I have obtained a system of lines in which $\varepsilon = 0,0001223$ of an inch, the lines of which are at distances so very equal, that the fixed lines of the first and second spectrum that are seen through it may be very clearly distinguished. * Through

* With this machine parallel lines, with intervals as wide as the lines themselves, may be etched at such a small distance from each other that 32000 will be contained in a Parisian inch; but I have not hitherto succeeded in giving them such equal distances from each other, which ought to be 0,00003125 of an inch. Not many faults of a hundredth part, that is, of 0,00000031 occur; and it is perhaps not possible for human hands, with any machinery that can be employed, to surpass this, since 100 or 200 parallel lines are of little use; and in such fine systems of lines several thousands are always required in order to obtain perfect intense spectra. It requires much good fortune, even with $\varepsilon = 0,0001223$ to find a diamond point which shall trace several thousands of such fine lines without becoming altered. I have hitherto only succeeded with one system of lines so fine. If, during the process of tracing, the diamond point becomes altered, all the preceding labour is lost. The point, without any apparent cause, often makes stronger or weaker lines; nor can it be discovered by the strongest microscope whether the point is fit to trace the proper lines. Hence it is only by trials that a useful point can be obtained. What renders the thing still more difficult is, that a small alteration in the inclination or position of the diamond, relatively to the plane of the plate of glass, materially alters the force of the lines. Since every line requires to be drawn singly, with great care, it may be easily conceived how much time and patience are necessary to trace two thousand lines with the requisite accuracy.

this system of lines spectra are produced, which are as large as those produced by very large prisms; and already in the first spectrum the line D (in the orange) is observed to be as good as double, so that the width of the space can be measured. And since through this system, for instance, D′ is already =10° 14′, the law of this modification of light can be deduced with very great accuracy from the experiments made with it.

In the case when the light fell vertically upon this system, in which $\varepsilon = 0{,}0001223$, I obtained,

C′ =	11°	25′	20″	F′ =	8°	26′	6″
C″ =	23	19	42	F″ =	17	3	34
D′ =	10	14	31	G′ =	7	27	19
D″ =	20	49	44	G″ =	15	3	9
E′ =	9	9	—	H′ =	6	52	36
E″ =	18	32	34				

These angles are so large, that, in reference to arcs, sines, and tangents, they deviate from each other very materially. Since the instrument with which these angles are measured gives 4″ without repeating, some idea may be formed of the degree of accuracy to which they can be depended upon.

The third spectrum, the fourth, and those following, were indeed well seen with this system; but the fixed lines in the various colours could not be distinguished with sufficient precision, in order to determine their distances from the axis quite as accurately as those in the first and second. *

The indicated measures of the first and second spectrum are

* However great the accuracy may be in reference to the equal distances of the parallel lines, it is natural that it should have its limits, for absolute perfection is unattainable. What influence a slight inequality in the spaces between the parallel lines may have on the distortion or confusion of the fixed lines in the different spectra may be judged of from the equation $\vartheta^{(r)} = \frac{r\omega}{\varepsilon}$. For, as it thence follows that $\delta\vartheta^{(r)} = -\delta\varepsilon\frac{r\omega}{\varepsilon^2}$, an inequality which amounts only to the hundredth part of this very small distance ε, ($\delta\varepsilon = 0{,}00000122$ inch,) must produce a disturbance of the fixed line D, in the first spectrum of 6′ 5″, in the second spectrum of 12′ 10″, in the third of 18′ 15″, and so forth. This is the cause why, in the first and second spectrum, the fixed lines may still be defined, while in the third and fourth, &c. they are not.

in the meanwhile sufficient to lead to a conclusion concerning the law of this modification.

As the distance of the parallel lines cut upon the glass from each other must be known with the greatest accuracy, and as these lines themselves are difficult to be distinguished by the most powerful microscope, at least cannot be counted, I endeavoured to etch the first and the last line somewhat stronger than the rest; and with a microscopic apparatus, adapted for this purpose, I measure the distance from the first line to the last, the etching machine itself reading the lines which are etched. In this way I know accurately how many of them are contained in the etched space. Thus, for instance, the glass of which I have been hitherto speaking contained 3601 lines. Then from the distance of the first from the last, the distance between the middle of any two, that is ε, may be very accurately known; and the proportion of the width of a line to the intermediate space between two lines may likewise be very nearly determined. If the lines were so thick that one touched another, and consequently had no space between them, no light could be regularly reflected from the etched surface, and would, as from every other polished surface, be dispersed. Were the intermediate spaces equally wide as the lines, the etched surface could only regularly reflect half as much light as an equal surface of glass that was not etched, therefore the quantity of regularly reflected light from an etched surface of glass is in proportion to the quantity of light which is reflected from a surface of glass of the same size not etched, as the width of the spaces between any two neighbouring lines is to the width of those lines.* It is scarcely necessary to remind the reader, that, in experiments thus made, care must be taken that from the second surface of glass no light shall be reflected.

With another system of lines on glass, in which $\varepsilon = 0{,}0005919$ of an inch, I obtained with the light falling upon it vertically:

* Even if the quantity of reflected light could be determined with extreme accuracy, this conclusion, from reasons which shall be hereafter mentioned, could only be considered as an approximation. In wires where ε is still much smaller than here, this conclusion would be very accurate. In the experiments here mentioned the determination of this proportion is of no consequence, but only that of the magnitude ε.

C'	$= 2° 20' 57''$	E'''''	$= 9° 28' 3''$
D'	$= 2 \quad 6 \quad 30$	F'	$= 1 \quad 44 \quad 19$
D''	$= 4 \quad 13 \quad 7$	F''	$= 3 \quad 28 \quad 45$
D'''	$= 6 \quad 20 \quad 7$	F'''	$= 5 \quad 13 \quad 23$
D''''	$= 8 \quad 27 \quad 43$	F''''	$= 6 \quad 58 \quad 18$
D'''''	$= 10 \quad 35 \quad 53$	G'	$= 1 \quad 32 \quad 22$
E'	$= 1 \quad 53 \quad 7$	G''	$= 3 \quad 4 \quad 57$
E''	$= 3 \quad 46 \quad 17$	G'''	$= 4 \quad 37 \quad 30$
E'''	$= 5 \quad 39 \quad 50$	H'	$= 1 \quad 25$
E''''	$= 7 \quad 33 \quad 41$	H''	$= 2 \quad 50 \quad 11$

The aggregate observations with both systems of lines are very nearly represented by the following equation:

$$\text{(II.) } \sin. \vartheta^{(\nu)} = \frac{\nu\lambda}{\varepsilon}.$$

With rays falling vertically the *sines* of the deviation of a coloured ray from the axis in the different succeeding spectra are as the numbers 0, 1, 2, 3, &c. *

The system $\varepsilon = 0{,}0005919$ has the peculiar property, that all the spectra produced by it on one side of the axis have more than double the intensity of those which lie on the other side of the axis. The lines of this system are indeed visible with a microscope, but no particular form can be distinguished. I therefore suppose the reason may be, that, in etching, the diamond point might have had such a position in respect to the plate of glass, that one edge of each line must have become sharp, and the other less defined; and I believe that this

* If the sines, and not the angles of deviation of a coloured ray in the different spectra had not been in the proportion in question, then through the finer systems of lines on glass, where $D' = 10° 14' 31''$, $D'' = 20° 29' 2''$, but, according to the experiment $D'' = 20° 49' 44''$, consequently by 20 minutes more, the sines of the angles have on the other hand this proportion. In the seconds we still meet in the calculation with a small difference, which is, however, too great to be attributed to an error in the observation. Whether this difference is to be looked for in a small imperfection of the lines, or lies in the nature of these phenomena, may be determined by a greater number of experiments with different very fine systems of lines. I do not here, however, give the angles quite faithfully, as I obtained them by the experiments without allowing a correction. I had repeatedly determined these angles, and each time by six repetitions; and in the lighter colours I obtained almost constantly the same angle accurate to a second; nevertheless, small constant errors might produce the above difference.

is confirmed by the following experiment: I traced parallel lines upon a plate of glass, covered with a thin layer of fat, in such a way that the fat in every line must have been cut sharp on one side, and less defined on the other, and actually obtained through this warp an appearance similar to that of the system before mentioned. If the ray does not fall vertically on the system of lines, but inclines towards it in the plane which vertically intersects the parallel lines, the effect is the same as if for these rays the distance of the parallel lines from each other, that is ε, were smaller in the proportion of the radius to the cosine of the angle of incidence than by a light received vertically. Consequently the distances of the spectra from the axis (ϑ) must become as much greater as the angle of incidence is greater, because (as the equation II. shows) the series of these distances increase in the same proportion as ε decreases. If, therefore, σ denotes the *angle of incidence*, that is, the angle which the incident ray forms with a line perpendicular to the plane of the glass, it was safe to conclude, from equation II. viz. $\vartheta^{(\nu)} = \frac{\nu\omega}{\varepsilon}$, that sin. $\vartheta^{(\nu)} = \frac{\nu\omega}{\varepsilon.\cos.\sigma}$.

But according to the theory of these phenomena, which will be adverted to hereafter, it may be predicted, that in this case the spectra on both sides of the axis will no longer be symmetrical; that, therefore, D′, for instance, on the one side of the axis must be larger than D′ on the other side. This is also confirmed by experiments which will be mentioned afterwards. In systems of lines in which ε is not very small the difference is not striking;* but it is uncommonly great on the contrary in those systems where $\varepsilon = 0{,}0001223$ of an inch; for when $\sigma = 55°$, we have on one side of the axis $D' = 15° 6'$, and on the other side of the same axis $D' = 30° 33'$.

Now, if the symmetrical spectra of the first class, which do not consist of homogeneous colours, and contain no fixed lines,† are important for the theory of these phenomena, the

* In fact, with coarse systems of lines, when σ is not very large, one may use the term sine $\vartheta^{(\nu)} = \frac{\nu\omega}{\varepsilon.\cos\sigma}$ with sufficient accuracy, as I have done in my Treatise "*On the New Modification of Light,*" page 62; but we shall farther on find an equally accurate and more simple term.

† *New Modification of Light,* &c. page 12, French translation, p. 55.

non symmetrical spectra of the second class are far more interesting, because they show the fixed lines; and from them the law of this modification of light can be deduced with extreme accuracy, and the theory of these phenomena can be put to the severest test. I give here the result of several experiments with the coloured rays D and F. In order to show on which side of the axis the angle ϑ lies, which measures the distance of the coloured ray from the axis, I denote with $-\text{I}, -\text{II}$...those spectra which lie on that side of the axis, where the received ray inclines to the plane of the warp; and on the other hand, with $+\text{I}, +\text{II}$...the spectra at the opposite side of the axis, where the obliquely incident ray makes obtuse angles with the system of lines, so that $D^{-\text{I}}$, $D^{+\text{I}}$, or $D^{-\text{II}}$, $D^{+\text{II}}$...denote the opposite situations of the rays D in the first or second spectrum. The angle of incidence σ is here to be understood in the same sense as above, that is, the angle which the incident ray forms with the perpendicular.

Experiments with the system of lines on glass in which $\epsilon = 0{,}0001223$.

$\sigma = 55°$

$D^{-\text{I}} = 15°\ 6'\ 36''$	$F^{-\text{I}} = 12°\ 44'\ 40''$
$D^{+\text{I}} = 30\ 33\ 10$	$F^{+\text{I}} = 19\ 58\ 54$
$D^{-\text{II}} = 27\ 23\ 18$	$F^{-\text{II}} = 23\ 16\ 50$

$\sigma = 50°$

$D^{-\text{I}} = 13°\ 58'\ 12''$	$F^{+\text{I}} = 11°\ 43'\ 53''$
$D^{+\text{I}} = 20\ 42\ 51$	$F^{+\text{I}} = 15\ 53\ 10$
$D^{-\text{I}} = 25\ 46\ 20$	$F^{-\text{II}} = 23\ 16\ 50$

$\sigma = 45°$

$D^{-\text{I}} = 13°\ 2'\ 37''$	$F^{-\text{I}} = 10°\ 54'\ 55''$
$D^{+\text{I}} = 17\ 14\ 44$	$F^{+\text{I}} = 13\ 37\ 38$
$D^{-\text{II}} = 24\ 25\ 30$	$F^{-\text{II}} = 20\ 33\ 39$

$\sigma = 40°$

$D^{-\text{I}} = 12°\ 17'\ 34''$	$F^{-\text{I}} = 10°\ 15'\ 29''$
$D^{+\text{I}} = 15\ 8\ 52$	$F^{+\text{I}} = 12\ 8\ 12$
$D^{-\text{II}} = 23\ 18\ 54$	$F^{-\text{II}} = 19\ 32\ 57$

$\sigma = 30°$

$D^{-\text{I}} = 11°\ 12'\ 22''$	$F^{-\text{I}} = 9°\ 18'\ 36''$
$D^{+\text{I}} = 12\ 40\ 30$	$F^{+\text{I}} = 10\ 17\ 34$
$D^{-\text{II}} = 21\ 42\ 5$	$F^{-\text{II}} = 18\ 4\ 35$
$D^{+\text{II}} = 28\ 50\ 5$	$F^{+\text{II}} = 22\ 30\ 10$

$\sigma = 20°$.

$D^{-I} = 10° \ 33' \ 2''$	$F^{-I} = 8° \ 44' \ 10''$
$D^{+I} = 11 \ 19 \ 23$	$F^{+I} = 9 \ 15 \ 22$
$D^{-II} = 20 \ 46 \ 54$	$F^{-II} = 17 \ 12 \ 45$
$D^{+II} = 24 \ 14 \ 30$	$F^{+II} = 19 \ 27$

In these experiments the instrument could not be used as a repeating one on the first angles. They are therefore, in respect to the seconds, somewhat less accurate than those obtained by light received vertically; but as the differences on one or the other side of the axis already amount to several degrees, a few seconds are no longer of consequence.

Thus, in the aggregate experiments of this kind, as D^{-I} has been obtained differently from D^{+I}, so likewise F^{-I} from F^{+I}; and the same was the case for the remaining coloured rays, of which I here omit the experiments. When the light is not received vertically, the spectra produced by the system of lines are not at all symmetrical on both sides of the axis; nay, the difference of their position, with large angles of incidence, is so considerable, that, even if it amounted only to the hundredth part, it could be easily observed.

(To be concluded in next Number.)

Art. XXII.—*Account of Halos and Parhelia observed in America.* *

On the 8th September 1816, between two and three o'clock, there was observed about the sun, at New Port, Rhode Island, a very curious halo, which lasted between 40′ and an hour. It was drawn by Mr D. Melville, and is represented in Plate I. Fig. 3. The halo encircling the sun S was of the ordinary size, but very bright, having the whole of its circumference tinged with the prismatic colours. On its upper and north-east limb there was a bright mock sun, the rays of which formed a second halo of a smoky white colour, well-defined in its whole circumference, but more faintly as it approached the primary

* Collected and abridged from Dr Silliman's *Journal*, vol. x. p. 368, and vol. xi. p. 325.

halo on its south-west limb where they united. This halo AB was double the diameter of the one round S, and had mock suns at A and B. The rays of light from A formed another circle *m n* (said to be double the diameter of A B, though the original figure does not so represent it,) and the rays from B a similar one *n p*. The rays of light thrown off at the crossing of these circles at *n*, formed segments *q r* of a fifth halo, about 120° of which was below the horizon.

A halo was seen on the 19th August 1825 in Tod County, Kentucky, which is shown in Plate I. Fig. 4. If we suppose E and W the east and west points, A the zenith, and B the sun, then CC is a circle with the prismatic colours of exceeding brilliancy, D D a very bright luminous circle passing through the sun B, E E, E E, two segments of circles intersecting D D at F. These segments were very bright about F, but became gradually invisible as they approached the sun. The points B, A, F were in a straight line, and the intersection F was the same height above the horizon as the sun, and moved north and approached the zenith, in the same proportion as the sun moved south, and approached the zenith. The circle D D, and the segments E E, EE, had the same diameter, and diminished in size as the sun approached the zenith. These circles were first observed about eight o'clock, and continued till eleven. There was not a cloud to be seen, and the haze was so thick high up in the atmosphere, that the sky appeared completely black, and the sun shone with so much splendour, and there was such a glare, that it was painful to the eyes to go into the light.

On the Friday following the same phenomenon appeared, with the addition of an elliptical halo *m n*, less brilliant than the external one.

On the 19th August 1825, there was seen at Jackson, in Tennessee, the halo shown in Plate I. Fig. 5, which is the same nearly as the one above described, and seen on the same day in Tod county. A is the zenith, B the true sun, C C, &c. are the parhelia formed by the intersection of the circles, D D two small segments of a large circle, and E, W, the east and west points of the compass. The luminous circle had much the appearance of a lunar rainbow ; that part of the small circle west of the true sun was more bright than the rest, the extreme north and south points of the two largest circles were very dim, and the eastern extremity of the small circle somewhat flattened. In this halo, the two circles *m n*, *n p* of Fig. 3 are completed, and there are additional segments at D D. In this halo, the circle of which A is the centre is less than that in Fig. 3, where there are also parhelia not seen in the other.

On the 14th August 1825, there was seen at Millbury, Massachussets, the halo shown in Plate I. Fig. 6. It was seen at eight o'clock in the morning, and continued till past eleven. S is the sun, A B a circle having the sun in its centre and about the size of the common halo. C D an ellipsis, and E F a large circle at the west of the sun through which its circumference passed. The colours, except at the points G H, were like those of the rainbow.

ART. XXIII.—*Description of Oxahverite, a New Mineral from Oxahver, in Iceland.* * By DAVID BREWSTER, LL. D. F. R. S. Lond. and Sec. R. S. Edin.

THE very interesting mineral which I now propose to describe was put into my hands by Henry Witham, Esq. whose knowledge of mineralogy and zeal for its progress are already well known to the society.

The specimens on which it is found were brought from the hot spring of Oxahver, in the north east of Iceland, by Mr Brown of this city. They are decided petrifactions, in which the wood has been replaced by calcareous spar of a fine ochre-yellow colour, and more or less crystallized. This opinion was doubted by competent judges who had seen some of the specimens, but I consider it as completely established by a specimen now upon the table, which, along with some others, Mr W. G. Thomson has been so kind as to send me from his cabinet.

The new mineral occurs on these petrified masses in thin veins, in amorphous masses, in aggregated groups of crystals,

* Communicated to the Royal Society, May 7, 1827.

and sometimes in insulated crystals implanted in the calcareous spar.

The crystals are acute octohedrons, with a square base, and therefore belong to the pyramidal system of Mohs. The angles at the base are truncated by planes parallel to the axis of the octohedron, and equally inclined to the adjacent sides of the base, so as to form, when enlarged, the faces of a square prism.

In submitting the most perfect crystals to measurement, a very remarkable peculiarity, which I have never before observed, is distinctly seen. Every face of the octohedron is a surface of double curvature, in consequence of which the maximum angle of the two opposite faces of the pyramid is 58°, while the minimum angle is 42°, giving a change of inclination of no less than 16°. The maximum inclination occurs at the base, and at the vertex of the pyramid, and the minimum inclination at an intermediate point, so that the crystal has a form very unusual among minerals. See Plate II. Fig. 5.

The general size of the crystals is about one-tenth of an inch in length, their surfaces are even, but not brilliant, and the small truncations of the angles at the base of the pyramid are more imperfect than those of the octohedron, the imperfections having the direction of the axis.

The crystals cleave with some facility perpendicular to the axis, and the plane of cleavage is considerably rounded, the convex surface being turned towards the apex of the pyramid. In no other direction have I been able to discover the least appearance of cleavage.

The hardness of this mineral is between 4.5 and 5.0, — between *fluor spar* and *apatite*, but nearer to the latter. Its specific gravity, as determined by a mass of forty-three grains, is 2.218.

The colour of the crystals is light-grey, leek-green, olive-green, and reddish-brown. They have one axis of double refraction coincident with the axis of the octohedron, like all other crystals belonging to the pyramidal class. This axis is *negative* like all those of the pyramidal class, excepting apophyllite, that cleave perpendicular to the axis, and its intensity is such, that at a thickness of 0.057 of an inch, and in a plane perpendicular to the axis, it polarizes the pink of the third order of colours.

Its index of ordinary refraction is greater than that of the stilbites and mesotypes, and is very near that of apophyllite.

This mineral is neither pyro-electrical, nor is it phosphorescent by heat.

From the characters which have now been described, it is obvious that this substance must be arranged under the second class, and the sixth order, or that of *kouphone spar* of the system of Mohs. It approaches very near to the apophyllite in form, in cleavage, in hardness, in specific gravity, in refractive power, and in the absence of pyro-electricity and phosphorescence. It differs from it, however, in the inclination of its pyramidal faces, a difference which even the unassisted eye can detect, and in having a *negative axis*, while apophyllite has a *positive axis* of double refraction. In noticing, however, this point of difference, it deserves to be remarked, that Mr Herschel found portions of crystals of apophyllite which exercised a *negative* action upon a particular part of the spectrum; and in the theory which I have published of this singular property, I have stated that I "had no doubt but apophyllites will yet be found in which the axis is *negative* for all the rays of the spectrum." If Dr Turner's analysis should approximate this substance to the apophyllite, the result would, on this account, be a very interesting one.

Before I conclude this notice, I may mention a curious property of this mineral, though it is slightly connected with its chemical relations, which will come under the consideration of Dr Turner.

Like Labrador feldspar, it contains a number of minute vacuities. When a complete crystal is placed in any of the mineral acids, they do not appear to exercise any action upon it, but are absorbed, rendering, as might be expected, the mineral more transparent. After a considerable time, the acid thus absorbed seems to act upon the substance, which is shown by a diminution of its transparency. The crystal however retains its external form even for weeks, but when it is taken out of the acid it may be crushed between the fingers.

Mr Henderson has given the following account of the hot springs of Oxahver, where this mineral was found.

The middle fountain, or *Oxahver*, the most celebrated of these springs, (the springs of Reykiahverf,) is situated about 150 yards S. W. from *Nordur-hver*. Its pipe is eight feet at its greatest diameter, and is surrounded by a strongly incrusted brim almost close to the orifice. The incrustations formed by the depositions of this fountain are peculiarly beautiful. The greater part of the mound seems covered with small thin pieces of wood, some of them half a foot long, which lie in almost every possible direction. The cavities, by the junction of the pieces, are often filled with a fine efflorescence, and various other curious petrifactions.—See Henderson's *Iceland*, p. 145.

Art. XXIV.—*Analysis of Oxahverite.** 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.

On exposure to heat in a glass tube, the oxahverite emits a considerable quantity of water, becomes brittle, and acquires a yellow ochrey tint, but does not suffer any change of form. Heated before the blowpipe, it fuses without difficulty, and yields a transparent colourless globule. With borax it melts into a transparent bead, and when fused with the phosphate of soda and ammonia, assumes the appearance indicative of the presence of silica. When heated before the blowpipe with the flux of bisulphate of potash and fluor-spar, as described in a former paper, the flame did not receive either a green or a red tint, and hence the absence of boracic acid and lithia may be inferred.

The oxahverite is readily attacked by the nitric or muriatic acid, even when diluted with water; so that these menstrua cannot be safely employed for separating the carbonate of lime in which the mineral is imbedded. When a crystal is put into strong muriatic acid, it gradually becomes opaque and brittle, but retains its form. Subjected in the state of

* Communicated to the Royal Society May 7, 1827.

fine powder to the action of muriatic acid, it suffers complete decomposition. A gelatinous residue remains, which, after exposure to a red heat, is found to be a light white powder readily soluble in a concentrated hot solution of the carbonate of soda, and possessed of all the properties of pure silica. The acid solution had a yellow colour indicative of the presence of the peroxide of iron. The addition of muriate of baryta did not disturb the transparency of the liquid. Pure ammonia caused a reddish-brown flocculent precipitate, consisting of the peroxide of iron and alumina. On adding oxalate of ammonia to the filtered solution, a copious white precipitate of the oxalate of lime ensued. The residual liquid, evaporated to dryness and ignited, gave a white fusible residue, in which carbonate of ammonia and phosphoric acid could discover no trace of magnesia, but which, with the muriate of platinum, yielded a copious precipitate of the yellow muriate of platinum and potash. The saline residue did not possess the property of communicating a yellow tint to flame, from which circumstance the total absence of soda is inferred.

From the preceding characters, it follows that the oxahverite is composed of silica, lime, potash, oxide of iron, alumina, and water. In addition to these ingredients I have likewise discovered a trace of fluoric acid. In the preliminary examination I had indeed failed in detecting this substance; but when, on observing the similarity in the composition of oxahverite and apophyllite, I repeated the experiments with a larger quantity of the mineral, I succeeded in procuring unequivocal indications of its presence. From a deficient supply of the oxahverite I have been unable to determine the precise proportion of fluoric acid; but the quantity is very minute, and I apprehend falls far short of one per cent.

With respect to the degree of oxidation of the iron, it is certain that this metal is in part at least in the state of peroxide; for, on acting upon the mineral with muriatic acid in a close vessel, and pouring the liquid into a boiling solution of the ferro-cyanate of potash, a blue precipitate appeared.

To discover the proportion of the constituents of this mineral, I exposed 22.95 grains of the fresh crystals, in fine powder, to the action of strong muriatic acid for forty-eight hours. The mixture was then evaporated slowly to dryness, and the soluble parts removed by dilute muriatic acid assisted by heat. The silica, collected and heated to redness, weighed 11.65 grains, equivalent to 50.76 per cent.

The acid solution was treated by pure ammonia in order to separate iron and alumina; and to the filtered liquid an excess of the oxalate of ammonia was added. The oxalate of lime, collected and exposed to a white heat, yielded 5.14, or 22.39 per cent of pure lime.

The precipitate, consisting of iron and alumina, was treated in the usual manner by pure potash. The peroxide of iron, thus procured, amounted to 0.78 of a grain, or 3.39 per cent; and the alumina to 0.23 of a grain, or 1 per cent.

The solution from which the oxalate of lime was obtained, was evaporated to dryness, and exposed to a red heat. The fused residue consisting of the chloride of potassium, weighed 1.52 grains, equivalent to 0.96 of a grain, or 4.18 per cent. of potash.

To ascertain the quantity of water contained in the oxahverite, 6.45 grains of the crystals were heated to redness. The loss was 1.12 grains, or 17.36 per cent.

On comparing the result of this analysis with that of apophyllite and tesselite, as given by Berzelius, it will be seen that the composition of these minerals is very analogous.

	Oxahverite.	Apophyllite.	Tesselite.
Silica, -	50.76	52.13	52.38
Lime, -	22.39	24.71	24.98
Potash, -	4.18	5.27	5.27
Peroxide of iron,	3.39	0.00	0.00
Alumina, -	1.00	0.00	0.00
Fluoric acid	a trace,	0.82	0.64
Water, -	17.36	16.20	16.20
	99.08	99.13	99.47

As the proportion of silica, lime, potash, and water, in oxahverite, is so nearly the same as that of the other minerals, it admits of doubt whether the iron and alumina, combined perhaps with a little water, are not to be regarded as accidental impurities, rather than as essential parts of the mixture. In this view the oxahverite would be a variety of apophyllite.

ART. XXV.—*On the existence and uses of Ciliæ in the young of the Gasteropodous Mollusca, and on the causes of the spiral turn of Univalve Shells.** By R. E. Grant, M. D. F. R. S. E. Fellow of the Royal College of Physicians of Edinburgh, and formerly Lecturer on Comparative Anatomy. Communicated by the Author.

WHEN we examine the surface of the minutest animalcules with a powerful microscope, we perceive that their quick locomotions are produced by the rapid vibration of very minute processes termed *ciliæ*, variously disposed on the surface of the body in the different species. In zoophytes, whose fixed and inert axis prevents them from swimming to and fro in search of prey like animalcules, we observe incessant currents of water directed to the mouths of the polypi, caused, not as is generally supposed by the motions of the tentacula, but by the quick vibration of *ciliæ* disposed either on the tentacula, or around the mouths of the polypi. I have already shown that the same minute vibratory organs exist on the surface of the reproductive gemmules, or so named *ova*, of a great variety of zoophytes, enabling these fixed and apparently inert animals to rise from the bottom of the sea, and swim rapidly from place to place during the first stage of their existence, separate from the body of the parent. Although the *ciliæ*, in the simplest orders of animals, might be considered as organs of motion destined to supply the place of the muscular system, a more extended application of the microscope will show that they are not confined to animals thus low in the scale, but are likewise of frequent occurrence in such as have the muscular and nervous systems highly developed, and probably that they have some influence in the first developement of the embryo of the most perfect animals. While watching the progress of the embryo of the *Buccinum undatum*, and of the

* Read before the Wernerian Natural History Society of Edinburgh on the 24th March 1827.

Purpura lapillus, with the view of determining the influence exerted by the enormous pulsations of the heart of the testaceous gasteropodous *mollusca*, in causing the oblique spire of univalve shells to lie always on the side opposite to that organ, I was early struck with the rapid and incessant motion of the amniotic fluid towards the fore part of the body of these animals during every stage of their developement within the ovum, and it was easy to observe by the aid of the microscope that these currents were produced by *ciliæ* placed around the margins of two funnel-shaped projections on the fore part of the young animal. On examining the cells newly deposited by the female *Buccinum undatum*, whether in basons of sea water, or on the sea shore, we find in each cell about a thousand very small yellow opaque spheres, suspended in a transparent gelatinous fluid, which has a saline taste, and leaves dendritic crystals on evaporation. These yellow bodies do not effervesce in nitric acid, nor can we perceive any lime secreted in the shell of the young animal before it comes in contact with the sea water by the opening of the cell at maturity. The yellow spheres are observed to assume an arrangement in curved and convoluted rows, and at length they are found grouped together into about twenty small separate masses, where they are united by a gelatinous basis. Soon after the formation of these twenty round groups, we observe the gelatinous connecting matter form a transparent covering on each group, which is the rudiment of the future shell, and on one side the gelatinous matter is lengthened outwards, so as to form the margins of an internal cavity whose entrance is surrounded with vibrating *ciliæ*, and in the interior of which we perceive a constant revolution of the particles of some fluid. The vibration of the *ciliæ*, and the revolving current in the internal cavity, are perceived long before the pulsations of the heart, or any appearance of that organ are discernible, and are the first indications of life in the embryo. The yellow opaque bodies occupy the shut end of the spire like the testicle and ovarium of the adult. The heart is formed on the left side of the transparent anterior part, and its motions are so great, that at each diastole the whole projecting anterior half of the animal is forced considerably to the right side, causing that part of the body, and consequently the shell, to assume a curved form, with the heart always on the convex side of the curve. The heart pulsates about twenty times in a minute, and the diastole of its cavities is much more sudden and remarkable than the systole. If the motions of the heart were the only powers which turned the body from a straight line, the spire of the *Buccinum* would revolve on the same plane round its shut extremity, like that of a *Spirorbis;* but as the animal's foot requires continually to descend over the *columella* of the shell, before it can reach a solid surface to creep upon, the body and the shell are thus incessantly deflected from the original plane, and forced to assume the spiral form which we observe in the adult *Buccinum,* and in most univalve shells. In the *reverse* shells, where the cone lies on the left side of the animal, we likewise find the heart in a reverse situation, being then on the right side. The two wide projecting circles of *ciliæ* at the sides of the mouth continue visible for some time after the escape of the young *Buccinum* from the general cell, and they are of such length and size that their motions can be easily followed by the eye aided by the microscope. The young of the *Purpura lapillus* are also inclosed in a horny general capsule, like those of the *Buccinum.* The ovum of the *Purpura* is shaped like a grain of corn, while that of the *Buccinum* is flat like a split pea. When first deposited, the horny covering in both is white and soft, but soon becomes yellow and firm, and the transparent gelatinous matter enveloping the young becomes gradually thinner as the young advance to maturity. There are about fifty-five young in each cell of the *Purpura,* and they exhibit the same mode of developement as those of the *Buccinum;* the same revolution of particles within the transparent part of the embryo give the first indication of life, and the same wide ciliated opening is seen on each side of the head, the *ciliæ* continuing to vibrate for some time after the escape of the young from the cell or ovum, as in the *Buccinum.*

These circles of long vibrating *ciliæ* I have also met with in the young of other genera of testaceous mollusca, as the *Trochus, Nerita,* &c. which are not inclosed in a general horny cell, but are merely enveloped in a soft gelatinous matter, by which they adhere to the leaves of *fuci* till they arrive at maturity. In such genera as have the *ova* enveloped only in a soft gelatinous matter, we find a delicate membrane surrounding each *fœtus*, and inclosing a thin amniotic fluid. In these the *ciliæ* are so long, and so rapid in their motions, that the young are seen within the *ova* revolving continually round their own axis, by striking the *ciliæ* against the inside of the containing membrane; and when they escape from the *ova*, they are carried with great velocity through the water by the vibrations of the *ciliæ*. I have observed the same appearances in the young of the naked gasteropoda as in the *ova* of different species of *Doris*, *Eolis*, &c. which are inclosed in a soft transparent gelatinous matter, and adhere by it to rocks or other solid marine bodies. The young in these genera are likewise surrounded, each by a thin membrane and amniotic fluid. They are seen almost continually revolving round their centre within the *ova*, and they swim rapidly forward by the action of their *ciliæ* when they escape from the *ova*. In those genera which deposit the young in a general horny cell, as those first described, we find no membrane or amniotic fluid surrounding each *fœtus*, but the horny covering is lined with a delicate membrane which incloses the whole of the embryos and the gelatinous fluid in which they are developed. The young of the *Buccinum*, when mature, escape from the cell, by a part of the horny covering separating on the inner concave side of the cell. The young of the *Purpura* escape by the falling off of a firm gelatinous plug from the free extremity of the cell. The portions of the outer covering which fall off are probably loosened by the motions of the young within; and as the young are still safely lodged in their cells when they first come in contact with the sea water by the formation of the aperture, we find the *ciliæ* in such genera much less developed than in the other genera without a horny covering. Their motions appear destined to bring a constant supply and renewal of pure sea water in contact with the young in the cells, in order to perfect the formation of the shell before their final departure from the now open cavity of the cell. In the *ova* which are enveloped in a gelatinous connecting matter without any horny covering, we observe that connecting matter become very soft and loose, and separate into long flocculi when the young have arrived at maturity; and when the *ova* separate successively from the general mass by the action of the waves, the young in each *ovum* is so large as nearly to fill the whole of the vesicle which contains it. The *ciliæ* in these species are so long, and move with such rapidity, while the young gasteropod is incessantly revolving round its own centre, that probably the continued pulsations of the *ciliæ* against the sides of the containing vésicle tend to abrade or weaken it, and thus aid the escape of the young animal. After their escape from the vesicles, the rapid vibrations of these long *ciliæ* cause the young animals to swim with great velocity to and fro in the water, which will greatly accelerate their means of procuring food during their infant state; and as they have neither a *byssus* to fix themselves to rocks, nor a calcareous shell to protect them from the violence of the sea, the power of rapid locomotion which they possess by means of the *ciliæ* will add much to their safety in an element in constant agitation.

There is a remarkable similarity in the structure of the ciliated parts in the embryos of all the *gasteropodous mollusca* I have yet examined, and even in the general form of these animals, whether naked or testaceous, in their infant state. The existence of those singular minute vibrating organs termed *ciliæ*, appears not to have been hitherto noticed in animals so high in the scale; but from their general occurrence in this extensive class, it is highly probable that they are much more frequent and important organs in the economy of the lower animals than observation has hitherto shown.

Art. XXVI.—*Description of a New Safety Gas Burner.* * By Mr William Warden, Engineer to the Edinburgh Portable Gas Company. In a Letter to the Editor.

Sir,

I take the liberty of sending you a plan of a safety burner

* In Number iv. p. 345 of this *Journal,* we have given a drawing and description of an improved patent gas burner invented by Mr Jennings, in which the cock shuts itself when the flame is extinguished. Ingenious as this contrivance was, we have no doubt that the following is more simple and efficacious, and more applicable in practice. The Society of Arts has adjudged to Mr Warden a silver medal for this invention.—Ed.

which will stop the discharge of the gas when the flame is extinguished without shutting the stop cock.

My plan or invention for the above purpose is as follows:

Immediately above an argand, or other burner, and surrounding the bottom of the flame, I place a hoop of brass lined with steel, shown at *a b*, Plate I. Fig. 7 and 8, and having an opening on one side at *b*, with a small projection *b*, *c*, on each side of the opening.

The gas being ignited, the brass expands more than the steel, and thereby brings together the opening of the hoop, so as to grasp a piece of metal *e d*, connected to the cock or valve at *g* by the levers *e f*, *f g*.

Should the gas be extinguished, the hoop *a b* cools, and immediately contracts, so as to relinquish its grasp of the piece of metal *d e* in connection with the cock or valve *g*, and by which the said cock or valve is held open, and consequently the end *d* of *d e* escapes from *b c*, and by its descent shuts the cock *g*. Although the hoop above-mentioned has been made of brass and steel, it may be made of any other metals that will act in the same way.

I have sent you a burner and cock fitted up with the above hoop, and a connection with the cock, merely to show you more clearly the principle upon which it acts.—I am, Sir,

Your obedient servant,

Portable Gas Company's Office, Wm. Warden.
21*st April* 1826.

Art. XXVII.—*On the Gradual Changes which take place in the interior of Cupriferous Minerals, while their external form remains the same.* * By William Haidinger, Esq. F. R. S. E. Communicated by the Author.

Mineralogists are very generally acquainted with the crystals from Chessy in France, having the form of blue copper, but consisting of fibrous masses of malachite. Such varieties are found in that locality, as well as perfect homogeneous crys-

* Extracted from a paper read before the Royal Society of Edinburgh on the 16th of April 1827.

tals ; but only extensive collections, or the large quantity gathered and preserved on the spot, both of which I had the good luck to examine, will allow of observing perfect and continuous passages from one to the other, by means of a series, which may be established of the occurring varieties, and of which these may be considered as the extremes. The series begins with such crystals as not only possess the shape of the blue copper, but likewise consist of that substance, with the exception of small particles of the green fibrous malachite, which appear like something foreign, accidentally imbedded in the otherwise homogeneous mass. It terminates in such varieties as scarcely betray the original shape of the hemi-prismatic crystals, the last blue particles having disappeared, and the fibres grown out even beyond the original surface of them, and showing disengaged crystalline terminations. The intermediate members distinctly possess the shape of crystals of the blue copper ; nay, they have occasionally even particles of the original substance here and there distributed over their surface, which to the last preserve a parallel position. They are not displaced by an increase of bulk of the newly formed species. The chemical difference between the two is not considerable. Several analyses published by Klaproth, Vauquelin, and Phillips, agree very nearly with the formulæ proposed by Berzelius, which are $\ddot{C}u\ Aq^2 + 2\ \ddot{C}u\ \ddot{C}^2$ for the blue copper, and $\ddot{C}u\ \ddot{C} + Aq$ for the malachite. The proportions of the ingredients are

	Blue Copper.	Malachite.
Oxide of copper, - -	69.16	71.89
Carbonic acid, - -	25.61	19.96
Water, - - -	5.23	8.15

The change effected during the process of decomposition is the loss of a portion of carbonic acid, which is compensated by an additional quantity of water. If the formulæ above-mentioned are resolved into their constituent parts, as given separately in the analysis, the blue copper is composed of three atoms of oxide of copper, two of water, and four of carbonic acid, while malachite contains three atoms of each. One atom of carbonic acid is therefore exactly replaced by one of water.

Haüy does not consider the crystals formed by aggregated masses of the green filamentous malachite as *Epigenies* of the blue copper, as he unites the two species into one, and rejects the slight difference in the results of the chemical analysis as irrelevant. Beudant, I believe, is the first naturalist who entertained a correct view of this subject.

Not only the blue copper, but also the imbedded octahedrons and dodecahedrons of octahedral copper-ore, are found in that locality in a state of incipient decomposition, resembling it in so far as the form of the crystals is not altered. There is one curious difference, however, in the progress of this decomposition. In the octahedral copper-ore the surface first turns green, by the absorption of oxygen and water, since the protoxide is converted into a hydrate of the peroxide, and then the change penetrates deeper into the mass, forming a more or less considerable coating of compact malachite; whereas the reverse takes place in blue copper, the surface of the crystals being the last portion which is converted into malachite, the decomposition beginning from the point of support. There are crystals of an octahedral form, consisting, at least near the surface, of fibrous malachite, of the same kind as that which often constitutes the body of crystals having the shape of blue copper, for the interior of them generally consists of octahedral copper-ore not decomposed. A dodecahedral crystal of octahedral copper-ore, changed into blue copper on its surface, is preserved in Mr Allan's cabinet, but such examples are rare.

The *cuivre hydro-silicieux* of Haüy, comprehending chrysocolla, is a species not yet well established, as the crystals usually observed in the collections are not in a determinable state. They are for the greater part converted into malachite, but their angles show that in their original state they have not been blue copper. I have seen crystals in Mr Allan's cabinet, pretty distinctly pronounced, in the shape of compressed six-sided prisms, the narrow faces meeting at angles of about 112°, and the narrow, with the broad faces at angles of about 122° and 126°, from which it appears that the original substance, as to form, belongs to the hemi-prismatic or tetarto-prismatic system. There is an angle in Haüy's description of 122° 19′ situated like the one of 122°; but the prism being supposed to be a right rhombic one, it follows that the other two angles will be 115° 22′ and 122° 19′. Besides, Haüy gives a specific gravity of 2.733 to his crystals, while the varieties of chrysocolla never go beyond 2.2. I know only one specimen, with crystals apparently homogeneous, and resembling chrysocolla, engaged in a pale brown clayey substance. It forms part of the magnificent collection of Mr Bergemann of Berlin, who intended to subject it to a chemical analysis, while Professor Gustavus Rose was to examine its mineralogical, and particularly its crystallographic characters. We have therefore to look to the ability and zeal of the Berlin mineralogists and chemists for more accurate information regarding this remarkable substance.

The blue copper, ground to an impalpable powder, is employed as a blue paint, of a very bright tint, paler than the mineral itself. It is not, however, highly valued, because it is apt to lose its original colour, and to turn green. This is mentioned by Haüy, who quotes authorities as old as Wallerius, and even Boetius de Boot, for the colour of the Armenian stone of the ancients.* The decomposition of the blue pigment is a case exactly similar to that of the blue crystals, as presented by the specimens found in mines.

Copper in its metallic state, when exposed to the action of the atmosphere, variously combines with the elements contained in that fluid.† I have seen remains of Egyptian vessels, in the possession of Captain T. D. Stewart, which had formerly consisted of copper or bronze, and still presented the exact outline of their original shape, with a pretty smooth surface. Some of the fragments were nearly one-fourth of an inch thick; but so complete was their disintegration, that they could be easily broken across with the hands, presenting on their fracture a compound mass full of small drusy cavities. In these the octahedral crystals of the copper ore, of which the whole mass consisted, were distinctly visible. The curved surface of most of the vessels was covered with atacamite,

* *Traité de Min.* 2de Edit. t. iii. p. 503

† This fact is mentioned in the translation of Mohs' *Treatise on Mineralogy*, vol. ii. p. 383.

sometimes crystallized, particularly on the concave sides. There were some white patches also which I did not then examine. During his residence in the Ionian Isles, Dr John Davy has paid much attention to similar changes which have taken place in ancient Greek armour and coins. He found * that the substances forming green, red, and white spots on the surface of these articles, consisting of alloys of copper and tin, were carbonate and submuriate of copper, octahedrons of the protoxide and pure metallic copper, and oxide of tin. In several instances there was no metallic copper formed, and the protoxide was blackened by an admixture of peroxide. Since it cannot be supposed that the substances formed on the surface of these bronze articles were deposited from any solution, Dr Davy infers that an internal movement of the particles must have taken place, caused by the influence of electro-chemical powers. Dr Davy's opinion, that such considerations will explain many phenomena occurring in the mineral kingdom, is shown to be perfectly correct by many facts observed in nature. In the native copper I never could observe any such changes, though I have examined a great number of specimens with the view of discovering them; but we have probably to attribute to the admixture of tin, and the electro-chemical action dependent upon the contact of the two metals, the greater disposition of bronze to form new compounds with the elements contained in the atmosphere and in water.

There are several species, in the composition of which sulphuret of copper enters as one of the most important ingredients, as the prismatic copper-glance, or vitreous copper, and the octahedral and pyramidal copper-pyrites, or the variegated copper and copper-pyrites. All of them are more or less subject to successive changes in their chemical constitution, while the form in some cases remains, and in others is entirely lost. Mr Allan is in the possession of a very interesting and numerous series of copper-ores, which he collected chiefly in the summer of 1824, on a journey in Cornwall, in which I had the pleasure of accompanying him. This series has given me an opportunity of noticing several peculiarities which had not been mentioned before by mineralogists.

* *Philosophical Transactions* for 1826, p. 55.

Dark grey crystals of copper-glance, with a bright metallic lustre, are often deposited on low six-sided prisms, with a tarnished surface, which, in respect to form, entirely agree with that species. Their surface, however, is never perfectly smooth. On breaking them they do not present a uniform appearance; generally the portions nearest the surface consist of the reddish metallic substance of variegated copper having an uneven fracture, while the rest possess the grey colour and perfect conchoidal fracture of the copper-glance. Often, and particularly in thin plates, the whole shows the appearance of variegated copper, whereas in large crystals the two species are more or less irregularly mixed up with each other. These prisms are sometimes more than an inch in diameter, but are usually smaller. The copper-glance, which originally occupied the regularly limited space, has been succeeded by variegated copper. The arrangement of the portions of both species in successive coats shows that the decomposition proceeded from the surface.

On breaking some of the six-sided prisms here alluded to, I found a stratum of copper-pyrites of its usual bright yellow colour contiguous to their surface, while the rest consisted of variegated copper. The original form had here still been preserved, but a new change in the chemical constitution had converted the variegated copper into copper-pyrites. The peculiar twin-crystals discernible in groups of six-sided plates crossing each other at nearly right angles, and the distinct form of the six-sided plates themselves, leave no doubt that two of Mr Allan's specimens, consisting entirely of copper-pyrites, owe their origin to the decomposition of copper-glance. One of them is covered with a black pulverulent oxide, but the surface of the other is perfectly bright, and of a fine brass-yellow colour. It presents to the observer the deceitful and puzzling appearance of copper-pyrites crystallized in nearly regular six-sided plates. No cleavage can be traced; but as this is not easily obtained in any of the species, it cannot form, in the present instance, a sufficient distinctive character between the simple and compound minerals.

The variegated copper itself occurs in distinct crystals, mostly small, which are hexahedrons. Some larger ones, but with curved and irregularly formed faces, occur in regular compositions, similar to those of fluor, two of them joining in a twin, which may be supposed in transverse position to each other in reference to one of the rhombohedral axes of the hexahedron. Each of these groups contains in its interior a six-sided prism, whose smooth surfaces may be relieved from the surrounding homogeneous mass merely by breaking off the latter. The position of this prism is such, that its planes, within the angles different from 120°, agree in position with the prism $R + \infty$, which is the limit of the series of rhombohedrons, the hexahedron showing here the properties of this form in regard to the principal axis of the enveloping twin-crystals of variegated copper. There is a face of the hexahedron contiguous to every lateral face of the six-sided prism; nay, it is possible that the existence of the twins depends upon that of the prisms, which might exercise a considerable influence in the deposition of the particles of the species of variegated copper. The substance of the prisms themselves is likewise variegated copper. They are divided into thin laminæ parallel to the base of the prisms, having externally a black colour, and scarcely any lustre, but presenting the usual appearance of variegated copper when broken across.

The original form is generally lost when the decomposition proceeds farther. In this case, what is usually called black copper will remain, a more or less pure peroxide of copper, which forms pulverulent masses. A specimen in the collection in Gratz, from the Bannat, with crystals of the form of copper-glance changed into this substance, is the only one I remember ever to have met with, in which the change has proceeded so far without at the same time altering the form. It is probable that it has taken place immediately, and not proceeded through the stages of variegated copper and copper-pyrites, though both of them, when decomposed, will likewise yield a black powdery residue.

The prismatic copper-glance is a pure sulphuret of copper, whose composition is expressed in Berzelius's chemical formula $Cu\ S$, the two ingredients, copper and sulphur, being in the ratio of 79.73 and 20.27. Most analyses give a slight quantity of iron.

According to the analysis by Mr Richard Phillips of a specimen of variegated copper from Ireland, this species is composed of one atom of protosulphuret of iron, and four atoms of sulphuret of copper, or $Fe\ S^2 + 4\ Cu\ S$. The three ingredients, copper, iron, and sulphur, are in the ratio of 62.67, 13.44, and 23.89.

The composition of copper-pyrites, from the analyses of Professor Henry Rose, might be considered as being essentially one atom of protosulphuret of iron, and one atom of a sulphuret of copper, which contains twice as much sulphur as the native sulphuret, the latter forming the species of prismatic copper-glance. Professor Rose is of opinion, however, that the copper contained in the mineral is in combination only with one atom of sulphur, as in other species, and that the whole mixture should be considered as a compound of one atom of protosulphuret of iron, one of persulphuret of iron, and two of the sulphuret of copper. The chemical formula is therefore $Fe\ S^2 + Fe\ S^4 + 2\ Cu\ S$, and the three ingredients, copper, iron, and sulphur, are in the ratio of 34.80, 29.83, and 35.37.

The changes, therefore, can be explained upon the supposition, that the copper contained in the original species has been replaced by iron, in a smaller quantity, however, as every particle of iron required twice the quantity of sulphur to be converted into protosulphuret in the variegated copper, and four times the quantity for that portion of it in the copper-pyrites, which is in the state of persulphuret. The compound of protosulphuret and persulphuret of iron, which, in the last species, is joined to the sulphuret of copper, is one of those forming the chemical constitution of magnetic pyrites.

When the sulphur is entirely driven off, and the copper attracts so much oxygen as to be converted into the peroxide, the substance of what is usually called black copper results. During this process often some of the carbonate is likewise formed.

Art. XXVIII.—*Account of the Diamond Workings and Diamonds of Sumbhulpore.* * By Peter Breton, Esq. Surgeon, Superintendant of the School of Native Doctors at Calcutta.

The districts of Chota, Magpore, and Sirgoojah, are not marked for their mineral productions, but Sumbhulpore † has been, from time immemorial, distinguished for its production of the finest oriental diamonds in the known world. They are occasionally found in the bed of the Mahanuddee, and at the mouths of other rivers which terminate in it. The following is an extract from the observations of a gentleman, whose source of information on this interesting subject was the best that could be obtained in Sumbhulpore.

"The Mahanuddee is navigable for six months in the year, though not without obstructions and difficulties for boats of three to four hundred Maund's burthen, from the sea to Sooreenarain, which cannot be less than 380 miles, and for smaller vessels as far as Sumbhulpore for ten months. Diamonds of various sizes, and of the first quality, are occasionally found at the mouths of the rivers Maund, Keloo, Eeb, and others, which all have their sources in the mountainous parts of Koorba, Sirgoojah, Raegurh, Jushpoor, and Gangpoor, and fall into the Mahanuddee on its left bank. They are also picked up after the termination of the rains amongst the mud and sand deposited on the beds of islands on the left bank, where the stream, being resisted, makes a sharp turn, by persons of a peculiar class, whose occupation it is to search for them. I cannot learn that diamonds have ever been found on the right bank of the Mahanuddee, or on the left bank above its confluence with the Maund at Chunderpore, or below Soanpore. It would appear, therefore, that they are washed down from the sides of the streams which flow from north to south through the mountainous and almost inaccessible track which occupies in Arrowsmith's Map, the 83d and 84th degrees of east longitude, and 21st and 22d degrees of north latitude. This

* This curious paper is abridged from the *Transactions of the Medical and Physical Society of Calcutta,* vol. ii. p. 261.

† The valley of Sumbhulpore is 410 feet above the sea.

inference is farther supported by the fact of their being not unfrequently met with in the beds of Nullahs in Raigurh, Jushpore, and Gangpore, though I have no reason to think that any attempt has been ever made to discover and open their mines or beds; and this may be chiefly accounted for by the state of society and government in these wild regions. Any attempt on the part of a private individual to appropriate to himself, or conceal a diamond, would, if discovered, have been assuredly punished with death; and the rajahs have mutually preferred this scanty and uncertain acquisition of precious stones in the manner I have described, to the publicity and consequent interference of the Mahomedan or Marhatta sovereigns, by whom they were in turn ruled, which would necessarily have resulted from the establishment and working of mines. Another obstacle has doubtless been the extreme insalubrity of the climate of the track under consideration,—an insalubrity which the observation of many years has convinced me always attached to mountainous and woody districts, in which gold and diamonds are indigenous. None but natives of the wilds, whose appearance sufficiently marks the ravages of disease, can enter them with impunity, excepting in January and the three succeeding months, and this would form the chief objection to the employment of skilful European mineralogists, whose researches, if they could be adequately persevered in, would, I am sanguinely of opinion, be attended with very interesting and important results.

"There were two tribes or casts of diamond searchers in Sumbhulpore, of whose origin, or of the period of their settlement in this part of the world, I can learn nothing. They have the appearance, however, of aborigines. The names of the tribes are Ihara and Tora. Sixteen villages of the poorer description have been always enjoyed by them in rent-free Jageers; of these four are in the hands of the Toras, ten possessed by the Iharas, and two have been given to their tutelary deity Bukeser Pat, an appellation of Mahadeo. They are under the direction of three chiefs, or Sirdars, two of the Ihara tribe, called Pater and Buhera, and one of the Tora, styled Seeree Ghakur. They search for gold as well as diamonds, and are allowed to dispose of all the former article they pick up. Their habits are extremely dissipated; and when they find a diamond they spend the money it procures for them in a continued scene of debauchery. In the Pergunnahs of Raegurh, Sonepoor, Jushpoor, and Gongpoor, are also to be found persons of this kind. In the two last mentioned a species of gold mine is to be found, the aperture only just large enough for a man to descend, but of considerable extent below. An account of the mine in Gongpoor, from which it is stated to me that a species of pure gold of considerable size have been obtained, remains to be submitted."

The diamond searchers, with their women and children, amounting to between four and five hundred persons, are annually employed from the month of November till the commencement of the rainy season in searching the bed of the Mahanuddee for diamonds. They examine such parts of the river as are obstructed by rocks from Chunderpoor to Sonepoor, a distance of about 120 miles, and all the hollows in the bed of the Mahanuddee in which alluvial matter is deposited. The process pursued by the searchers is extremely simple, and three implements only are used by them. The first is a kind of pick-axe, with one pick called ankooa; the second a plank of about five feet in length, and two feet in width, made a little concave towards the centre, and a rim of three inches in height on each side, called Doer; and third, a board of similar form, but only half the size of the former, called Kootla. With the pick-axe the earth is dug out of the hollows, and collected in heaps near the stream; pieces of this earth are then placed by the women on the large board, which is so inclined as to allow the earth, when mixed with water, gradually to run off; the pebbles and coarse gravel are then picked and thrown away, and the remaining mass is afterwards removed from the large to the small board, and spread over the latter, to admit of every particle being minutely examined, and gems and grains of gold, if any be present, being collected. The earth in which the diamond is usually found consists of a mixture of stiff reddish clay, pebbles, and a small proportion of sand, and a little oxide of iron. This earth the searchers take particular pains to find, and they examine every particle of it with the greatest attention.

"Although employed exclusively in this occupation from time immemorial, the Iharas have not the remotest idea of what constitutes the matrix of the diamond. Mr Mawe, in his *Account of the Diamonds of Brazil*, states, that 'the only places where diamonds have certainly been found in modern times are the central and southern parts of India proper, the peninsula of Malacca, the Island of Borneo, and the mountainous district called Serro Dofrio, and other places in Brazil. Neither the rock in which it occurs, nor the other minerals with which it is accompanied in Malacca and in Borneo, are at all known. In India it is found in detached crystals, in a kind of indurated ochrey gravel; but whether or not this is its native repository is uncertain.'

"The diamonds of Brazil, like those of India, are found in a loose gravel-like substance, immediately incumbent on the solid rock, and covered by vegetable mould and recent alluvial matter. This gravel consists principally of rounded quartz, pebbles of various sizes mixed with sand and oxide of iron, and inclosing rounded topazes, blue, yellow, and white, and grains of gold. In some parts of the diamond territory of Serro do Frio, which I visited, the gravel is cemented by means of the oxide of iron into a considerably hard conglomerate, forming rocks and low hills. On the sides of these are water courses produced by the torrents during the rainy season, the beds of which are very unequal and excavated. In these hollows diamonds are not unfrequently discovered. The usual and regular method of searching for diamonds is to collect the disintegrated conglomerate in which they are found at the bottoms of rivers and of ravines, and by a laborious process of washing as long as the water comes off discoloured, to separate the mud from the distinct grains. The residue thus cleaned is subjected to an accurate examination for the diamond which it may contain. These are distinguished partly by their crystalline form, but principally by their peculiar lustre, slightly verging on semi-metallic, but which cannot be adequately described by words.

"If the above-mentioned conglomerate is not the real matrix of the diamond, its true geological situation is unknown, for it has never as yet been discovered in any other rock."

Now, although the Sumbhulpore diamond is more frequently found in the red earth above described, yet it is now and then met with in other kinds of compositions. The proof of this red conglomerate being its matrix is by no means established. In the late Dr Voysey's *Description of the Diamond Mines in Southern India*, it is stated that the only rock in which the diamond is found is the sandstone breccia. *

In the reign of the former rajahs and ranees in Sumbhulpore, the right to all diamonds found in the bed of the Mahanuddee was established, and on a diamond of magnitude being found by the Iharas, the finder was rewarded by a grant of a small village in Jageer, and by presents in money and clothes. When detected in secreting a diamond, they were punished with death, or by being severely beaten and deprived of their Jageers, and of the privilege of again searching for diamonds.

The facility with which a diamond, when found by the Iharas, can be secreted, (for, instead of vigilance being exercised over them, they are left to use their own discretion in searching for this gem,) and the extreme difficulty in detecting the fraud, render it more than probable that many very valuable diamonds are at this moment in the possession of the finders, which they are afraid to disclose. For in 1818, on the power of the British government being established in Sumbhulpore, a diamond, which had been secreted by the searchers from the former rulers of Sumbhulpore, was actually brought and delivered to the late political agent, and by him sent to government as a part of the property of Sumbhulpore, which, by right of conquest, became the property of the state. It weighed eighty-four grains, and was valued at 5000 rupees.

At Sumbhulpore the quality of the diamond is named after the four tribes of the Hindoos. A diamond of the first quality is called Brahmin; the second is named Chetree; the third Bysh; and the fourth Soudra; and, from experience, the native jewellers judge pretty accurately of their respective qualities. The weights they employ for weighing the diamond are the ruttee and masha, the former is a fraction less than two grains troy weight, and seven ruttees make a masha. Rough diamonds are estimated according to their quality. The first

* See this *Journal*, No. xi. p. 97.

quality is valued at per masha, 500 sicca rupees; second at 400 sicca rupees; third at 300; and fourth at from 175 to 200 sicca rupees per masha. This mode of valuing a rough diamond is somewhat different from the rule laid down by Jeffries for ascertaining the value of this gem in its native state. According to Jeffries the carat weight of a rough diamond is squared, and then multiplied by 2, and the product is the value of the gem in pounds Sterling. For example, a diamond of 20 carat weight, $20 \times 20 = 400 \times 2 =$ L. 800 Sterling. If the product of the square of the carat weight of a cut diamond be multiplied by 4 instead of 2, its total will be the value of a cut diamond in pounds Sterling. This rule applies only to diamonds of small weight, for the value of a diamond of magnitude increases, without any established rule, rapidly with its size.

The only account of the rough diamonds found in the Mahanuddee, and delivered by the finders to the legal owners of them, that I can find, is the annexed.

Years.	No. of Diamonds.	Weight.			By whom received from the Diamond Finders.
		Mashahs.	Ruttees.	Troy Weight, Grains.	
Unknown	1	20	4	288	Ranee Ruttun Coher.
1804	1	4		56	Do. Do.
1805	1	7		98	Do. Do.
1806	none				
1807	1	22		308	Do. Do.
1808	1	1		14	Do. Do.
1809	1	48		672	Chunderjee Bhoonsla, Coms. in Sumbhulpore.
	3		$3\frac{1}{2}$	7	Do. Do.
	1	1		14	Sacca Ram Gopaul.
1810	2	$2\frac{1}{2}$		35	Chunderjee Bhoonsla.
1811	1	4		56	Do. Do.
1812	none				
1813	1	2		28	Mahadeo Rae.
1814	none				
1815	1	2		28	Do. Do.
1816	1		$6\frac{1}{2}$	13	Do. Do.
1817	1	2		28	Do. Do.
	1		2	4	Do. Do.
1818	1	6		84	Do. Do.
	1	1		14	Do. Do.

"The large diamond found in 1809 was of the third (Byshes) quality. It was picked up in the month of October at a place called Herakode, in the bed of the Mahanuddee; and its delivery to Ranee Ruttun Coher was unluckily delayed on account of her being engaged in performing the funeral ceremonies of her husband's mother; and before they were finished the Mahratta troops arrived and expelled her from the country. A traitorous servant of hers betrayed the secret of the valuable stone to Chunderjee Bhoonsla, the commanding officer, who persuaded the diamond finders to surrender it to him by promises of the grant of a fine village and a thousand rupees. On the following morning, when they appeared to claim performance, they were reproached for bringing a stone instead of a diamond, and driven from his presence."

Art. XXIX.—*Notice of some Remarkable Twin-Crystals of Phillipsite.* By Baron Von Beust of Dresden. With Observations by W. Haidinger, Esq. F. R. S. E.

Near the village of Sirkwitz, between Loewenberg and Bunzlau, in Lower Silesia, there are two quarries in a compact, black, columnar basalt, situated on the right bank of the river Bober. Throughout the rock are found less compact portions, often of the size of a man's head, consisting of a brown earthy mass, in which a great number of the crystals of Phillipsite are imbedded. Sometimes they occur also in the compact basalt.

Both simple crystals and twins, or regularly compound ones, are found among them. The former do not so much occur singly, as rather aggregated in small imbedded groups, and show the simplest forms known in the species, the four-sided prism, terminated by a four-sided pyramid, whose faces are striated parallel to two of its terminal edges. In the twin-crystals the extent of the two individuals is very frequently so nicely balanced that the result is scarcely distinguishable from a simple form belonging to the pyramidal system. The striæ on the faces of the pyramid, when minutely examined, always yield the means of ascertaining the actual compound state of the crystals.

Figure 4, Plate II. represents a very remarkable one among the crystals which I have observed. The portions *a*, *b*, *c*, *d*, belong to one individual, while *e* and *f* are portions of the corresponding faces of the other. The substance of the two individuals is so irregularly continued beyond the face of composition, that it is difficult to say how this face is situated.

The hardness of the crystals I found = 4.5, (between fluor and apatite,) and their specific gravity = 2.2.

Observations.

With the paper from which the preceding account is an abstract I was favoured by the Baron Von Beust, a distinguished pupil of Professor Mohs, for the purpose of inserting it in some future portion of my paper on the regular composition of crystallized bodies. The mineral was named by him *Paratomous Kouphone-spar*, or *cross-stone*, but as, from the specific gravity given = 2.2, it rather appears to belong to what has since been described under the name of Phillipsite, I thought that the value of his communication would be better appreciated if given by itself. From the circumstance of this low degree of specific gravity, I was led again to ascertain that of several substances usually considered as varieties of harmotome, some of which proved to agree with the mineral of Baron Von Beust, while others were considerably above it. The following were the results which I obtained:—

1. Fragments of large crystals from Strontian in Argyllshire, - - - 2.429
2. Detached crystals from Andreasberg in the Hartz, 2.435
3. Crystals of a greyish-white colour, occurring associated with analcime in trap, at Campsie in Stirlingshire, - - - 2.446
4. Another variety from the same locality, but of a pale reddish-white colour, - - 2.467
5. Large crystals from a cavity in basalt from the Giant's Causeway, - - 2.259
6. The Phillipsite of Levy from Aci Reale in Sicily, 2.200

The last result may perhaps be liable to a slight correction, as the whole quantity I had to operate upon did not exceed 220 milligrammes. It is however decidedly inferior to the specific gravity of the harmotome properly so called. This variety occurs in small crystals aggregated in globular shapes, which again form together reniform coatings in the cavities of an amygdaloid. The crystals are very easily separated by the slightest pressure.

7. The milky opaque crystals from the inside of cavities of an amygdaloid from Vesuvius, 2.190.

The latter were sometimes considered as harmotome, but more frequently went by the name of abrazite. From the exceedingly minute quantity of the crystals I could detach, this specific gravity, like the preceding one, should again be determined from a more considerable quantity. These crystals, when exposed to the action of the atmosphere, are inclined to be decomposed, and though they preserve their external shape, they present, when broken across, a fibrous tissue, analogous to the crystals, which once were blue copper, but have been changed into malachite.

So many different results have been obtained by chemists on analyzing the varieties, formerly comprised under the name of harmotome, that an exact indication of their physical properties now becomes imperiously called for, in order to inform us what we should consider as a species, and what as a variety. It appears distinctly that there are differences in the specific gravity, which no doubt correspond to the chemical composition, in as much as some kinds, besides silica, alumina, and water, contain baryta, others lime, and others lime and potassa. The regular forms, that is to say the angles of the crystals, have not been ascertained in any of them, chiefly owing to the great difficulty of procuring specimens that will allow of a minute examination. This nevertheless is unavoidably requisite to fix our opinion on the subject. The question is one of great importance, as it refers to the influence of the substitution of one isomorphous substance for another in a chemical mixture of the same description, on the determination of the mineralogical species. It is only the actual examination of their physical properties that can decide on the latter, whatever may be the results of chemical analysis.

Art. XXX.—*Description of a Stereometer.* By James Alexander Ventress, Esq. Communicated by the Author.

The bulk of a known weight of solid, of irregular figure, is generally obtained by immersion in water. In the common weighing bottle for ascertaining the specific gravity of solids in the state of powder, a known weight of the powder is introduced into a phial, and the interstices filled up with water, the difference between the quantity of water required to fill the phial when empty, and after the powder is introduced, being evidently the bulk of the powder. But if the powder dissolve in water or the liquid employed, we obtain by this means not the space which the substance occupies in the solid state, but that which it occupies when in solution. The difference is considerable and irregular.

The stereometer which I propose is not liable to error from this source. In the coniometer of Captain Say and Mr Leslie errors of this kind are also avoided, although in a way totally different.

To illustrate the principle of the instrument proposed, let us suppose a quantity of any powder or saline body, which we wish to examine, to be introduced into the common weighing bottle, and a phial full of water adroitly inverted over it, so that the system was air-tight. The water in the superior phial would descend, and fill up the interstices of the powder, while the displaced air would ascend and occupy the upper part. It is evident that the quantity of air in the upper phial will represent the interstices of the powder, or the difference between the bulk of the powder and the capacity of the weighing bottle, which is known. In the weighing bottle we learn the bulk of the solid by marking the quantity of water necessary to fill up the interstices; in the stereometer proposed, by measuring the air which previously occupied these interstices. The following construction is found to be particularly convenient for that purpose.

As in the illustration, two vessels, A and B, are employed, (See Plate II. Fig. 2,) A being analogous to the weighing bottle, and B to the inverted phial. A is ground so as to fit into B air-tight, and is intended for the reception of the solid. B contains a glass stop-cock near that extremity into which the vessel A is ground to fit. Through its perforation, the vessel B is filled with water previous to each experiment. Upon joining the two vessels and turning the stop-cock, the water in B descends and displaces the air in A, which is made to contain just as much water as the ball and stem of B. If, therefore, the vessel A were empty when the water is allowed to descend, the air which it contained would evidently occupy the whole of the ball and stem of B ; but if a quantity of solid matter has been introduced into A before the water is allowed to descend, the air which rises into B will be diminished by the bulk of the solid, and the water will not fall to the bottom of the stem as in the former case, but stand at a certain height in it. That the height at which the water stands in the stem may be easily appreciated, it is graduated from the bottom upwards into hundredths of a cubic inch of its capacity. If, with a known weight of powder, the water stood at the point marked 50 on the stem, the bulk of the substance would therefore be $\frac{50}{100}$, or $\frac{1}{2}$ a cubic inch. Knowing thus the weight of a certain bulk of the substance, we have only to compare it with the bulk of the same weight of distilled water, to obtain an expression for the specific gravity of the substance on the usual scale.

In the instrument which has been constructed, and which is represented in the figure, the lower vessel, or rather the lower vessel together with that part of the upper vessel which is beneath the stop-cock, contains 2.33 cubic inches, which is also the sum of the capacities of the ball and stem. The stem itself contains 1.40 cubic inches, is long (sixteen inches,) and widened into a ball at the top, the only use of which is to enable us to dispense with a great length of tube, which would inevitably follow from its being so small as above described, and which smallness is requisite for the delicacy of the instrument.

The construction of the instrument might perhaps be considerably facilitated, by making the part of B (see Fig. 2.) under *b*, of brass, with a brass stop-cock. To the neck of A a brass ring might be cemented, and the two vessels made to fit into each other by screwing. To avoid the slight compression of air in A, which it would be difficult to avoid in screwing, a minute hole might be drilled into B at *p*, into which a small screw should be passed after the connection between A and B is completed. *

Should a portion of the substance of which we wish to ascertain the specific weight be dissolved by the water, which occurs in nearly all saline bodies, the liquid would be slightly expanded, or contracted from that cause, and consequently the air above would be proportionally condensed or rarified. When solution takes place the liquid more generally contracts, as the density of a solution is generally greater than the mean density of its constituents. The air above is therefore in most cases of solution slightly rarified.

But this is easily corrected by separating the parts A and B under water, and then sinking B till the surface of the water in the stem coincides with the surface of the water without. In this way we obtain the true specific gravity of the substance in the solid state.

It is proper always to employ water which has been recently boiled, and which contains little air, to fill the upper vessel, as many salts, when dissolving, appear to disengage the air which water holds absorbed, which, mixing with the air from the interstices, would derange the calculation. It has been found that air passing up so rapidly through the boiled water, as it does in the present case, is not sensibly absorbed, so that no error of an opposite kind is committed by employing water previously deprived of most of its air.

ART. XXXI.—*Notice of some new observations by Mr Brooke on the Sulphato-tri-carbonate of Lead.* By WILLIAM HAIDINGER, Esq. F. R. S. E.

MR Brooke has communicated to me, in a letter of the 14th of May, some very important observations on the optical structure of certain varieties of the sulphato-tri-carbonate of

* Stereometers, with such modifications, may be had handsomely executed, from John Dunn, optician, 25, Thistle Street, Edinburgh.

lead, which I am confident will lead to such a thorough examination of this substance, as cannot but remove every doubt or difficulty still prevailing among many mineralogists as to the perfect establishment of the species in all its physical properties.

During an optical examination lately commenced, Mr Brooke was surprised to find that the two first crystals of the sulphato-tri-carbonate of lead, the first substance he examined, had only one axis of double refraction.* They had the form of rhombohedrons with truncated apices. One of them was yellow, the other green. He found this to be the case in all those varieties whose forms appeared to be rhombohedrons with truncated apices, also in some green hexagonal prisms, and in a yellow hexagonal prism terminated by trihedral pyramids. On the contrary, he found the flat crystals, some yellowish, or colourless, or greenish, to have two axes inclining to each other at small angles, for the accurate admeasurement of which he was getting constructed a particular instrument. He says that he has not yet sufficiently examined the crystalline forms of the biaxal crystals; but that he suspects they will, if not rhomboids, turn out to be right rhombic prisms.

Mr Brooke proposes also to examine chemically these two sets of crystals, which, on the supposition of their forms being connected partly with the right rhombic prism, and partly with the rhombohedron, provided also that they contain the same ingredients, would be in a similar relation to each other, as arragonite and calcareous spar.

* I have examined some of these crystals sent to Mr Haidinger, and find that they have one negative axis of double refraction coincident with the axis of the rhomb, and without any trace of composition. The optical law of primitive forms thus derives an additional support from this observation.—D. B.

Art XXXII.—*On the Structure and Characters of the Lernæa elongata*, Gr. *a New Species from the Arctic Seas.* By R. E. Grant, M. D., F. R. S. E., Fellow of the Royal College of Physicians of Edinburgh, and formerly Lecturer on Comparative Anatomy. Communicated by the Author.

The various classes of animals spread over the globe, whether inhabitants of the dry land, or of lakes and rivers, or of the atmosphere, or dispersed through the vast abyss of the ocean, find in the rich and varied clothing of organic matter covering the nakedness of the earth, sufficient nourishment not only for their own subsistence and growth, and for the continuance and multiplication of their species, but likewise sufficient to enable each individual to support various tribes of parasitic inhabitants. Innumerable species of *Insects*, *Arachnidæ*, and *Annelides* move to and fro on the surface of their bodies, feeding on the excreted matters of the skin, or sucking the vital fluids from the interior. Various kinds of *ova* are deposited, matured, and hatched under the skin, although the animals they contain are not destined to a parasitic life. An immense variety of *Worms* live and propagate, imbedded in the muscular and cellular tissues, in the internal cavities and vessels, and in the parenchymatous substance even of the best protected organs of the body. And various fluids and secretions of the living system contain myriads of *Infusoria*. The class of Worms, to which the following undescribed animal is considered as most nearly allied, contains the most remarkable forms, and the greatest number of species of parasitic animals; and from their ravages in the living body of man, and of the animals most subservient to his wants, from the very equivocal nature of their origin, and from their singular forms, structure, and habits, these species have engaged the particular attention of many distinguished naturalists, as Redi, Le Clerc, Muller, Bremser, Rudolphi, &c. Although most parasitic worms live entirely imbedded in the animals on which they feed, the remarkable tribe of *epizoariæ* to which the *Lernæa* belongs, are found only attached to the surface, or partially buried in the superficial soft parts of marine and fresh-water fishes, while the rest of their body hangs constantly exposed to the action of the external element. From this partially exposed situation of the *Lernææ*, they partake of a mixed life, exhibiting in the same individuals a combination of the characters and forms both of *entozoa* and of *insects*. Like intestinal worms, they have a simple structure, a soft, naked, and feebly irritable body, they are permanently fixed to the animal, and they live by sucking the internal fluids. From the external situation of the *Lernææ*, however, they have not only organs for piercing and sucking the animal substance like *entozoa*, but also parts variously constructed for attaching themselves to the surface of the body like *insects*; they exhibit the rudiments of antennæ, and some of the species are asserted by Blainville to have sessile eyes. (See *Journal de Physique*, xcv. 374.) The constant exposure of their body to the vicissitudes of a foreign element has rendered it more consistent and stiffer than in those which are always buried in the fleshy substance, and consequently the *Lernææ* exhibit the rudiments of articulations to admit of their necessary movements, like the higher animals which have an external or internal skeleton. No articulations are necessary where the animals are composed entirely of soft parts. These affinities with the higher classes of invertebrate animals, which have induced Lamarck to consider the *epizoariæ* as a distinct class, higher in the scale than worms, and which have greatly perplexed other naturalists in their classification, are well exemplified in the *Lernæa elongata*, particularly in the perfect symmetry of its form, in the great length and regularity of the two tentacula, in the distinctness and firm texture of the head, in the rudimentary antennæ and appendices of the mouth, and in the regular form of the body and two ovaria.

The *Lernæa elongata*, which I have so named from its very elongated and slender form, has been several times observed attached to the eyes of the Greenland shark by that enterprising and intelligent navigator, Captain Scoresby, and is mentioned and figured in his *Account of the Arctic Regions*, (vol. i. p. 538, and Pl. XV.) as "a singular appendage to the eye" of that animal. "To the posterior edge of the pupil of the

Greenland shark," (he says,) " is attached a white vermiform substance one or two inches in length. Each extremity of it consists of two filaments; but the central part is single." Two specimens of this remarkable parasite, preserved in spirits along with the eyes of the shark to which they adhered, were brought by him some years ago from the Arctic Seas, and presented to Dr Brewster, then engaged in investigating the structure and functions of the organ of vision, who has kindly favoured me with the larger of the two specimens, nearly three inches long, and probably the largest *Lernæa* hitherto met with. From the corrugated appearance of the tentacula, and the firm texture of the whole body, this specimen appears to have contracted by the long action of the spirits. In its present state the dimensions of its parts are:—

		Inches.	Lines.
Tentacula,	length, -	1	1
	thickness,		$\frac{3}{4}$
Head,	length, -		$1\frac{3}{4}$
	breadth, -		$1\frac{1}{2}$
Body,	length, -		$7\frac{1}{2}$
	breadth, -		2
Ovaria,	length, -	1	$1\frac{1}{2}$
	thickness, -		1

It has a straight, lengthened, and slender form, without any lateral prolongations or branchial appendices. Its surface is naked, smooth, glistening, and of a pale yellowish white colour; and it has a pretty firm cartilaginous consistence, probably increased in the present instance by the action of the spirits. It consists of two long cylindrical *tentacula* (*a*, *b*,) Plate II. Fig. 5, by the extremities of which it adheres to the outer surface of the cornea of the shark; a very distinct depressed *head*, (*c*, *d*,) with four antennæ, and two hooks at the sides of the mouth; a subconical *body*, (*d*, *e*,) tapering above towards the head, and terminated below by a broad base, in the middle of which are two thick pendent *labia* concealing the anus (*e*;) and two long, thick, cylindrical *ovaria*, (*f*, *p*.) The *tentacula* arise from the sides of the lower surface of the head, and appear a little compressed and contracted at their origin, (*b*.) From this part they are regularly cylindrical, and taper almost imperceptibly to near their extremities, where they taper more suddenly, and terminate in four small round fleshy tubercles surrounding a very small amber-coloured horny disk. They are covered with a thick, transparent, colourless, and tough membrane, deeply marked transversely with numerous corrugations, and through which we can perceive with a common lens numerous white longitudinal striæ composed of muscular filaments. The outer transparent membrane appears quite homogeneous. The two horny disks of the tentacula were applied closely to each other, buried in the substance of the cornea, and covered with a hard transparent amber-coloured substance, which cemented their concave surfaces firmly together. Other fourteen circular diseased marks were discoverable on the transparent cornea, occasioned either by the bites of the same animal, or by the attachment of different individuals. The interior of the tentacula contained a white soft flocculent matter, surrounding a thick central fasciculus of very coarse straight stiff fibres of a grey colour, extending the whole length of the tentacula. The white longitudinal muscular bands were very distinctly seen on the inside of the tough covering of the tentacula, and a tough white filament, sending off branches like a nerve, was found running along the whole cavity of each tentaculum. This nervous filament was proportionally as large and distinct as that found in the central cavity of the arms of cephalopodous animals. There is a very thin layer of white transverse muscular filaments surrounding the tentacula exterior to the longitudinal bands. On examining the extremities of the tentacula under the microscope, I could perceive no reflected teeth on the tubercles or disk for piercing, as we find on the anterior tubercles of the *Echinorynchus* and other *entozoa.*

The *head* is shaped like the body of a common spider-crab, being broad and round behind, and tapering to a point on the fore part. It is convex, smooth and glistening above, and on each side of its anterior margin there is a small white knotted process *(c)* like the rudiment of a jointed antenna. Immediately below the beak we observe the circular extremity of a short cylindrical tubular proboscis, *(h)* at each side of which there is another very small and soft antenna, *(n, n.)* Beneath this second pair of antennæ, there are two rudimentary lips embracing the proboscis. Near the back part of the lower surface of the head arise two fleshy peduncles *(m)* from the same broad fleshy protuberance, and extend forward along the base of the head. Each of the fleshy peduncles is terminated anteriorly by a broad compressed white horny hook, *(l)* curved inwards, and tuberculated on its concave margin like the pincers and the inner jaws of a crab. The hooks are strong, white, opaque, and elastic; and the outer covering of the whole head is of an elastic horny texture, so transparent on the upper surface as to allow the internal parts to be seen through it. On removing this horny case from the head, a very complicated, though extremely minute structure presented itself beneath. Within the anterior prominent beak there was a white pulpy matter like the ganglion we find in that situation in crabs, and the nerves of the tentacula could be traced nearly to that part. There was no appearance of eyes on this remarkably distinct head. The head is united to the body by a very narrow contracted neck, *(d)* as in insects. The *body* is of a lengthened, straight, and subconical form, slightly carinated longitudinally in the middle of the anterior and posterior surfaces, prominent and muscular along the sides, and marked transversely with two small contractions in the upper narrow part, and one near the middle. The membrane covering the body is so transparent before and behind, as to exhibit the glandular parts surrounding the intestinal canal within. The body is a little ventricose in the middle, and terminates suddenly below by a broad and lobed base, in the middle of which two large prominent labia conceal the anus, (*e.*) The intestinal canal, of great width, passes in a straight line from the mouth to the anus without the slightest convolution or curvature. The upper part of the intestinal canal in the situation of the neck (immediately below *d)* I found much dilated, of a glandular texture, and filled with a firm yellow coagulated matter, probably the remains of the food last swallowed. I have found a similar coagulated matter, of a darker colour, filling the intestinal canal of the skate-leech, *(Pontobdella muricata,* Lam.) which lives by sucking the white blood from the surface of the skate. The whole digestive canal of the *L. elongata* was surrounded with, and imbedded in a soft glandular mass of a yellow colour, and consisting of innumerable small lobes, filling the greater part of the abdominal cavity. This glandular substance corresponds in situation and appearance with the liver of crustaceous and molluscous animals. The abdominal parietes consisted of a double membrane, with numerous strong longitudinal fasciculi of muscular fibres interposed between them. The muscular bands were strongest on the sides. There were some loose portions of coarse circular fibres adhering to the outside of the body, which fell off on first handling the specimen. Two white longitudinal filaments running along the back part of the abdominal cavity, appeared to be nerves continued from the œsophageal ganglion of the head. The wide intestinal canal contracted as it approached the two external protuberances, between which it opened at the base of the body. The anus lay on the back part of the depression between these labial protuberances, and a minute aperture, *(o,)* like the puncture of a needle, was seen on the fore part of that depression. I could perceive no indications of a circulating system in this animal, although it was carefully dissected under pure water, and examined with the aid of lenses. Blainville was equally unsuccessful in his attempts to discover traces of a circulation, although he believes in its existence, on the reports of those who have examined *Lernææ* alive. The absence of a circulating system would remove the *Lernææ* to a place much below the class of molluscous animals, in which Linnæus, Bruguières, Ocken, and many other naturalists have placed this genus.

The two *ovaria*, of great size and length, hang by very narrow oviducts, *(f,)* from deep depressions on the outside of the labial protuberances. They resemble the enlarged figure of those of the *L. clavata* given by Muller, (*Zool. Dan.* Pl. XXXIII. Fig. 1. *b.*) They were quite straight, cylindrical, of equal thickness throughout, distended with ova, glistening, and smooth on the surface, and regularly rounded at both extremities. The delicate membrane containing the *ova* is so transparent and colourless, that the angular forms of the *ova* can easily be perceived through it. The *ova* viewed through the coat of the ovarium appear regular hexagonal bodies of an opaque yellow colour, and disposed in perpendicular and transverse rows; but when removed from the ovaria they appear spherical, and their angular appearance on the surface, which has been remarked in other species, is probably occasioned by the pressure of the external coat. When the ova were torn under the microscope, they appeared to consist of a thin vesicle filled with a soft opaque yellow matter. On breaking the ovarium the ova appeared to be disposed in regular concentric layers, and connected together by a glutinous matter. The oviducts are only narrow continuations of the two sacs containing the ova, and after entering the abdomen on the outside of the labia, they open into the bottom of the intestinal canal close to the anus. There is a small white depressed glandular body, within the abdominal cavity, placed on each oviduct close to its entrance into the anus or cloaca. It is probable, from the structure of the parts, that the ova, when mature, pass into the abdomen to be discharged by the anus, or by the minute aperture anterior to the anus, and that they receive some covering from these white glands as they pass through that part of the oviducts. From analogy and appearance, there can be no doubt that the yellow spherical bodies filling the two pendent ovaria are the ova of this animal; but it is not yet ascertained whether all the individuals possess these ovaria, or whether there are separate sexes. In the specimen of the *L. elongata* retained by Dr Brewster, the two ovaria were wanting, but it is very probable that they had fallen off, from their naturally feeble attachment to the body, and from there being no other perceptible difference in their external form and parts. Scoresby likewise has described and represented the ovaria as parts of constant occurrence in this animal. The fixed life of the *Lernæa* would lead us to suppose the sexes united in the same individual. Some of the species live so deeply imbedded in the surface of the animals to which they adhere, that only the ovaria are seen projecting. The internal structure, and the mode of generation of *Lernææ*, and even the place which they occupy in the scale of animals are still undetermined. Much light might be thrown on this genus, and many new species discovered by the attentive observation of those annually engaged in the whale fisheries in the Greenland seas, where the largest species are known to abound. Many species of this animal have been described and figured by Muller, Linnæus, Bosc, Bruguières, Ocken, Lamarck, Lesueur *(Jour. of Philadelphia)*, and Blainville, but the species above described appears to have escaped their notice. The most obvious characters of the *L. elongata* are two simple cylindrical *tentacula* longer than the body; *head* distinct, ovate, depressed, with four small antennæ, two serrated hooks, and a circular mouth in form of a proboscis; *body* subclavate, ventricose, simple, terminated above by a narrow neck, and broad and lobed at the base; two *ovaria* longer than the body, thick, straight, cylindrical, and exhibiting through the outer covering hexagonal ova disposed in perpendicular rows.

Plate II, Fig. 5, represents the *Lernæa elongata* twice the natural size, adhering by its tentacula to the outer surface of the transparent cornea of the shark.

a, The horny extremities of the tentacula buried and cemented together under the surface of the cornea.

b, The compressed origin of the tentacula from the under and back part of the head.

c, The anterior pair of knotted antennæ.

d, The narrow neck most distinct on the back part.

e, The anus,

f, The oviduct.

g, A hard flat pointed prominence above the mouth.

h, The cylindrical proboscis.

i, The anterior point of the head.

l, The horny serrated base of the jointed hook or lateral jaw.

m, The fleshy peduncle of the hook or jaw.

n, *n*, Two very small and soft filiform antennæ.

o, Minute opening on the fore part of the base of the abdomen.

p, *p*, Lower rounded terminations of the two ovaria.

q, Numerous diseased circular spots on the cornea.

Art. XXXIII.—*On the Atomic Weight of Nickel.* By Thomas Thomson, M.D. F. R.S. L. and E. Professor of Chemistry in Glasgow. Communicated by the Author.

I have been induced to draw up a few remarks on the atomic weight of Nickel from meeting with the following paragraph in Dr Turner's *Elements of Chemistry*, p. 418 :—

"Nickel is susceptible of two stages of oxidation. The composition of its oxides is stated very differently by different chemists. According to the experiments of Rothoff and Tupputi 29.5 is the atomic weight of nickel. Thomson estimates it at 26, and Lassaigne at 40. (*Ann. de Chim. et de Phys.* tom. 21.) Lassaigne, whose analyses are the most recent, attributes this discordance to the presence of cobalt in the nickel employed by preceding chemists, a supposition which is by no means improbable. According to his experiments, the two oxides are thus constituted.

	Nickel.		Oxygen.
Protoxide,	40	+	8
Peroxide,	40	+	16"

Had Dr Turner attended to the experiments on nickel and cobalt published by Berzelius, Berthier, and myself, he would have seen that the atomic weights of the two metals are identical, and consequently that the presence of cobalt in the nickel employed by preceding chemists could have had no influence whatever in altering the atomic weight.

The experiments of Lassaigne were shown to be inaccurate by Berthier in a paper published about two years ago. (*Ann. de Chim. et de Phys.* 25, 94.) His results are nearly a mean between those of Berzelius and my own. He employed an oxide of nickel which he had carefully freed from every trace of cobalt and from every other impurity.

Berzelius's number for the atom of nickel, (when divided by two to bring it into accordance with the simple atomic doctrine of the British chemists,) is 3.69755.

Berthier reduced 1000 parts of protoxide of nickel to the metallic state by exposure to a sufficient heat in a charcoal crucible. In two experiments he got 775 parts of metallic nickel ;

in another 788 parts. Now, when nickel is reduced in this manner it always imbibes a little carbon. It is clear from this that 1000 oxide cannot contain more than 775 parts of metallic nickel. Indeed it is probable that the quantity is not quite so much. Protoxide of nickel, then, according to Berthier's experiments, is composed of

Nickel.		Oxygen.
775	+	225 or
3.44	+	1

So that instead of 5, the atomic weight of nickel, as stated by Lassaigne, the true number is certainly not greater, and probably not so great as 3.44.

I shall now describe an experiment which I was induced to make on reading the above paragraph in Dr Turner's book. I need not observe that the most minute attention was paid to the accuracy of the results, and that all the precautions suggested by a great deal of practice in these kinds of investigation were employed to guard against mistake.

When speiss is dissolved in sulphuric acid by means of nitric acid and the sulphate of nickel separated by crystallization, the crystals contain no trace of arsenic acid, or iron, or bismuth, or antimony ; but they are still contaminated with a little sulphate of copper and a little sulphate of cobalt. Five hundred grains of these crystals were dissolved in distilled water, and a current of sulphuretted hydrogen gas was passed through the liquid till the whole copper was precipitated. The sulphuret of copper thus thrown down was digested in *aqua regia*, the solution filtered, and a few drops of sulphuric acid added to it. It was then evaporated to dryness, and the sulphate of copper thus obtained being redissolved in water, the black oxide was precipitated by caustic potash, and ignited. It weighed 3.33 grains, equivalent to 10.4 grains of crystallized sulphate of copper.

From the sulphate of nickel thus freed from copper, I precipitated the oxide of nickel by means of carbonate of soda. The pale green coloured precipitate was well edulcorated, and being diffused (while still moist) in distilled water, a current of chlorine gas was made to pass through it till every thing soluble was taken up. By this process the oxide of nickel is dissolved, while the oxide of cobalt remains behind in the state of a hydrate, and still retaining mixed with it a certain proportion of oxide of nickel.

The muriate of nickel thus purified was converted into sulphate in the usual way. The solution was concentrated, and left to spontaneous crystallization.

I consider sulphate of nickel made in this way to be quite pure. It contained no trace of arsenic, copper, cobalt, bismuth, or antimony, the only foreign metals which I have been able to discover in speiss. Having thus obtained pure sulphate of nickel, let us proceed to the analysis of the salt.

1st, 34.25 grains of the crystals were dissolved in as small a quantity of distilled water as possible; 26.5 grains of recently ignited chloride of barium were separately dissolved in a minimum of distilled water.

These two solutions were mixed, the mixture placed on the sand-bath, together with the washings, and evaporated till the whole was reduced to about an ounce measure. It was then thrown upon a filter. The clear liquid which passed through was tested in the usual manner for sulphuric acid and barytes; but no trace of either of these two substances could be found in it. Hence the barytes from 26.5 grains of chloride of barium had just saturated the sulphuric acid in 34.25 grains of sulphate of nickel,—that is to say, 34.25 grains of sulphate of nickel contains just ten grains of sulphuric acid. *

2d, 34.25 grains of the same crystals of sulphate of nickel were cautiously heated over a spirit lamp in a small platinum crucible, raising the heat very slowly as the water evaporated, till at last the salt was brought into a state of dull but perceptible ignition. It was kept in this state till it ceased to give out any more aqueous fumes, and then weighed. The loss of

* I collected the sulphate of barytes thus formed. After edulcoration and ignition it weighed 29 grains. But as 10 grains of sulphuric acid require for saturation 19.5 grains of barytes, there is a deficiency amounting to half a grain. The reason of this deficiency was this. When I was adjusting the filter on which the dry sulphate of barytes had been collected, in order to make it as nearly as possible of the same size as the filter in the opposite scale, a piece of the sulphate of barytes sprung out and fell upon the floor. I have no doubt that this piece amounted to half a grain, though I was unable to collect it.

weight was exactly 15.75 grains. The salt thus rendered anhydrous had an orange colour while hot, but became yellow on cooling. To see whether it had lost any acid, water was poured upon it. For some time no appearance of solution was perceptible; but after being digested on the sand-bath for twenty-four hours, a complete solution was obtained; thus showing that the salt still retained the whole of its acid. 34.25 grains of sulphate of nickel then contain 15.75 grains of water.

3d, 34.25 grains of the same crystals were dissolved in water, and mixed with a sufficient quantity of carbonate of soda to throw down the oxide of nickel. The oxide thus obtained was edulcorated, dried, and ignited. It had a dirty olive-green colour, and weighed 8.44 grains. It was quite insoluble in ammonia; but dissolved with facility in *aqua regia.*

Thus the constituents of 34.25 grains of sulphate of nickel were found to be,

Sulphuric acid, -	10.
Protoxide of nickel, -	8.44
Water, -	15.75
	34.19
Loss, - -	0.06
	34.25

The salt being neutral, and 10 being equivalent to 2 atoms of sulphuric acid, let us divide by 2, in order to see the atomic weight of protoxide of nickel deduced from this analysis. We have for the composition of the salt,

1 Atom sulphuric acid, - -	5.
1 Atom protoxide of nickel, -	4.22
7 Atoms water, - - -	7.875
	7.095
Loss, - - -	0.03

The atomic weight of protoxide of nickel comes out 4.22. But there is a loss in the analysis amounting to 0.03 grain.

Let us see to which of the constituents of the salt this loss belongs.

(1.) The residual liquid from (paragraph 1) was evaporated to dryness, and just as much water added drop by drop to the salt as was sufficient to dissolve it. No sulphate of barytes remained undissolved, nor did muriate of barytes indicate the presence of any sulphuric acid in the liquid. Thus it appears that the loss does not fall on the sulphuric acid. The whole of it was obtained.

(2.) The yellow salt of (paragraph 2,) before trying its solubility in water, was laid upon a quantity of ignited charcoal, and kept in a red heat for five minutes; but no farther loss of weight was sustained. There is no reason then to suspect that the whole water was not driven off.

(3.) The liquid from which the nickel had been thrown down by carbonate of soda was concentrated as much as possible, and then put into a crystal tube shut at one end. On looking down through this liquid, (which occupied a space of about four inches in the tube,) a green shade of colour was very perceptible. It is obvious from this that it still retained some nickel in solution.

Thus it appears that the loss in the analysis was owing to the nickel not being completely precipitated by the carbonate of soda. If we add this loss to the nickel, we have the constituents of sulphate of nickel as follows:—

1 Atom acid, -	5.
1 Atom protoxide, -	4.25
7 Atoms water, -	7.876
	17.125

Thus the atomic weight of protoxide of nickel is 4.25, as I have before shown it to be.

From the experiments of Berthier there can be no doubt that the atom of nickel weighs 3.25. I have made no experiments on peroxide of nickel. My opinion respecting its constitution is founded solely on the experiments of Rothoff. With these experiments the statement of Lassaigne does not agree. But it is obvious enough that his results are not quite accurate. Were we to correct them by substituting the true atomic weight of nickel they would give us,

	Nickel.	Oxygen.
Protoxide composed of -	3.25	+ 1
Peroxide of -	3.25	+ 1.7

numbers approaching pretty nearly to those given by Rothoff.

Upon the whole, I see no reason to doubt that we are in possession of the true atomic weights both of nickel and cobalt.

ART. XXXIV.—*Notice regarding the Ova of the Pontobdella muricata*, Lam. By R. E. GRANT, M. D., F. R. S. Edin., &c. Communicated by the Author.

THE ova of the *Pontobdella muricata* or Skate-leech, (Fig. 6 and 7. Pl. II.) consist of small dark coloured spheres attached by a narrow twisted neck to a spreading membranous base. Each sphere consists of a double capsule containing a thick gelatinous fluid, in the middle of which the young animal lies coiled up generally in one spiral turn. The ova have much the appearance of the seeds of the black pepper, being about two lines in diameter, and having a rough and dull external surface. On the opposite sides of the spheres there are two round prominences, which fall off when the animal is come to maturity, and leave two circular apertures to admit the sea water, or to allow the young *Pontobdella* to escape. The outer capsule, which has a dark greenish brown colour, is thicker and more porous than the inner membrane, which is smooth, thin, and very tough. The stalk which connects the sphere to the flat base is solid, of a black colour, and firm consistence internally, and is strongly marked with longitudinal prominent ridges, which have a twisted and fibrous appearance. The spreading base which adheres to stones, shells, or other hard bodies, consists of the same tough dark-coloured substance as the outer layer of the ovum and the stalk, and is marked with elevated radiating ridges like diverging roots. The gelatinous matter within is at first thick and of a milky colour, but becomes more colourless, transparent, and thinner, as the *Pontobdella* approaches maturity, as I have observed in the ova of many molluscous animals. The young animal is visible when only about half a line in length, in the middle of the gelatinous matter, and only one young *Pontobdella* is found in each ovum. The animal is at first quite transparent and of a whitish colour; and when ready to escape, it is nearly an inch in length and has all its external characters distinctly marked. We find these ova generally in groups of thirty or forty adhering to solid bodies in deep water where the *Pontobdella* resides. The merit of having first ascertained them to belong to that animal is due to my zealous young friend Mr Charles Darwin of Shrewsbury, who kindly presented me with specimens of the ova exhibiting the animal in different stages of maturity. They nearly resemble the ova of the *Amphitrite* described and figured by Basterus, (*Op. sub.* Pl. V. Fig. 1. A, B, C, and p. 38.) The ova of the *Pontobdella* have probably escaped notice from the animal generally frequenting the bottom of deep water, where it lives by sucking the blood from the surface of flat fishes; or they may have been mistaken for young marine plants, such as the *Fucus loreus*, from the fibrous appearance and deep-green colour of their outer capsule. The description of the ova of the lower animals forms an interesting, though much neglected part of the history of the species; and an imperfect acquaintance with this part of zoology has sometimes led distinguished naturalists to mistake the ova of marine animals for zoophytes, and zoophytes for the ova of animals.

Plate II. Fig. 6, Entire ovum of the *Pontobdella muricata*, of the natural size, showing the two round lateral prominences, the narrow fibrous stem, and thin spreading base.

Fig. 7, Ovum of the *P. muricata* divided horizontally, to show its double covering, and the young animal coiled up in the gelatinous matter within.

Art. XXXV.—ZOOLOGICAL COLLECTIONS.

1. *Account of the Capture of a Female Orang Outang, caught on the coast of Sumatra.* By Captain Hull. *

Having heard of the capture of the large Orang Outang, which was described in this *Journal*, Number viii. p. 193, Captain Hull dispatched a young man to the spot where it was taken, in the hope of his meeting with another Orang of the same kind. After a lapse of several months he returned to Bencoolen, bringing with him a large female orang, as the fruit of his enterprise.

On his arrival at Truman, where he was kindly received, he heard various accounts from the natives of the animal he was in search of, called by them Orang Mawah, Mawi or Mawy. These animals, they said, resided in the deepest part of a forest, distant from Truman about five or six days journey, and they appeared very averse to undertake any expedition in search of them, stating, that these beings would assuredly attack any small party, especially if a woman should be with them, whom they would endeavour to carry off. They were unwilling also to destroy these animals from a superstitious belief that they are animated by the souls of their ancestors, and that they hold dominion over the great forests of Sumatra. After some days debate, however, and hearing that a Mawah had been seen in the forest, the young man collected a party of twenty persons, armed with muskets, spears, and bamboos, and having marched in an easterly direction for above thirty miles, fell in with the object of his search. The orang was sitting on the summit of one of the highest trees with a young one in its arms. The first fire of the party struck off the great toe of the old orang, who uttered a hideous cry, and immediately lifted up her young one as high as her long arms would reach, and let it go amongst the topmost branches, which appeared too weak to sustain herself. During the time the party were cautiously approaching her to obtain another shot, the poor animal made no attempt to escape, but kept a steady watch on their movements, uttering at the time many singular sounds, and glancing her eye occasionally towards her young one, seemed to hasten its escape by waving her hand. The second volley brought her to the ground, a ball having penetrated her breast, but the young one escaped. She measured four feet eleven inches in length, and two feet across the shoulders, and was covered with red hair.—It is probable from the spot where this animal was found being so near to Truman, that she was the mate of the one destroyed by the party from the brig. Her remains, consisting of the skin and all the bones, were transmitted home by Captain Hull to Sir Stamford Raffles.

2. *On the use of the Odoriferous Gland of the Alligator as a Bait.* By Thomas Bell, Esq. F. L. S. &c.

The following is a brief notice of Mr Bell's curious speculations on

* This and § 3, 6, 7, are extracts of memoirs read at the Asiatic Society of Calcutta. They are from the *Calcutta Government Gazette* or *Journal*, conducted with great ability.

the use of the submaxillary odoriferous gland of the crocodile, which was lately read before the Royal Society.

"Beneath the lower jaw of the alligator and the crocodile on each side, is situated a gland which secretes an unctuous substance of a strong musky odour. About two years since, the author of this paper discovered in it a structure which is without parallel in the glandular system of other animals. His observations were made on the common American alligator. In this animal the external orifice of the gland is situated about two-thirds of the lower jaw backwards from the symphysis, being a longitudinal slit a little within the lower edge of the basis of the jaw, through which exudes the substance just mentioned. During warm weather, when the animal feeds freely, the secretion is copious; but in winter it is much diminished in quantity, and is less powerful in scent. The gland itself is a simple follicle of an elongated pyriform figure lying between the skin and the under surface of the tongue. In an alligator of four feet in length it is about half an inch long, and one-sixth of an inch in diameter. This gland is enveloped by extremely fine and delicate muscular fibres, disposed obliquely, consisting of two fasciculæ, passing repeatedly over and under the gland, which unite at its base in a long and slender round muscle closely attached to the corner of the *os thyoides*, and following the course of another muscle, apparently identical with the *mylo hyoideus* in the mammiferous animals. The use of the muscle appears to be to bring the gland into a proper position for its discharge, and then to operate the discharge by pressure. The author, considering the situation of the gland near the mouth of the alligator, and the predatory habits of the animal, together with its voracity of fish, *and the well-known partiality of fish for odoriferous oils and extracts, conceives that this secretion acts as a bait,* attracting the fish to such a position as will enable the alligator readily to seize them in his usual way of seizing his prey, by snapping sideways at them.

3. *Account of the Chiru, or Unicorn of the Himalayah Mountains.* By Mr Hodgson, Surveyor General of India.

Mr Hodgson's paper on the *Chiru* concerned the animal which has been so often mentioned as the Unicorn of the Himalayah. The reports respecting this animal were so numerous and concurring, and so borne out by the specimens of single horns sent down at various times to the Asiatic Society, and by Bhotea drawings of a deer-like animal with one horn springing from the centre of the forehead, that scepticism was almost silenced by the variety and quantity of evidence. The zeal of Mr Hodgson for the advancement of knowledge, and which has afforded to the Asiatic Society the means of judging of the Literature, Antiquities, Arts, and Natural Productions of the Himalayan Region, has at length settled the question respecting the *Chiru* or antelope of the Bhoteahs. The skin and horns sent by Mr Hodgson were the spoils of an animal which died in the Menagerie of the Rajah of Nepal, to whom it was presented by the Lama of Digurchi, whose pet it had been. The persons who brought the animal to Nepal informed Mr Hodgson that the favourite abode of the Chiru is the Tingri Maidan—a fine plain or valley through which the Arrun flows, and which is situated immediately beyond the snows by the Kooti pass; that in this valley beds of salt abound, to which the *Chirus* are said to resort in vast herds. They are represented as in the highest degree wild, and unapproachable by man, flying on the least alarm, but if opposed, assuming a bold and determined front. The male and female are said to present the same general appearance.

The living subject of Mr Hodgson's description presented none of those formidable attributes with which the tales of the Bhoteas had clothed the *Chiru*. In form and size he offered the common character of the antelope tribe, lived chiefly on grass, and did not seem dissatisfied with his captivity, although his panting showed that even the climate of Nepal was oppressive to him,—he at length sunk under a temperature which rarely exceeded 80° as a maximum at the commencement of the hot weather. Although timid, and on his guard against the approach of strangers, he would, when warily laid hold of, submit patiently to handling.

The general form of the animal was graceful, like that of other antelopes, and was adorned with their matchless eye. His colour was reddish or fawn on the upper, and white on the lower part of the body. His distinguishing characters were, first, long sharp black horns, having a wavy triple curvature, with circular rings towards their base, which projected more before than behind; and secondly, two tufts of hair projecting on the outer side of each nostril, together with an unusual quantity of bristles about the nose and mouth, and which gave to his head a somewhat thickened appearance. The hair of the animal resembled in texture that of all the trans-Himalayan animals which Mr Hodgson has had the opportunity of examining, being harsh and of a hollow appearance. "It was about two inches long, and so thick as to present to the hand a sense of solidity; and beneath lay a spare fleece of the softest wool.

Dr Abel's remarks on Mr Hodgson's paper chiefly concern the specific characters and dimensions of the animal, and present a formal description of it drawn from the data furnished by Mr Hodgson, and Dr A's. own examination of its remains. Dr Abel proposes to call the animal *Antilope Hodgsonii*, after its discoverer.

4. *On the size of the Asiatic Elephant.*

The following notice respecting the size of the Asiatic elephant we have received from a correspondent in India. "The catching of the elephants has just commenced, and at least a score of subjects may be procured in the course of the season. It is strange that M. Cuvier should continue to repeat the old story of the Asiatic elephant being *fifteen* or *sixteen* feet high. I do not believe that they ever exceed *eleven* feet; and some years ago I wrote a letter on this subject, which was published in the *Calcutta Journal*, and in which I requested information respecting any elephant exceeding that size;—but no answer was ever returned to that request."

5. *On the Growth of the young Boa Constrictor hatched from the Egg.*

In the eighth Number of this *Journal*, p. 22, we communicated, from a correspondent in India, a very interesting notice respecting a young brood of Boa Constrictors hatched from the egg on the 6th July 1825.

Their length when they were hatched was *eighteen* inches long; but we are informed by a letter from our correspondent, dated 10th October 1826, that they have increased to *thirty-eight* inches, having grown *twenty* inches in fifteen months.

6. *On the Growth and Habits of a young Rhinoceros.* By Mr Hodgson, Surveyor General of India.

Mr Hodgson's observations on the rhinoceros form the continuation of a paper read at a meeting of the Physical Committee of the Asiatic Society in February 1825, on the Gestation of the Rhinoceros, at the close of which he proposed to furnish to the Committee, from time to time, an account of the rate of growth of one of these animals which was born in the Menagerie of the Rajah of Nepal. The first dimensions taken of the animal were made at three days old, when it measured two feet in height, three feet four inches and three quarters in length, and four feet and seven-fourths of an inch in its greater circumference; since that, it has increased in the following proportions: From three days to one month it gained five inches in height, five inches and three quarters in length, and three inches and three quarters in circumference; while, from the age of one to fourteen months, it increased one foot seven inches in height, two feet in length, and two feet seven inches in circumference. From fourteen to nineteen months four inches in height, one foot four inches and a half in length and two feet four inches in circumference; the Rhinoceros being at the date of the last measurement in December 1825, four feet four inches high, seven feet four inches and a half long, and nine feet five inches in circumference.

In general aspect the cub now resembles the mother, the heavy folds of the skin which were wanting in July last being fully formed in December. The nasal horn at the latter period scarcely protruded two inches beyond the skin.

The observations of Mr Hodgson are of great value in reference to all questions respecting the rate of developement and full growth of many of the larger animals, respecting which scarcely any authentic statements are to be found in authors, although they have exercised the genius of Buffon and other philosophical writers. The diminished ratio of increase of height remarkable in the later period of developement, as stated by Mr Hodgson, renders it probable that the animal will yet be a long time in arriving at its adult size, a supposition which is also rendered probable by its seventeen months' gestation, and the slow growth of its horn.

Mr Hodgson, in pursuing his inquiries, has had occasion to remark the amiableness of the young animal's disposition, both towards his keeper and strangers, an instance, he observes, of the power possessed by Asiatics through their tranquil familiarity of taming the most formidable quadrupeds.— That the rhinoceros will submit to the domesticating influence of man we have seen more than one instance, nor would the tractability of this herbivorous animal seem in any way a matter of surprise, when we know that the fiercest of the carnivorous tribe have become the attached companions of their master, if the rhinoceros had not been held up by writers of every age and country as a standard of brutal and untameable fury. India exhibits numerous proofs of false conclusions by natural historians regarding the habits and temper of animals, and affords a field of interesting inquiry respecting their instinct, as contradistinguished to what might be called their educatable faculties.—This subject has hitherto, we believe, only been treated by the naturalists of Europe, who have relied in many cases upon very vague or insufficient narratives, but never by any person residing in the native country of the animals whose history has been recorded.

7. *On the Edible Birds' Nests of the Tavoy and Mergui Islands in Siam.*

Edible birds' nests are found in considerable quantity on the islands off the Tavoy coast, but they are very generally met with throughout the Archipelago. They are in most perfection in January, but are gathered also during the six weeks preceding and following that month. The quantity obtainable in any one season is uncertain, for Malay, Chinese, Siamese, and other boats are accustomed to come in amongst the islands, and to carry off part of the produce: it also partly depends upon the dexterity of the nester, who, by disturbing the swallows just when the nest is completed, obliges them to multiply their labours. The operation of the nester is not always free from danger, as he has to climb precipices by the help of ropes and flying ladders made of rattans, and the caves into which he has to penetrate are noisome, and in some places so intricate, that he is apt to lose himself.—The nesters use considerable quantities of arrack and opium. It is probable that the Burman collections did not exceed two Peculs in the season, but there is little doubt that five or six times that quantity might be obtained.

The farm of these nests, which had let the year before only for 500 rupees, was knocked down since we took possession, at 15,000 rupees for those of the Tavoy Islands alone; and 5000 rupees more were expected for those of the Mergui Islands.

Art. XXXVI.—HISTORY OF MECHANICAL INVENTIONS AND PROCESSES IN THE USEFUL ARTS.

1. *On the Explosion of Steam Boilers.** By Jacob Perkins, Esq.

It has been generally considered a well established fact, that the caloric of steam, at a given elasticity, is invariably the same when in contact with water; but this is far from being the case. It may be, and often is, so generated as to indicate very high degrees of temperature without a corresponding increase of power, so as evidently to prove that temperature alone cannot be relied on as a measure of the elastic power of steam. Many experimentalists have thus undoubtedly been led into error, especially

* Mr Perkins has been so obliging as to transmit to us copies of this and the following article, which he has printed for the information of his scientific friends.—Ed.

in reference to high temperatures. If any part of the boiler which contains the steam be suffered to become of a higher temperature than the water contained in it, from want of a sufficient supply, the steam will readily receive an excess of caloric, and become supercharged with it, without acquiring proportional elasticity. In some recent experiments I have heated steam to a temperature that would have given all the power that the highest steam is capable of exerting, which would have been 56,000 pounds to the square inch, if it had had its full quantum of water; yet the indicator showed a pressure of less than five atmospheres. Having satisfied myself, by repeated experiments, as to the certainty of this curious fact, the thought struck me, that, if heated water were suddenly injected into the superheated steam, the effect would instantly be the formation of highly elastic steam; the strength of which would depend upon the temperature and quantity of the supercharged steam and of the water injected. To ascertain the truth of this theory, I made the following experiments:

A generator was filled with water and heated to about 500 degrees, and, consequently, exerting a force of about 50 atmospheres; but the pressure valve being loaded to about 60 atmospheres, it prevented the water from expanding into steam. The receiver, which was destitute of both water and steam, was heated to about 1200 degrees: a small quantity of water was injected into the generator with the forcing pump, which forced out from under the pressure valve into the receiver a corresponding quantity of heated water, and this instantly flashed into steam, which, from its having ignited the hemp cord that covered the steam-pipe ten feet from the generator, must have been at a temperature of at least 800 degrees, which would be equal to about 800 atmospheres; but from want of water to give it its necessary density, the indicator showed a pressure of about 5 atmospheres. Whether the pressure of the steam, which was rushing through the steam-pipe, was at 5 or 100, or more atmospheres, the steam-pipe kept up at the high temperature before-mentioned, which I attributed to the steam being supercharged with caloric. The pump was now made to inject a much larger quantity of heated water, and the indicator showed a pressure of from 50 to 80 atmospheres: it soon expanded, the throttle valve being partly opened, to the former pressure of about 5 atmospheres. The water was then injected again and again, and the indicator was observed to oscillate at each stroke of the pump from 5 to between 40 and 100 atmospheres, according to the quantity of water injected; clearly showing that, at this reduced pressure, there was a great redundancy of heat, with little elastic force. It soon occurred to me that to this might be traced the true cause of the tremendous explosions that suddenly take place in low as well as high pressure boilers.

There are many instances where, immediately before one of these terrific explosions had taken place, the engine laboured; showing evidently a decrease of power in the engine. To illustrate the theory of sudden explosions, let us suppose the feed-pipe or pump to be choked; in this case the water would soon sink below some parts of the boiler, which should be constantly covered by it, thus causing them to become heated to a much higher temperature than the water. The steam now being in contact with the heated metal, readily takes up the heat and becomes supercharged with it.* Since caloric will not *descend* in water, it cannot be taken up by the water which is below it. The steam thus supercharged will heat the upper surface of the boiler in some cases *red-hot*, † and will ignite coals or any other combustible matter which may be in contact with it. If the water which is kept below the supercharged steam by the pressure of it, should, by any circumstance, be made to take up the excess of caloric in the steam, as well as that from the upper part of the boiler, which has become heated above the temperature of the water, in consequence of the water having been allowed to get too low, it will instantly become highly elastic steam, and an explosion cannot be prevented by any safety valve hitherto used. To show how the water may be suddenly brought in contact with the overheated parts of the boiler, as well as with the supercharged steam, it will be necessary to state the following facts:

As long as water is not heated above 212 degrees it will simply boil, and give off atmospheric steam, without the water having any tendency to rise with it; but as it becomes more and more elevated in temperature, its disposition to rise with the steam becomes more and more apparent; but

* Practical engineers have frequently witnessed the destruction of the packing of pistons by their becoming charred, although the steam issuing was in contact with the water, the temperature of which did not exceed 230 degrees. It is very evident that this steam was surcharged with heat, and was much above the temperature of the water upon which it was reposing, and in a suitable state to produce explosion, had the water been allowed to rise with the steam, by drawing it off faster than it was generated.

† Mr Moyle, a practical engineer from Cornwall, gave me the following interesting fact:

On going into his boiler-room, he observed a ladder, the foot of which rested on the top of his boiler, to be in flames: he instantly ascertained that the top of the boiler, from some cause which he was then unable to determine, had become *red-hot;* with all possible promptitude he ordered the fire to be quenched, which probably saved his premises, and perhaps his life. Mr Moyle found, upon examining the boiler when cold, that very little water remained in it.

The following similar fact has been recently communicated to me by Mr Williams, principal manager of the Dublin and Liverpool Steam Company:—He was alarmed in the night-time, during one of his passages from Ireland to Liverpool, by the strong smell of burning pine, which, after a diligent search, he found to proceed from a pine block which had been accidentally thrown on the top of the boiler, and which was discovered to be on fire.

A stronger case still was that of an explosion at the iron-foundry at Pittsburgh, North America. As is the practice in North America, a high pressure engine of sixty or eighty horse power was supplied with steam from three separate cylindrical boilers, each being thirty inches diameter, and eighteen feet long. One of these boilers had for some time been observed to be getting red-hot; but as the other two supplied a sufficiency of steam for the work then doing, it was disregarded until it exploded. The main body of the boiler separated from one of its ends at an angle of 45 degrees, and passed off like a rocket through the roof of the building, and landed about 600 feet from it.

as the steam presses on the surface of the water in the same ratio as the water increases in temperature, it only boils without rising, as when at atmospheric pressure; but if the steam should be drawn off faster than it is generated, this artificial pressure would be taken off, and the water would rise with the steam in proportion to the suddenness and rapidity of its escape. The water and steam in this mixed state thus filling every part of the boiler, the excess of caloric in the supercharged steam, as well as the extra heat from the boiler, will be instantly taken up by the water which rises with the steam, by which means the steam becomes sufficiently dense (or powerful) to produce the fatal effects too often experienced, not only from high but from low pressure boilers. If, for instance, the water, (as has before been noticed,) which is exposed to the fire, should be suffered to get below any part of the boiler, the steam will soon become supercharged with heat. If a boiler thus circumstanced should have the weight taken from the safety valve, * or a small rent effected in the boiler from its giving way by the pressure of the steam, an explosion will be sure to follow. A remedy for this kind of explosion, which appears to be the only serious one, is that of not allowing the water to subside below any part of the boiler which is exposed to the fire. In case the water should settle, it may be known by having a tube, with its upper end trumpet-mouthed, and its lower end fixed in the boiler, entering a few inches below the surface of the water; then, as soon as it subsides sufficiently to allow the steam to blow off, the blast will give warning that no time should be lost in supplying water or checking the fire. † When highly super-

* It was stated in evidence at the coroner's inquest taken at the Humber, in the case of an explosion on board of the Graham steam-boat, that, just before the explosion took place, twenty pounds were taken off the safety valve. Now, if the steam in this boiler had been properly generated, the relief given to the safety valve could not have produced explosion; but if the water had got low in the boiler (as was probably the case,) and the steam supercharged with heat, the ready way to produce explosion was to allow the steam to escape faster than it was generating, when kept in the lower part of the boiler by the pressure of the confined steam.

Several instances have occurred when there has been sufficient warning, by the rushing of the steam from a rent or fracture, for the bystanders to escape from injury before the explosion took place. There has been at least one case where the boiler was raised from its bed into the air by the force of the steam issuing from the rent (upon the principle of the rocket) before the water had sufficiently expanded, by the removal of the steam, caused by the rent or fracture, to take up the heat of the boiler and the supercharged steam, when an explosion took place after the boiler had been raised many feet in the atmosphere, and a separation took place with great report, one part rising still higher, while the other dashed with great force on the ground. It is, I believe, a fact, that more persons have been killed by *low* than by high pressure boilers. It is but about twelve months since sixteen persons were killed by the bursting of a low pressure boiler in Flintshire. High pressure boilers have since been substituted. Some of the most dreadful accidents from explosions which have taken place in America have occurred from low pressure boilers.

† This will apply only to low pressure boilers, on account of the height of the column which would be required to balance the pressure of the steam. The high pressure engines, as used in Cornwall, would require a column varying from 60

charged steam is rushing from the safety valve, or any other aperture, it may be known by its perfect invisibility, even in the coldest day, nor can it be seen at any distance from the valve or cock; it is, however, condensible, as may be seen by holding any cold substance in its range.

2. *On the Economy of using highly Elastic Steam expansively, &c.* By JACOB PERKINS, Esq.

The diagram, Figs. 9 and 10, will show the economy of using steam expansively, and also the method of compensating for the inequality of the pressure on the piston, which, if steam of 400lbs. to the square inch is used, and stopped off at the quarter stroke, will end its stroke at 100lbs. per inch. The diagram will also show that the motion of the piston is constantly varying, while that of the crank is uniform in its motion. *

From repeated experiments and much reflection, I am led to believe that there is great economy in using very high steam, and that expansively: that the higher you can practically use the steam the sooner you may put it off. The diagram shows the gain in cutting off the steam at quarter stroke. Let the piston, which is represented by the line *k* 1 *a*, descend to *i b*, being one quarter of the stroke, with a constant pressure of 400lbs. per square inch. At this point let the steam be cut off and expand to double its volume; when it arrives at *h c*, it will be exerting a pressure of 200lbs. per inch, producing a mean of 300lbs. per inch through the quarter stroke. Let the steam again expand to double its volume, and the piston will finish its stroke at *f e*, at 100lbs. per inch, giving a mean of 150lbs. per inch for each quarter, which add to the other two quarters, 400. 300. 150. 150. and the whole sum will be 1000 (†,) giving an average pressure of 250 per square inch. It will be seen that, when the stroke is completed, the cylinder will be filled with steam at a pressure of 100lbs. per inch, which will be the same in quantity as though the steam had begun with a pressure of 100lbs. per inch, and continued all the stroke at that pressure. By using the same quantity of steam expansively, beginning at 400lbs. there is a gain of 150 per cent. If the steam is used at 600lbs. per inch, and cut off at one-eighth of the stroke, 225 per cent will be the gain. To compensate for the unequal pressure of the steam on the piston two cylinders should be used, particularly for steam-boats and pumping, where the fly should be dispensed with. With the following arrangement it will be seen, while one of the pistons is at its greatest power, the other is acting with a diminished power.

The piston 1, Fig. 9, in descending from *a* to *b*, moves in the same time

to 120 feet; and the new high pressure safety engine, now coming before the public, would require a column more than four times as high as St Paul's cross to balance the steam.

* This diagram does not pretend to mathematical accuracy; the object is merely to explain to the practical mechanic, in a sufficiently clear and concise manner, the principle of the advantage gained by using steam expansively.

† If the steam had continued the whole length of the stroke at 400lbs. per square inch, the sum would have been 1600lbs., consuming four times the steam with the addition of only 60 per cent. to the power.

through only half the space through which the crank moves, as will be seen by its path from 1 to 3. A force of 400lbs. is exerted on the square inch (that being the pressure of the steam,) in the first quarter of the stroke: at this point the steam is cut off, leaving the other three-fourths of the stroke to act expansively. The piston 1, Fig. 10, having completed half its stroke, when piston 1, Fig. 9, begins its stroke, and consequently a compensation near enough for all practical purposes takes place.

It will be seen, that while the piston 1, Fig. 9, has performed one-fourth its stroke, that the piston 1, Fig. 10, has moved from *c* to 6, performing seven-sixteenths of its stroke in the same time. The mean in each quarter, from *c* to *e*, Fig. 10, being 150lbs. the amount of pressure to be added to the first quarter of the stroke of the piston, Fig. 9, (which was 400lbs.) is 275lbs. producing an available power of 675lbs. at this part of the stroke. The piston, Fig. 10, now moves but two-sixteenths of its stroke from 6 to e, and f to 8, while the crank moves through two of its divisions, from 6 to 8, which would, in another part of its path, move (within a fraction) with the same velocity of the piston. The piston, Fig. 10, in moving from 6 to *e*, gives a power of 25lbs. being the last of the expansion which ends at 100lbs. per inch. The piston, Fig. 10, in moving from f to 8, being the beginning of the stroke, gives a power of 100lbs.; thus a power of 125lbs. will be acting in the piston 1, Fig. 9, while moving from b to d, giving a power of 475lbs. to which add 125, will show a power of 600lbs. at this part of the stroke. The piston 1, Fig 9, now descends from *d* to *e*, being the last quarter of the stroke, giving 125lbs. of power to act with the piston 1, Fig. 10, while moving from 8 to h, giving a power of 600lbs.; add to this the 125lbs. and it will give a power of 725lbs at this part of the stroke. The piston 1, Fig. 9, now begins its stroke of 400lbs. per inch at f, and continues to g with the same power, while piston 1, Fig. 10, moves from h to 12, giving a power of 300lbs. to be added to the 400lbs., obtained at the first quarter of the stroke of the piston 1, Fig. 9, at f and g, producing at this part of the stroke 700lbs. of power. The piston 1, Fig. 9, now moves from g to i, giving a power of 475, while the piston 1, Fig. 10, moves from 12 to k and a to 2, giving a power of 125; which add to 475, gives a power of 600 at this part of the stroke. The piston 1, Fig. 9, now moves from i to 1, being the last quarter of the stroke, giving a power of 125lbs., while the piston, Fig. 10, moves from 2 to c, producing a power of 600; to which add 125lbs. will make 725lbs. at this part of the stroke. We have, therefore,

Fig. 9, AA, 400	Fig. 9, BB, 475	Fig. 9, CC, 125
Fig. 10, AA, 275	Fig. 10, BB, 125	Fig. 10, CC, 600
675	600	725
Fig. 9, DD, 400	Fig. 9, EE, 475	Fig. 9, FF, 125
Fig. 10, DD, 275	Fig. 10, EE, 125	Fig. 10, FF, 600
675	600	725

By this arrangement, it will be seen that a compensation is obtained, giving a more equable power than that which is produced by the single engine, whether high or low pressure, since it is well known that at two points of the revolution of the crank the power ceases during at least one-twelfth of the time, which is the reason that so large a fly-wheel is necessary. It is particularly applicable to steam-boats, and may be used to great advantage in the double pump, as well as the balance-bob lifting pump, used in Cornwall for mining purposes, by the use of proper gearing. The present single stroke expansive engines used in Cornwall for pumping are preferred to all others on account of their economy, although they are very limited as to the extent of the expansive principle, for want of compensation, as nearly the same power is wanted to finish the stroke of the pump as to begin it.

The variation of the velocity of the piston occasioned by the compound motion of the crank and connecting rod is not taken into view in this diagram. As the connecting rod is intended to be four diameters of the path of the crank, the variation will make no practical objection, being, at its greatest value, but one-thirty-second part of its range. If the engine should be worked by a connecting rod, as is sometimes the case in steam-boats, say only one diameter of the path of the crank, the variation at each end of the stroke would amount to a practical defect, since the piston would move with nearly three times the velocity at the lowest quarter of the stroke that it would at the first quarter. Thus circumstanced, the crank must be above the cylinder.

As the law of expansion seems not yet to be settled, an arithmetical expansion has been used for this diagram which, from its approximation to the real law, will be quite near enough for practical purposes. Many who are of the school of Tilloch and Wolf believe that the expansive power of steam depends upon heat only; while the Soho experiments are said to prove that elasticity depends simply on density, without regarding temperature, viz. that if a cubic foot of steam at atmospheric pressure weighs one ounce, 50 atmospheres of steam would weigh 50 ounces; but Dalton, who is undoubtedly much nearer the true law, would make 50 atmospheres weigh but about 34 ounces.

I have no doubt that the nearer the atoms of water are made to approach each other by compression, the greater will be the repulsive action of caloric, and that in a more rapid ratio than has hitherto been allowed, especially in highly compressed steam. Its comparative density, with the increase of power, diminishes faster than has been supposed even by Dalton.

3. *Method of making Transparent Soap.*

Tallow is the basis of all soaps for the toilette, known under the name of Windsor, because olive oil forms a paste too difficult to melt, and having an odour too powerful for mixing with perfumes.

Tallow-soap dissolved with heat in alcohol returns to its solid state on cooling. It is this fact which has led to the discovery of transparent soap. When well prepared, this soap should have the appearance of fine white sugar candy. It may also be coloured, and vegetable colours are for this purpose preferable to minerals. Any person can make the soap by putting into a thin glass phial half a brick of Windsor soap, cut small, filling the phial half full of alcohol, and placing it near the fire till the soap is dissolved. This mixture put to cool in a mould gives the transparent soap.—*Archives des Decouvertes et des Inventions Nouvelles.*

4. *Mode of Preparing Emery.* By Mr Hawkins.

Mr Hawkins, finding that the emery sold in the shops was totally insufficient for the purpose he had in view, namely, grinding two flat surfaces of hard cast steel accurately, thought of applying a process he had seen for washing over *diamond dust,* to emery; and to be certain that his emery was of good quality, he purchased of an emery-maker a quantity of those small lumps or grains, which had longest withstood the action of the cast-iron runners, and bed, and thus insured the hardness of the emery; these pieces were reduced to powder in a cast-iron mortar and then separated into different portions by sieves.

He then washed over the finest emery thus obtained, using oil instead of water, as in the usual process, the former holding it in suspension for a much longer time, and in this way he obtained a series of emeries which had floated one, five, ten, fifteen, twenty, forty, and eighty minutes, amongst which he found every variety necessary for his purpose, and keeping them in boxes which were numbered according to the minutes they had floated, he could at any time prepare more of any one kind. In this way Mr Hawkins readily attained his object; and ultimately by selecting these grains of emery which resisted longest the action of the pestle and mortar, he obtained some so hard as to be capable of cutting a ruby, when employed instead of diamond dust.

Mr Gill, by grinding Greek emery-stone between two flat and hard steel surfaces, and washing off the lighter portions in oil, found that those which subsided in half a minute, when examined by a microscope, had entirely resisted the friction, and were perfectly crystallized sapphires.—(*Tech. Rep.*)

5. *Account of a Travelling Railway.* By George Hunter. Esq.

This ingenious invention, which is secured by patent, is represented in Plate I. Fig. 11. which represents a waggon with its travelling railways *b, b.* The small running wheels *a a* of the waggon have their peripheries formed into a groove like a pully, which moves upon the round edge of the same circumference of the circular railways *b b.* The peripheries of the circular railways are covered with flat tire like ordinary wheels, and, from their magnitude, they surmount obstacles more readily than the small wheels *a a* would do. When an obstacle presents itself to the railway *b b,* they stand still, and the small wheels *a a,* rising on their inner circumference, help them to surmount the obstacle.

In order to confine the circular railways, Mr Hunter proposes to introduce a guide arm and pully, as shown at *c* and *d,* Fig. 12.

In justice to an ingenious individual, it is necessary to state, that almost the same invention was submitted to the Society of Arts for Scotland on the 27th December 1822, by Mr Heriot, carpenter at Duddingston, under the title of *a model of a new construction of wheels for carriages, called a Moveable Railway.*

Art. XXXVII.—ANALYSIS OF SCIENTIFIC BOOKS AND MEMOIRS.

I. *Account of a Curious Manuscript Volume, entitled "The Discoverie and Historie of the Gold Mynes in Scotland, written in the year* 1619. By Stephen Atkinson." Printed A. D. 1825, with a Preface and an Appendix of Notes, for distribution among the Members of the Bannatyne Club. By Gilbert Laing Meason, Esq. F. R. S. Edin.

This most singular work, with a copy of which we have been favoured, furnishes us with a complete and very instructive history of the mining schemes which agitated the whole of Scotland in the 16th and 17th centuries.

The chief object of mining speculation in Scotland was the search after *gold.* That gold existed, and that it even now exists diffused through certain mountains, particularly in the south of Scotland, there can be no possible doubt. Its diffusion is, however, in such very sparing quantity, as to render it questionable if it ever has been detected *in situ,* that is, actually imbedded in its solid matrix. The rock in which it is contained has, like all other rocks, been for ages subject to gradual disintegration, and it is from the result of this disintegration, namely alluvial deposits, that grains of gold have been collected. The native gold of Scotland has thus been indebted for its developement to a process which has occupied a duration of time that cannot be estimated; and as it is probable that the investigation of the contents of this alluvium has been long since completed, and, consequently, the supply of Scottish gold exhausted, we must wait for a revolution of many more thousand years before the bed will be again sufficiently rich with gold, once more to tempt the avarice of mankind.

For a narrative of the mining speculators of Scotland we are indebted to the manuscript volume written by one Atkinson, an Englishman, and now printed with some very valuable notes and a preface by Mr Laing Meason for the use of the Bannatyne Club. From this work we shall make a few extracts.

Atkinson distinctly informs us, that gold was to be found "on Crayford Moore, and Fryer Moore, within Clidesdale; on Robburt Moore, and Mannocke Moore, in Nydesdale; uppon Glangaber Water, and in Henderland, within the fforrest of Atricke." We are also instructed that the gold found at Crawford Moor and other places was obtained from alluvium, generally after it had been diffused through the vallies by great rains, and that the ore was afterwards separated by washing.

Atkinson's speculations, that the gold found in these places was the result of the general deluge, would accord with the views of many geologists of the present day. We shall quote what he says on the subject, particularly as it is introductory to a very interesting description of the mode in which the Scottish gold was formerly collected. The passage is as follows: "God said unto the Trinity, 'Let there be dry land,' which was long after the worlde's creation, and immediately it was so, at which time the generall deluge was; and then, even att that time, naturall gold and silver (which now is found to be in combes and vallies) was forced and toorne from his bedd or vazen, from his dwelling-place, viz. God's treasur house in the earth, &c. And thyther even our Scott's gold, which is now found in sternes, or in graines, and peices, did discend, or was washed downe. In which vallies, combes, skirts of hills, or cloughes, even untill this present day, it hath laid still and not removed, except after a great speat of raine, the force whereof doth breake and weare the superficies of the earth, but not the solidd earth; after which, the Scotts men, and women, and children, run to seeke for it, and doe find it still, even untill this day: and thereby they find with it alsoe the saxere stones in great abundance, and alsoe much of the calamineere stones; but the salineere stones is as small as the musterd seede, and some like meale; and the sappar stone in lumps, and like unto the fowls eyes or birds eggs. And the most strangest of all is this; there is found naturall gold, linked fast unto the sappar stone, even as vaines of lead ewer and white sparrs doe growe togeather, &c. But theire usuall manner is, when they seeke for gold in combes and vallies, to frame or make a long sowgh, or scowring place, into which they bringe the streame water, to scower away the light earth from the heavy sandy earth, and to cull away the great stones from the heavy sand, which sand or heavy earth they scrape into theire troughe or tray, and by stirring it, and washing the same often, there is found both raine gold, flatt gold, pale gold, and blacke gold: yett all these be naturall gold, &c. And alsoe all these are called perfect compacted gold, made in the beginning of the worlde, and engendreth with these stones aforesaid amongst rocks and craighs, without the helpe of sonn, moone, or starrs."

We shall now give a brief chronological view of the history of the gold mines of Scotland, as far as can be collected from Mr Atkinson's work and the illustrations of Mr Meason.

James IV. who was a studier of Alchemy, is the earliest of the Scottish monarchs who is recorded to have worked the gold mines. In his reign the gold mines of Crawford Moor were said to have been first discovered. These mines were worked under the inspection of Sir James Pettigrew, who employed some Englishmen and Dutchmen to conduct the refining and melting department.

In the year 1526 a company of Germans obtained a grant from James V. for twenty-one years of the gold and silver mines of Scotland. In this reign three hundred men are said to have been employed for several summers in washing gold, of which they are reported to have obtained L. 100,000 in English money. Gold was also said to have been got in the Pentland Hills, in Langham Water, in Megget Water, and other places.

In the early part of the reign of James VI. probably between 1580 and 1592, two Dutch painters, De Vos and Bronkhorst, (brought over to execute the pictures in the gallery of Holyrood-House,) entered into a partnership to work the gold mines of Scotland. Nicholas Hilliard, jeweller to Queen Elizabeth, was also a mining adventurer of this reign. The success of Cornelius De Vos is thus curiously described. "This Cornelius was sent thither to discover the golden bedd or vaine, at the charge of certaine marchants in London, who procured unto him Queen Elizabeth's signett unto the king's majesty, that now is king of England, &c. then only of Scotland. And then Cornelius went to view the said mountains in Clidesdale and Nydesdale; upon which mountains he got a small taste of small gold. This was a whett-stone to sharpen his knife upon; and this naturall gold tasted so sweet as the honny or honny-combe in his mouth. And then he consulted with his freinds at Edenburgh; and by his persuasions provoked them to adventure with him, showing them first the naturall gold, which he called the temptable gold, or alluring gold. It was in sternes, and some like unto birds' eyes and eggs: he compared it unto a woman's eye, which intiseth her joyes into hir bosom. And Cornelius so earnestly persuaded his late frequented friends in Scotland, that he possessed them to adventure also with him. The Earle of Morton had ten partes. Mr Robert Ballentine, then secretary, had ten partes. Abraham Peterson, a Dutchman of Edinbourgh, had ten partes. James Reade, a burgeous of Edinbourgh, had five partes. And Cornelius reserved to himself, and his London freinds which adventured with him alsoe, ten partes. Some brought corne, some victuals, and some malt or meal, besides monies; and amongst them all L. 5000 Scotts. Cornelius then set to work six score of men in vallies and dales; he employed both lads and lasses, idle men and women, which before went a begging. Within the space of thirty days, they caused to be conveyed into the king's mint-house, half a steane weight of natural gold, viz. viij. pound weight, worth L. 450 Starling." Afterwards, when the Earl of Morton was regent, he obliged Cornelius "to bring all such naturall gold as he thereafter should gett into the mint-house at Edinbourgh, where it was afterwards coyned into iij. pound Starling peeces, of an ounce weight each peece. Much gold was then bought from the poor workmen for twenty shillings the ounce weight."

In the same reign, Abram Grey, a Dutchman, was an adventurer. He is said by Atkinson to have brought with him certain artsmen from England, and others of his own countrymen, into Scotland, which were at London. His success is thus noticed:—"At Winlocke-head he gott a good quantity of naturall gold. With this naturall gold gotten in the Greybeard's time, (for so was he called, because of his great long beard, which he could have bound about his middle,) was made a very faire deepe basin, of the same naturall gold, without any addition of any other gold att Edenborough, in Cannegate Streete; it was made by a Scottsman; it contained, by estimation, within the brymes thereof, an English gallon of liquor. The same basin was of clean, neat, naturall gold; itself was filled up to the brim with coined pieces of gold, called unicorns, which basin and pieces both were presented unto the French king by the Earl of Moreton, who signified upon his honour unto the king, saying, 'My Lord, behold this basin, and all that therein is; it is natural gold, gotten within this kingdom of Scotland, by a Dutchman, named Abraham Grey.' And Abraham Grey was standing by, and affirmed it upon a solemn oath. But he said unto the said kinge, that he thought it did engender and increase within the earth, and that he observed it so to do by the influence of the heavens. And he said that it increased, and grew more and more, but neither by the power of the sun, moon, nor stars, but by the omnipotent power of God, as he thought. And then the Earl of Moreton stood up, saying, 'I also believe that it engenders within the earth, but only of these ij. elements, (viz.) the water and the earth ; and that it is and was made perfect malliable gold from the beginning by God, the Creator thereof. But it was not, nor is not, pure fine gold, without any allay, as was Opheire gold ; but,' said he, 'I am certain, that all this gold, (viz.) the cup and all the pieces therein, are of natural Scott's gold, without any other compound or addition.'"

Another adventurer was Mr George Bowes, an Englishman, who is thus noticed :—"He procured a commission into Scotland unto the gold mines. He discovered a small vaine of gold, which had much small gold in it, uppon Winlocke-head. But he swore all his workmen to keepe it secrett, and never to disclose the same unto the King of Scotland, nor his counsell : for so he had promised to do, at his departure from the Queene of England, if he found it. And he went home richly into the north country, where he dwelt ; [but] unfortunately, in riding to see the copper works and mines in Cumberland, at Keswicke, as he was going downe into the deepe pits, the ladder broke, and the earth fell in uppon him, and so was bruised to death ; and thus he lost his life, and the vaine of gold was not since discovered in Scotland."

In A. D. 1593, James VI. granted the gold, silver, and lead mines in Crawford or Friar Moor, and Glengonnar, to Thomas Foullis, goldsmith in Edinburgh, for twenty-one years.

The king was due to Foullis L. 14,594, and his majesty pledged in security some gold plate.

In A. D. 1597, Foullis worked the lead mine to some extent, but was annoyed, as he stated, by the broken men of the borders.

Sir Bevis Bulmer is another mining hero of this period, who, visiting Scotland under Queen Elizabeth's patronage, is said to have been very successful. He had a patent from her majesty to obtain gold, and procured it on Mannock Moor, Winloch Water, Robbart Moor, Fryer Moor, Glangonner Water in Clydesdale, Crawford Moor, at Langclough, where he found gold in a vein of other substances, which they discovered in searching the rock, after discovering two pieces of gold five and six ounces in weight. In a piece of brown spar, weighing two pounds, (described to be like sugar candy,) a piece of gold one ounce weight was said to have been extracted. Mr Bulmer conceived his operations to be of such consequence that he erected a stamping mill. "Upon Glangabere Water, in Henderland," says Atkinson, "within the forrest of Atrick, Mr Bulmer gott the greatest gold, the like to it in no other place before of Scotland ; but he was at no cost to bring home water-courses there, nor build no houses to dwell in, neither staid he long. And he had there sometimes great gold, like Indian wheate, or pearl, and blacked-eyed like to beanes. And he did not mean to settle his workmen there, untill another fitter time should serve, for he was driven away by force of weather, and called away by other great occasions, (as is said,") &c.

It is also added, that "amongst all the gold which Mr Bulmer had gotten in Scotland, besides that which he had given amongst his friends, this is to be noted, that he presented unto the late Queen Elizabeth so much natural gold as made a porringer of clean gold."

Bulmer, in the next instance, sought to gain over King James to embark a capital in mining concerns. The monarch's cupidity for gold was at first greatly excited, as appears from the following very remarkable conversation which took place between him and Bulmer. "And shortly after Bulmer said that his majesty conceived so good an opinion of the mines, that he had them much in remembrance, (amongst other his great and mighty business,) esteeming them to be none of the smallest pleasing unto God, nor the least that God had ordeyned for man within the earth. Therefore the king had devised a plot how the said gold works might be set awork anew, and thereby become commodious unto his crowne and dignity, and so a great terror to all the enemies of God, if it hitt, which I will declare hereafter," &c.—'I doubt the silver mines of England decayes,' saith the king, 'else are not found so plentiful as in times past.'—'It is true,' said Mr Bulmer, 'and therefore,' quoth the king, 'as I desire to have a new onsett to find out from whence this natural gold doth descend, so I have meditated thereuppon, and have devised a plott how the gold mines may be set open, and thereby become profitabler than heretofore; and to that purpose I have devised this plott, whereby they may continually be supplied and continued in working without ceasing, and thus, with labour of man, may hills and mountains be turned into dayles and vallies, and the waters run over the hills, and so after courses into other places.'—And Mr Bulmer liked well of the plott, and said, 'That it is the most readiest way to discover it, but it was a chargeable way, for it is as easy to find the true philosopher's stone.'—'I have also foreseene and prevented that,' quoth the king. 'It is thought fitting that Bulmer shall be a superior or chief thereof, because of his trust and skill, which was liked of by the lords of the counsell in Scotland. Therefore, let Bulmer procure, or move twenty-four gentlemen within England, of sufficient lands and livings, or any other his freinds of Scotland, that shall be willing to be undertakers thereof, and to be adventurers towards the discovery thereof, and see that all these gentlemen be of such sufficiencie in lands, goods, or chattels, as the worst be worth L. 10,000 Starling, else L. 500 per annum Starling; and all such gentlemen to be moved to disburst L. 300 Starling, each man in monies or victuals for maintenance of the gold mynes in Scotland; for which disbursement each man to have the honour of knighthood bestowed upon him, and so for ever to be called the *Knight of the Golden Mynes*, or the *Golden Knyght*."

It is unnecessary to make any further remark on this quixotic project, than that it was truly worthy the name and character of the British Solomon.

In A. D. 1607, the discovery of the silver mine of Hilderston, near Linlithgow, took place, which raised the most flattering expectations. Ten tons of the various metals were sent to England to be assayed, and were refined by Atkinson, (then a refiner in the Tower of London.)

In A. D. 1608, Sir Bevis Bulmer was appointed, by patent, master and surveyor of the Hilderston mine, and under his direction it was worked for the crown three years. He called the shaft of one silver mine at Hilderston God's blessing. The silver was got out of what was called red metal, and the purest sort contained in it twenty-four ounces of fine silver obtained from every hundred weight.

Bulmer soon gave up these works to pursue other mining speculations; for in the year 1613 Sir William Alexander, Thomas Foullis, and Paulo Pinto, a Portuguese, got a grant of the mine of Hilderston on paying a tenth of the refined ore. The vein, however, eventually failed.

We may now advert to Atkinson himself, the author of the very curious account of the mines of Scotland. He had served an apprenticeship to a refiner in London of gold and silver, and was admitted a refiner in the Tower of London, A. D. 1586. He afterwards was engaged in Devonshire in refining silver from lead ore. He was taught his mining skill by B. B. an "ingenious gentleman," and was two years in Ireland with Sir Bevis Bulmer. He was afterwards tempted to leave his refining business, in order to explore gold mines in Scotland. In A. D. 1616 Atkinson obtained leave to search for gold and silver in Crawford Moor on paying to the king one-tenth of the metals found. He probably, as Mr Laing Meason supposes, wanted money for the undertaking, and therefore wrote to his majesty; and after comparing several of the king's acts to those of David and Solomon, suggested the opening of the gold mines of Scotland, which would make his majesty the richest monarch in Europe, yea, in all the world. The Scots' gold mines were compared by him to God's treasure-house, and named Ophir gold for their goodness. "Some have doubted," (he adds,) "that any goodness could be produced from Scot's ground; arguing it in the following reasons:—First, That, as it were admitted by schoolmen that gold and silver were engendered by the heat of the sun and moon, there could be no such metals in Scotland, because the sun and moon did not there shine:" which objection the author answers by an apt allusion to the heat that exists in deep mines, or in the entrails of the earth, which he supposes to be quite sufficient for the purpose of engendering gold. After this hypothesis he pays an extravagant, and almost profane compliment to King James, which he introduces by a sort of side-wind. "Lett my judiciall man understand, that twenty fathoms under ground, within the entrails of the earth, it is as hott, even in the coldest country or nation under the whole scope of Heaven, as in the hotest; so that it is no argument that in Scotland there can be no naturall gold or silver, for assuredly it hath bin found there uppon Crayford Moore, and other moores adjoyning thereto, before any man now alive was borne, some thereof in solidd places, uppon mountaines and mosses, and some in shallow places, within vallies and dales, neere to the river or brooke-side, yea, even as if the omnipotent Creator of Heaven and earth should have invited the king's majesty thereunto for a great blessing.

Atkinson then proceeds to point out some of the localities of the gold; and the comparison which he makes of a certain district of Scotland which is watered by rivers to the Garden of Eden, is in precisely the same extravagant character. "In the second chapter of Moses, called Genesis, I read, (viz.) 1st, that God planted a garden in Eden, where he put man. In Clydsdale and Nydsdale, within the kingdom of Scotland, (is a place) which may be compared unto it, (the garden of Eden,) or called a second garden, though not so pleasant and fruitful, yet richer under ground than above for gold. And there be four waters or rivers, the heads whereof descend out of mountaines and mosses, or hard rocks and craggs. These rivers are also divided, by God's omnipotent power, into foure heads. The name of one called Glangonnor water, within Clydsdale. The name of the second is called Short-clough water, upon Alwayne, within Clydsdale, upon Crawford Moore. The name of the third river is Winlocke-head, or Wynlocke-water, upon Robbart Moore, within Nydsdale. The name of the fourth river is called Mannocke-water, upon Mannocke Moore, within Nydsdale."

The king, however, eventually gave no ear to these fine stories. He had already expended L. 3000 in the gold mines of Crawford Moor, and had obtained not quite three ounces of gold.

But it is now time to close this narrative. It appears that Sir Bevis Bulmer completely failed in his mining speculations, which was attributed to his having too many irons in the fire, and to his too great extravagance. "He wasted much himself," says Atkinson, "and gave liberally to many for to be honoured, praised, and magnified, else he might have been a rich subject, for the least of these frugalities (profusions) were able to rob an abbot. By such sinister means he was impoverished, and followed other idle venial vices to his dying day, that were not allowable of God nor man: and so once down aye down, and at last he died at Awstinmoore, in my debt L. 340 Sterling, to my great hinderance, and left me in Ireland much in debt for him. God forgive us all our sinnes!"

The last account which we have of these mines is that, in A. D. 1621 a lease was granted to John Hendlie, physician, to work the gold mines in the mining districts of Lead Hills and Wanlocke-head for twenty-one years.

This curious history is now brought to a close. If these gold mines had been thought of in the year 1825, it is not impossible but that their revival might have been contemplated, and that the minds of the mad projectors of that period might have been diverted from the golden mountains of Mexico to hunt for treasure on the cold and dreary plains of Crawford Moor. The last project would have had this advantage, that it would have dispersed a few of the thousands which have been idly squandered away in distant speculations among our own countrymen.

Mr Laing Meason has edited this volume with a care and judgment that cannot fail to be highly gratifying to the gentlemen who compose the members of the Bannatyne Club, the patriotic object of which is the preservation of early Scottish records and literature. The notes are highly valuable. They comprise, among various matters, a collection of early documents illustrative of the localities of other metals besides gold, said to have been found in Scotland.

II.—*The Steam-Engine Theoretically and Practically Displayed.* By GEORGE BIRKBECK, M. D. F. A. S. M. A. S. &c. and HENRY and JAMES ADCOCK, Civil Engineers. Illustrated by a series of splendid engravings from working drawings made expressly for this publication. No. I. 4to, pp. 48. John Murray, *Albemarle Street.*

AMONG the numerous works on the Steam-Engine which have lately issued from the press, there are none which can bear any comparison with that which is now before us, either in its excellence as a work of practical science, or in the splendour of its embellishments. As this number contains only a portion of the introductory dissertation on steam, we are not able to judge of the manner in which the operation and construction of the different steam engines will be described ; but judging from the perspicuity with which this preliminary portion has been drawn up, we have every reason to suppose that the remaining parts will be executed in a manner worthy of Dr Birkbeck's reputation and talents.

In the present number, Dr Birkbeck commences with an account of the experiments of Dr Black and others on latent heat, and then proceeds to give a detailed account of the experiments of Mr Watt, Mr Southern, Mr Dalton, Dr Ure, and Mr Taylor, on the elastic force of steam. The results of these experiments are drawn up in a copious tabular synopsis, which is suited to the scales of Fahrenheit, Reaumur, and the centigrade, and extends from 32° to 343° of Fahrenheit. The author then proceeds, with the aid of well engraved wooden cuts, to detail the methods by which these philosophers conducted their respective experiments, and the number is concluded with an account of the formulæ in which M. Biot has expressed the result of Mr Dalton's experiments.

Dr Birkbeck has not given any account of the ingenious paper on the elastic force of steam at high temperatures, published by our distinguished countryman Mr Ivory on the 1st of January 1827, but it is probable that his dissertation was in the press before that date.

The only criticism which we are disposed to make on this part of the work relates to the introduction of mathematical formulæ, and we would strongly recommend it to Dr Birkbeck to separate all such formulæ from the text, and to throw them, along with discussions of a profound nature, into notes or appendixes. There is not one reader out of an hundred, however well he may have been educated, who is capable of following such investigations, and even those who have successfully pursued mathematical studies in their youth, are quite unable to apply them in their manhood.

The present number, the price of which is only six shillings, is illustrated with no fewer than Six Quarto Plates, (two of which are double) containing the following subjects.

1. Boulton and Watt's single acting engine. *Elevation.*
2. do. do. *Section.*
3. }
4. } Side and front views of the mechanism for opening and shutting the valves.
5. Plan of the beam,—general plan, and details.
6. Lloyd's steam engine, *Elevation* and *Plan.*

From this brief notice, the reader will be able to form a pretty correct notion of this valuable work, which promises to reflect great credit upon Dr Birkbeck, and upon the respectable civil engineers by whom he is assisted.

Art. XXXVIII.—PROCEEDINGS OF SOCIETIES.

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

March 19, 1827.—Professor Dunbar read an inquiry into the structure of the Greek, Latin, and Sanskrit verbs, with some observations to show that the latter were derived from the former.

April 2.—The following gentlemen were elected Members:

The Reverend Edward Burnet Ramsay, A. B. of St John's College, Cambridge.

The Reverend James Walker, D. D. of St John's College, Cambridge.

Sir William Hamilton read an Essay "on Phrenology considered in its constitution."

April 16.—There was read a Paper "on a New Combustible Gas, by Thomas Thomson, M. D. Professor of Chemistry, Glasgow.

This gas was obtained from *pyroxylic spirit,* formed by the distillation of wood, and manufactured by Messrs Turnbull and Ramsay of Glasgow. Pyroxylic spirit has a specific gravity of 0.812, and an agreeable smell, and is used in lamps in place of alcohol. Dr Thomson found that the gas extricated from a mixture of aqua regia and pyroxylic spirit consisted of

New inflammable gas,	29
Nitrous gas,	63
Azotic	8
	100

the specific gravity being 1.945, that of air being 1. The specific gravity of the new gas was 4.1757, and it was composed as follows:

1 Atom hydrogen,	0.128
1 Atom carbon,	0.750
1½ Atom chlorine,	6.750
	7.625

and its atomic weight is 7.625. Hence Dr Thomson calls it the *Sesqui-chloride of Carbo-hydrogen.*

On the same evening there was read another paper by Dr Thomson, entitled *Some Experiments on Gold.* The object of this paper was to determine whether the peroxide of gold contained *two* or *three* atoms of oxygen. The evidence from the analysis of Berzelius and Javal was in favour of *three* atoms, and hence chemists had considered the peroxide of gold as a *ter-oxide.* This result is confirmed by Dr Thomson, who finds that peroxide of gold is composed of

1 Atom of gold, - - - -	25
3 Atoms of oxygen, - - - -	3
	28

In this paper Dr Thomson also determines that *muriate of gold* consists of

2 Atoms muriatic acid, - - -	9.25
1 Atom peroxide of gold, - - -	28.
5 Atoms water, - - - -	5.625
	42.875

Dr Thomson then proceeds to show, in opposition to the views of Berzelius, that the permuriate of tin, like the muriate of gold, is more probably a muriate than a chloride.

On the same day a paper was read " On the gradual changes which take place in the Interior of Minerals, while the external form remains the same," by William Haidinger, Esq. An extract from this paper is given in the present Number, p. 126.

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

March 20, 1827.—The following Gentlemen were elected Members:—

Ordinary.

George Swinton, Esq. Calcutta.

Honorary.

David Gordon, Esq. Engineer to the Portable Gas Company, London.
Rev. W. Scoresby, F. R. SS. L. and E. Liverpool.
Dr Thomas Traill, F. R. S. E. Liverpool.
George Harvey, Esq. F. R. S. L. and E. Plymouth.

Associates.

Mr Alexander Rose, Edinburgh.

There was read a letter from David Gordon, Esq. to Dr Brewster, on a remarkable decomposition of oil gas. See our last Number, p. 325.

Mr Sivwright exhibited a new species of file, formed by the separated surfaces of chalcedony.

The model of a new gate, by Mr John Currer, was exhibited and described. This gate opened and shut by the action of the carriage that approached or quitted it.

A model of a machine for lifting and letting down weights, by Mr John Currer, was exhibited and described.

Art. XXXIX.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Comet of December* 1826.—This comet was discovered by M. Gambard at Marseilles on the 27th December. The elements are as follows:

	D.
Passage of Perihelion, 1827, Mean time from midnight,	31. 989
Longitude of perihelion, - - -	34° 0′ 50″
Longitude of node, - - -	191 44 33
Perihelion distance, - -	0.455
Inclination, - - -	72 4 15
Motion	Retrograde.

2. *M. Westphal's Table of Variable Stars.*—The variable stars hitherto known are thirteen in number. The following table given by our author contains their positions for 1820, the total period of their change, the extreme intensities of their light, and the name of the astronomer who first observed them.

	R. Asc.	Decl.	Period in Days.	Max. of Light. Mag.	Min. of Light. Mag.	Observers.
Whale, -	32° 34′	3° 48′ S	331.96	2 to 4	Invis.	Fabricius.
Perseus, -	44 7	40 15 N.	2.37	2 —	3 to 4	Goodrick.
Leo, -	144 28	12 15	311. 4	5 to 6	Invis.	Koch.
Virgo, -	187 20	7 59	146	5 to 7	Invis.	Harding.
Hydra, -	199 58	22 21 S.	494	3 to 4	Invis.	Montanari.
North Crown,	235 17	28 43 N.	335	6 to 7	——	Pigott.
Hercules, -	256 36	14 36	60. 5	3	3 to 4	Herschel.
Sobieski's Shield,	279 23	5 53 S.	60. 6	5 to 6	6 to 7	Pigott.
Lyra, -	280 52	33 10 N.	6.44	3	5	Goodrick.
Antinous -	295 49	0 33	7.18	4	5	Pigott.
Cygnus, -	295 54	32 27	47. 5	4 to 6	Invis.	Koch.
Cepheus -	335 37	59 30	5.36	3 to 4	4 to 5	Goodrick.
Aquarius, -	353 37	16 17	382. 5	6 to 7	Invis.	Harding.

In a separate account of each star, the author explains in detail his observations and calculations. In almost all of them the increase of light is more rapid than its diminution.

	Increase.	Diminution.
Whale, - -	40 days	66 days
Perseus, - -	4 hours	4 hours
Leo, - -	30 days	48 days
Virgo, -	39	42
Hydra, - -	43	83
Hercules, - -	23	39
Sobieski's Shield, -	19	42
Lyra, - -	3	3.4
Antinous, - -	2.7	4.5
Cygnus, - -	39	73
Cepheus, . -	1.5	3.9

See *Neueste Schrift. der Naturforsch. Gesells in Danzig.* vol. i. 2 cah. p. 3.

MAGNETISM.

3. *Lebailliff's Needle for showing the smallest quantity of Magnetism.*—This needle consists of two magnetised sewing needles placed at the two

ends of a straw, suspended by its middle with a silk fibre without torsion. The two poles of the needle are placed so as to render the earth's action upon it almost nothing. M. Lebailliff has modified the apparatus in various ways, as M. Becquerel has remarked its extreme sensibility depends on the length of the arm of the lever, at the end of which the magnetic action is exercised, and on the neutralization of the earth's action. This apparatus has led to the following curious discovery.

4. *Singular Magnetic Property of Bismuth and Antimony.*—When either bismuth or antimony is brought near the poles of M. Labailliff's needle, above described, they exert *upon both poles a very decided repulsion.* M. Becquerel, who mentions that he saw this experiment with astonishment, remarks that this doubly repulsive property has been recognized only in these two metals. An account of this curious fact was laid before the Philomathic Society of Paris on the 31st March 1827.—*Le Globe, Avril* 3, 1827.

METEOROLOGY.

5. *Hourly Meteorological Observations on the* 17*th July.*—Those meteorologists who have hitherto made the hourly meteorological observations in pursuance of the recommendation of the Royal Society of Edinburgh, are earnestly requested to continue them on the *seventeenth of July.* In consequence of a typographical mistake in the notices to Correspondents in our last Number it was called the 15th June.

6. *Luminous Spots near the Horizon.*—M. Atwater in a memoir on the climate of Ohio, in Dr Silliman's *Journal,* remarks that, before a storm, he has often noticed in an evening of the latter part of autumn, and sometimes in the winter, a phenomenon which he never saw on the east side of the Alleghanies. Some one spot or spots near the horizon in a cloudy night appeared so lighted up, that the common people believed there was some great fire in the direction from which the light came. He had seen at once two or three of these luminous spots not far from each other; generally there was but one, and a storm, invariably proceeding from the same point near the horizon, succeeded in a few hours.

II. CHEMISTRY.

7. *New compound of selenium and oxygen.*—Professor Mitscherlich has discovered a new acid of selenium, consisting of one atom of selenium and three atoms of oxygen, and consequently analogous in composition to sulphuric acid. Its appropriate name will of course be *selenic acid,* since it contains more oxygen than the compound hitherto known by that name; while to the latter, the composition of which is similar to that of sulphurous acid, the term *selenious acid* must hereafter be applied. The isomorphism of selenium and sulphur is already known, and principally established from the identity of form of the compounds, which they produce with lead,—sulphuret of lead, or galena, and seleniuret of lead, both of

which show distinct cleavage in the direction of the faces of the hexahedron, and are altogether so similar, that for a long time they were actually mistaken for each other. Professor Mitscherlich now finds also that the forms of the new seleniates are analogous to those of the sulphates; and what renders the discovery still more interesting is, that the salts may be obtained in crystals superior in beauty even to the sulphates themselves. Among several very interesting species resulting from the new acid, combined with the bases, was obtained an anhydrous seleniate of soda, with a form corresponding to the anhydrous sulphate of soda, and also to the sulphate of silver. It is very remarkable that the form of the seleniate of magnesia is hemiprismatic, and the same as that obtained when the sulphate of the same base is made to crystallize at a high temperature.

8. *Theory of the Formation of mineral waters.*—Mr Struve of Dresden has contrived to form saline solutions, very nearly agreeing with those found in nature, by forcing pure water, or water impregnated with carbonic acid, to pass under considerable pressure through pulverised portions of the rock which occurs in the vicinity of the natural spring. The following instance will give an idea of the extent of the resemblance in the solid contents of two kinds of water, the one artificial, the other natural. The artificial solution was formed by forcing first carbonic acid, and then water impregnated with it, under a pressure of nearly two atmospheres, through a cylinder 84 inches high, filled with 3 pounds 14 ounces of powdered clinkstone, and as much of clean sand. The water began to ooze out from the uppermost layer only about twelve hours after the beginning of the process. The natural spring compared with it is the acidulous water of Bilin in Bohemia, a country which in that vicinity abounds in clinkstone.

Substances contained in 16 ounces of water,	Clinkstone water.	Bilin Water.
Carbonate of soda, - -	21.974	22.732 gr.
Muriate of soda, - - -	1.963	2.884
Sulphate of potash, - -	1.670	1.735
Sulphate of soda, - - -	4.859	6.171
Silica, - - - -	0.512	0.355
Carbonate of lime, - - -	4.480	3.066
Carbonate of magnesia, - -	1.126	1.196

In the same manner Mr Struve has also produced saline waters similar to those of Teplitz in Bohemia from the porphyry out of which the springs there issue; waters like some of Egra from the basalt of Liebenstein, near Egra; and waters resembling the spring called the "Kreuzbrunn" at Marienbad from the basalt occurring between Tepl and Marienbad. All the appearances of natural mineral springs may be explained by a theory corresponding to the facts observed.—(Schweigger's *Journal*, vol. xvii. p. 374.)

9. *Caustic Potash.*—We have received the following notice from Mr T. Graham. "In dissolving the caustic potash in sticks of the apothecaries,

I had occasion to remark that a considerable but variable proportion of pure oxygen gas was always emitted. In one case a stick of forty grains in weight yielded 200 grain measures during solution, although in general the quantity was considerably less. The effervescence was similar to what a slight admixture of peroxide of potassium would occasion. There appeared to be some connection between the amount of oxygen and the quantity of brown insoluble impurities remaining after the solution of the potash. It is probable that the peroxide of iron, from the iron vessels employed in the manufacture of caustic potash, contributes either directly or indirectly to the production of the phenomenon. A knowledge of the fact may occasionally be useful, as previous to its detection a series of results in gaseous analysis was vitiated by it."

10. *Composition of Nitric Acid.*—The 12th volume of the *Annals of Philosophy, O. S.* (p. 351) contains the translation of a paper on the composition of nitric acid, by Berthollet. The process employed was that of decomposing nitrate of potash by heat in a porcelain retort, the weight and nature of the gaseous products and of the residual potash being ascertained. From these experiments the author concluded that nitric acid is composed of 69.6 oxygen + 30.4 azote, instead of 74.08 of the former, and 25.92 of the latter element, as now generally admitted.

Dr Thomson observes, that, though he has no doubt of the inaccuracy of Berthollet's analysis, he cannot pretend to account for the fallacy. Having lately prepared some oxygen gas by decomposing nitre, Mr Phillips found that the last gaseous product, if not entirely azotic gas, contained so little oxygen that it extinguished a candle. Upon pouring water into the gun-barrel to remove the potash, he found that oxygen was immediately evolved, and in such quantity that an ignited stick was immediately inflamed; and the combustion continued for a considerable period.

Now Berthollet distinctly, though erroneously, reports, that the potash retains no oxygen: but it is evident from the experiment now stated, that peroxide of potassium is formed; and it appeared probable to Mr Phillips, that the quantity is sufficient to supply the deficiency of about 4½ per cent of oxygen in Berthollet's experiment.—*Philos. Magazine and Annals of Philosophy* for April.

11. *Nitrification.*—In a letter to M. Longchamp, published in the 34th vol. of the *An. de Ch. et de Physique*, M. Gay-Lussac has defended the old theory of nitrification against the objections of the former chemist, of whose views we gave a short notice in the preceding number of the *Journal.* M. Longchamp has endeavoured to establish the two following points. 1. That nitric acid and its salts are generated in substances, or in places, which contain neither animal nor vegetable matters, and which have never been exposed to the emanations from animals. 2. That nitric acid is formed exclusively by the elements of the atmosphere. With respect to the first position, M. Gay-Lussac denies that it is supported by any decisive fact. He has shown that different kinds of chalk, and other calcareous substances in which nitrate of lime is gradually formed, and which

were supposed by M. Longchamp to be free from animal matter, yield ammonia by distillation. The reasonings in favour of the second statement M. Gay-Lussac declares to be vague and inaccurate. He admits that nitric acid may, from some unknown causes, be generated without the aid of azotized matters; but contends that the idea of its being exclusively found in that way is quite untenable. He affirms that the most ignorant manufacturer of salpetre is aware that animal matters assist very powerfully in the formation of that salt, and that they do so on quite different principles than by affording moisture.

12. *Solidification of Bromine and some new compounds of that substance.* By M. SERULLAS.—*Ann. de Chimie et de Physique*, vol. xxxiv. The solidification of bromine takes place at a temperature between 0 and — 4° F. In the solid state it is friable.

13. *Hydrocarburet of Bromine.*—This compound was formed by adding one part of the hydrocarburet of iodine to two parts of bromine contained in a glass tube. Instantaneous reaction ensues, attended with disengagement of caloric and a hissing noise, and two new compounds, the bromuret of iodine, and a liquid hydrocarburet of bromine are generated. By means of water the former is dissolved, while the latter, coloured by bromine, collects at the bottom of the liquid. The decoloration is then affected by means of caustic potash. If in this process the hydrocarburet of iodine is in excess, very little hydrocarburet of bromine is formed; but a sub-bromuret of iodine, analogous to the sub-chloride of iodine described by Gay-Lussac, will then be obtained.

The hydro-carburet of bromine, after being washed with solution of potash, is colourless, heavier than water, very volatile, of a penetrating ethereal odour, and of an exceedingly sweet taste, which it communicates to water in which it is placed, in consequence of being slightly soluble in that liquid. It hence appears that its properties are absolutely the same as those of the liquid proto-hydrocarburet of iodine described by M. Serullas in the 25th vol. of the *An. de Ch. et de Physique.* Chemically, however, it differs from this compound in yielding bromine instead of iodine when decomposed, in forming white instead of violet vapours when thrown on red-hot porcelain, and in not acquiring a colour by exposure to the air. It becomes solid at a temperature between 21° or 23° F.

M. Serullas finds that the compound which M. Balard formed by letting a drop of bromine fall into a flask of olefiant gas, is identical with the hydrocarburet of bromine just mentioned.

14. *Hydrobromic Ether.*—This compound is made in a manner similar to that by which M. Serullas prepared the hydriodic ether. (*An. de Ch. et de Ph.* t. xxv. p. 323.) Into a tubulated retort are introduced 40 parts of alcohol of specific gravity 0.837, and one part of phosphorus; and then seven or eight parts of bromine are added by successive small portions. Whenever the bromine comes in contact with the phosphorus, there ensues a rapid combination with increase of temperature, and subsequent forma-

tion of hydro-bromic and sulphurous acids. The distillation is then conducted at a gentle heat, and the volatile parts are collected in a cold recipient. On diluting the distilled liquor with water, the ether separates and descends to the bottom; and if any acid has passed over, it may be removed by the addition of a small quantity of potash.

Hydro-bromic ether is colourless and transparent, very volatile, heavier than water, of a strong and ethereal odour, and pungent taste. It is soluble in alcohol, and is precipitated from that fluid by water. It undergoes no change of colour by being kept under water, in which respect it differs from the hydriodic ether.

15. *Cyanuret of Bromine.*—The mode of preparing this compound is analogous to that by which M. Serullas procured the cyanuret of iodine. At the bottom of a small tubulated retort, or a rather long tube, are placed two parts of well-dried cyanuret of mercury, so as to secure an excess of it, and after cooling the apparatus by cold water or a frigorific mixture, which last precaution is indispensable in summer, one part of bromine is added. A strong reaction ensues, and so much caloric is disengaged that a considerable portion of the bromine would be dissipated unless the temperature had been previously reduced. The new products are the bromuret of mercury and the cyanuret of bromine, the latter of which collects in the upper part of the tube in the form of long needles. After allowing any vapour of bromine, which may have risen at the same time, to condense and fall down upon the cyanuret of mercury, the cyanuret of bromine is expelled by a gentle heat, and is collected in a recipient carefully cooled.

As thus formed, the cyanuret is crystallized, sometimes in small regular colourless and transparent cubes, and sometimes in long and very slender needles. In its physical properties it is so very similar to the cyanuret of iodine, that they may easily be mistaken for each other, especially when the crystals of the cyanuret of bromine possess the acicular form. They agree closely in odour and volatility, but the cyanuret of bromine is even more volatile than the cyanuret of iodine. It is converted into vapour at 59° F. and crystallizes suddenly on cooling. Its solubility in water and alcohol is likewise greater than that of the cyanuret of iodine. Caustic potash in solution converts it into the hydro-cyanate and hydrobromate of potash. This solution gives a precipitate of the cyanuret and bromuret of silver, separable from one another by ammonia, which dissolves the latter and not the former.* The proportion of each may probably be determined in this way.

M. Serullas remarks, that all the reagents to which he has subjected the cyanuret of bromine always left the bromine with all its characters, even under circumstances favourable to its decomposition, were it not a simple substance.

The cyanuret of iodine is highly deleterious. A grain of it dissolved in a little water, and introduced into the œsophagus of a rabbit, proved fatal

* There is surely some mistake here: the cyanuret of silver is soluble in ammonia.—E. T.

on the instant, acting with the same rapidity as prussic acid. From the volatility and noxious qualities of this substance, great care is necessary in making experiments upon it. This circumstance, together with a deficient supply of bromine, prevented M. Serullas from continuing the investigation of its properties.

16. *New Sources of Bromine. Poggendorff's Annals*, 8th volume.—The discovery of bromine in the water of the Dead Sea, made by Professor Gmelin of Tübingen, has been confirmed by M. Hermbstaedt. This interesting substance has also been found in several salt springs in Germany. Thus it has been detected in the mother water of the salt works at Theodörshalle by Professor Liebig, as mentioned in the last Number of this Journal; at the salt works at Rappenau in Baden by Professor Geiger; at those of Dürrheim, Schweningen, Wimpfen, and Jaxfeld, by Professor Frommherz of Freyburg; and at those of Halle by Dr Meissner; of Schönebeck by M. Hermann; and of Rosenheim in Bavaria by Vogel.

17. *Supposed Chlorate of Manganese in the native Peroxide. Philos. Magazine, and Annals of Philosophy for April.*—Mr MacMullin having observed, (*Institution Journal*, vol. xxii. p. 231,) that when sulphuric acid is added to peroxide of manganese chlorine is evolved, he conceived it might be derived from an admixture of muriate of manganese, iron, or copper; but as, on washing some of the peroxide with water, he did not find that any chloride of silver was precipitable from it, he concluded that the peroxide in question contains no salt of muriatic acid. On continuing his experiments to discover the source of the chlorine, he inferred that the chlorine combined with the black oxide is in the state of chloric acid; and that the native oxide is, at least in part, and probably in proportions varying with the different specimens of the ore, a native chlorate of manganese.

This point has recently been examined by Mr Phillips, who has arrived at a conclusion totally different. He procured first some common peroxide of manganese, a second and pure specimen from Warwickshire, and a third crystallized variety from Germany. These were reduced to powder, and on the addition of sulphuric acid, chlorine was evolved from each. Separate portions of them were then washed with distilled water; and on the addition of nitrate of silver to the washings, the chloride of silver was immediately precipitated; whereas sulphuric acid being poured upon the washed peroxide, no chlorine whatever was evolved. But being unwilling to trust merely to his own observation, Mr Phillips added sulphuric acid to an unwashed portion, and to one which had been washed;—a bystander immediately detected the odour of chlorine in the former, but not in the latter case.

To determine the nature of the salt which furnished the chlorine, Mr Phillips evaporated a portion of the washings very low, in order that, if any common salt were present, it might crystallize. He was however unable to procure any of it: sulphuretted hydrogen indicated no appearance of any metallic muriate, but oxalate of ammonia gave proof of the presence of lime, and muriate of baryta of sulphuric acid. Hence it appears that the native peroxide of manganese usually contains a small admixture of the muriate and sulphate of lime.

18. *Analysis of the Meteoric Stone which fell near Ferrara in* 1824.—Mr Laugier found the stone to be thus composed:

Peroxide of Iron,	43
Silex,	41.75
Magnesia,	16.
Oxide of Chrome,	1.50
Oxide of Nickel,	1.25
Sulphur,	1.
	104.5

The quantity of sulphur and nickel is less in this than in other meteorites.—*Ann. de Chim. Feb.* 1827, tom. xxxiv. p. 141.

III. NATURAL HISTORY.

MINERALOGY.

19. *Crystallized Pyrope.*—In the Iser mountains in Bohemia, crystals of this species have lately been discovered by a pupil of Professor Zippe of Prague. In this new locality pyrope generally also is found in grains, but many of them exhibit traces of a crystalline surface, and one individual in particular showed the perfect form of a hexahedron, the length of its sides being about a line, with faces slightly curved, as is often the case in diamonds. Professor Zippe described it in a particular memoir, which was read before the Society of the National Museum of Prague. He establishes it there as a species of its own, belonging to the genus garnet of Mohs, under the name of hexahedral garnet.

20. *Remarkable optical property of Dichroite.*—Professor Marx of Brunswick discovered that dichroite, cut parallel to the crystallographic axis of the crystals, has the property of polarizing light exactly in the same manner as tourmaline. This substance, therefore, promises to become highly valuable to those who occupy themselves with the optical examination of minerals, since it is not uncommonly found of a uniform texture and colour, and considerable degrees of transparency. The mineral has the property of polarizing light also when cut perpendicular to the axis, as might have been anticipated from the circumstance of its having two axes of double refraction.—(Schweigger's *Journal*, vol. xvii. p. 368.)

GEOLOGY.

21. *Dr Hibbert's System of Geology.*—Dr Hibbert is in considerable forwardness with the system of Geology which he has many years been preparing for publication. It is intended to contain a succinct view of the History of the Earth, with a geological arrangement of the various mineral substances which each description of rock contains, and a particular account of the organic remains which have been discovered in the

various strata. A considerable portion of the work is dedicated to an inquiry into the changes which are still going on to alter the surface of the globe. Dr Hibbert, preparatory to the completion of his work, is visiting the continent with the view of satisfying himself on some important questions connected with the subject of rocks of igneous formation. For this purpose he is undertaking a personal examination of several of the most noted volcanic districts of Europe.

22. *Mr Scrope's Memoir on the Geology of Central France.*—We regret much that we have been obliged to postpone an analysis of this interesting work to our next number. In the meantime, we may assure our geological readers that they will find it one of the most valuable memoirs that for a long time has been given to the world. The memoir itself consists of a quarto volume of nearly 200 pages, and is illustrated with 18 folio plates, several of which are of great size, and exhibit at the same time a geological and a picturesque representation of the remarkable volcanic district of which it treats. Our coadjutor, Dr Hibbert, has gone to examine the same region, and will zealously take up the subject where it has been left by Mr Scrope.

ZOOLOGY.

23. *System of Ornithology.*—Captain Thomas Brown, F. R. S. E. &c. has published Number I. of his "*System of General Ornithology.*" It contains *Six* Imperial Quarto Plates, on which are represented twenty-four birds, coloured after nature. It is intended in this work to give figures of all the known species, distinct varieties, with the female, and occasionally the young birds. The whole are to be drawn from nature and engraved by the author, from these superb collections, the Jardin du Roi at Paris; the Museum at Haerlem; and in Britain from the British, Edinburgh University, and East India Company's Museums. This work is to be published in numbers every two months, containing six plates; from twenty to twenty-four figures. The descriptive letter-press will be brought forward every six months, with complete descriptions of the birds published in the preceding numbers, including their instincts, habits, localities, and comparative anatomy.

We understand that these splendid figures are finished by Captain Brown himself, which will give a fidelity of representation unusual in such works. In short, the birds in the number we have seen are so highly finished that they may be taken for drawings.

BOTANY.

24. *Natural History of the Auricula.*—Captain Thomas Brown, F. R. S. E. &c. is preparing for publication a work on the *Auricula*, which is to appear in 4to numbers every two months, containing four plates coloured after nature. This work will contain about sixty of the most beautiful varieties of that esteemed flower, with a complete account of its natural history, mode of cultivation, admixture of soils, &c. and a list of the known varieties, by whom they were raised: together with a catalogue of the best collections in Great Britain.

IV. GENERAL SCIENCE.

25. *Rumford Medals Adjudged.*—The Royal Society of London has adjudged the medals on Count Rumford's donation to M. Fresnel, for his application of the theory of undulations to the polarisation of light.

26. *Dr Brewster's System of Popular and Practical Science.*—The object of this publication is to furnish the educated classes, but particularly the young of both sexes, with a series of popular works on the various branches of science, brought down to the humblest capacities, and yet capable of imparting scientific knowledge to the best informed ranks of society. A series of such works has long been a desideratum among Parents and Teachers of Youth, and the want of them among the middle and upper classes of society is more deeply felt at the present time, when general knowledge is so eagerly sought for, and when the press is teeming with productions pretending to be books of popular and practical science, but which, with the exception of the Library of Useful Knowledge, and the admirable works of Miss Edgeworth, Mrs Marcet, and some others, are compilations of incorrect statements and exploded opinions.

There is not a more common error than to suppose that works of science must be easily understood, because they contain no mathematical reasoning, or because they are confined to those portions of science which are usually explained by popular writers. The plainest subject is often made inaccessible by the language and the manner in which it is treated; while on the other hand, by a perspicuous style and suitable methods of illustration many abstract branches of knowledge may be rendered plain to persons of very moderate capacities.

In order to write a work truly popular, the author must have experienced the difficulties of communicating scientific instruction, and must have practised the methods by which these difficulties can be overcome. He must be familiar with the details of the science of which he treats;—with its relations to kindred branches of knowledge; and with its applications to the various purposes of domestic and civil life. In some of these respects, particularly from his experience in drawing up most of the copious scientific Treatises for the *Edinburgh Encyclopedia*, the author conceives that he is in some measure qualified for the present work; and he has no scruple in stating his opinion, that many departments of science, which have been hitherto deemed beyond the reach of ordinary capacities, may be made perfectly clear and intelligible.

Though this work is one of very humble pretensions, the author is not disposed to undervalue the credit of executing it with success. Next to the merit of original discovery, and perhaps superior to it, is that of laying open to thousands of our species fields of knowledge from which they have been previously shut out by the intellectual thorns with which they are beset.

In entering upon this undertaking, the author is deeply sensible, that while the first purpose of all knowledge is to make us wiser, its main and ultimate object is to make us better. Under this conviction he will not fail to draw the attention of his readers to those marks of wisdom and benevolence of which the material world bears so deep an impress;—to strengthen those feelings of humility and gratitude which the contemplation of nature so strongly excites;—and thus to render intellectual wisdom subservient to moral discipline and religious improvement.

The first of this series of Treatises will be a *Popular Treatise on Astronomy*, in one volume Post 8vo, illustrated with Plates; the second Treatise will be on *Optics*; and these will be followed by separate and complete Treatises on the various subjects of Science and the Useful Arts, containing the most recent discoveries and improvements made both in this country and on the continent.

27. *Siamese Islands of Ko-si-Chang and Ko-Cramb.*—Many islands which had never been visited by Europeans have been recently explored by the last English ships which entered the River Siam. They lie about eight leagues from the south of that river in 13° 12′ north lat. and 100° 55 east of Greenwich. The two largest are called Ko-Si-Chang and Ko-Cramb.

The first is 2½ leagues long, and one broad. It is covered with wood, and the mountains are very high. There are no inhabitants upon it, excepting the keeper of a temple, built by the officers of the Cochin Chinese Junks, upon a hill on the south shore, who come here every year to trade at Bankok.

In order to take advantage of the wood and water, a harbour has been made for the country ships which ascend the river, and the European vessels can also profit by their example.

Upon the other island, which is less extensive, the Siamese fishermen have established themselves, and their habitations are surrounded by cultivation. Besides the vegetables which have been observed before, they have a species of Ignama not eatable; but the bulbiferous sorts grow to a most extraordinary size; *they are sometimes ten feet in circumference, and weigh* 474 *pounds;* the fecula, when dried, is used as a specific in fevers. Many beautiful kinds of pigeons, which seem to have abandoned the continent to take refuge in the isles of the Gulf of Siam, are seen in the woods of Ko-Si-Chang. There is in particular a large white species with a black tail; another with the plumage brown and purple; and a third kind of a smaller size, whose covering is of a most brilliant green.

Between the two principal islands the ships find a spacious anchorage, well sheltered from the winds and the high seas. The entrance to the harbour is by two openings, but the one to the north is preferred. Although the anchorage is good, it is prudent to use iron cables, because many parts of the bottom are covered with loose rocks, and the tides, which in spring rise to the height of ten feet, form a very strong current across the harbour.

In spite of these inconveniences we should not be surprised if England were to form an establishment upon these isles, whose situation at once commands the commerce of the kingdom of Siam.—*Le Globe, Mars* 27, 1827.

Art. XL.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE FEBRUARY 8, 1827.

9. March 21. For certain Improvements in Machinery or Apparatus for Printing Calicoes and other Fabrics. To Matthew Bush of Dalmonach Printfield, near Bonhill, in the neighbourhood of Dunbarton, North Britain.

10. March 30. For an Improvement in the process of Refining Sugar. To Morton William Lawrence, County of Middlesex.

11. March 30. For a new Invention of an Engine for Moving and Propelling Ships, Boats, Carriages, Mills, and Machinery of every kind. To William Wilmot Hall, of the City of Baltimore, United States of America.

12. April 2. For certain Improvements in the construction of wheels designed for driving machinery, which are to be impelled by water or by wind, and which said improvements are also applicable to propelling boats and other vessels. To John Oldham, Dublin.

13. April 3. For the Construction of a New Engine for giving motion by the expansive power of the vapour of liquids. To Thomas Howard of New Broad Street, London.

14. May 7. For an Improvement or improvements on power looms for weaving cloth of different kinds. To John Paterson Reid, Glasgow.

15. May 7. For an Invention of certain improvements in the Boilers used for making Salt, commonly called Salt Pans, and in the mode of applying heat to the brine. To Joseph Tilt of Prospect Place, County of Surrey.

16. May 21. For the Invention of a new method of constructing gasometers, or machines or apparatus for holding and distributing gas. To Charles Barwell Coles, Esq. and William Nicholson, Manchester.

17. June 8. For certain Improvements in manufacturing carpets. To Thomas Clarke, County of Leicester.

Art. XLI.—CELESTIAL PHENOMENA,

From July 1st to October 1st 1827. Adapted to the Meridian of Greenwich, Apparent Time, excepting the Eclipses of Jupiter's Satellites 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.

JULY.

D.	H.	M.	S.	
1	19	8		☽ First Quarter.
1	23	30		♄ ☌ ☉
2	8			♀ ☌ ι ♉
2	16	14	51	☌ ☽ α ♍ ☽ 11′ N.
3	15	11	43	☌ ☽ λ ♍ ☽ 73′ S.
4	4	51	30	☌ ☽ 2 α ♎ ☽ 21 S.
4	12			☿ ☌ δ ♋
5	1	42	6	☽ ☌ κ ♎ ☽ 67′ N.
5	6	8	22	☽ ☌ λ ♎ ☽ 75′ N.
5	10	21		Em. I. Sat. ♃
5	10	38	49	☽ ☌ 1 β ♏ ☽ 34′ N.

D.	H.	M.	S.	
5	10	40	5	☽ ☌ 2 β ♏ ☽ 33′ N.
5	13	5	46	☽ ☌ ν ♏ ☽ 3′ N.
6	15	5	41	☽ ☌ ξ Oph. ☽ 56′ N.
7	11	9	53	☽ ☌ 2 μ ♐ ☽ 67′ N.
8	10	30		○ Full Moon.
9	11	29	58	☽ ☌ β ♑ ☽ 22′ N.
12	1	45		♂ ☌ with ☉
14	18	41	29	☽ ☌ ε ♓ ☽ 71′ N.
15	8	35		☾ Last Quarter.
16				☿ Greatest Elong.
16				♀ ☌ ν ♊
17	13			♀ ☌ μ ♊
18	23	25	6	☽ ☌ ε ♉ ☽ 29′ N.
19	6	15		♅ ☍ ☉
21	8	47	37	☽ ☌ ν ♊ ☽ 56′ S.
23	5	13		☉ enters ♌
23	12	44		● New Moon.
24	9	12	18	☽ ☌ 1 α ♋ ☽ 27′ N.
24	10	15	27	☽ ☌ 2 α ♋ ☽ 5′ N.
24	20			♃ ☌ γ ♍
25	15			♀ ☌ ♄
27	17	38	21	☽ ☌ γ ♌ ☽ 40′ S.
28	9			♀ ☌ δ ♊
29				☿ Station. near π ♌
31	11	55	8	☽ ☌ 2 α ♎ ☽ 7′ S.

AUGUST.

D.	H.	M.	S.	
1	5	8	39	☽ ☌ 4 ζ ♎ ☽ 69′ S.
1	18	41	44	☽ ☌ 1 β ♏ ☽ 46′ N.
1	18	43	3	☽ ☌ 2 β ♏ ☽ 45′ N.
1	21	13	40	☽ ☌ ν ♏ ☽ 15′ N.
3	0	5	37	☽ ☌ ξ Oph. ☽ 65′ N.
3	20	44	40	☽ ☌ 2 μ ♐ ☽ 74′ N.
5	21	52	56	☽ ☌ β ♑ ☽ 21′ N.
6	17	40		○ Full Moon.
6	23			♂ ☌ δ ♋
9	7			☿ ☌ ο ♌
11	3	9	55	☽ ☌ ε ♓ ☽ 57′ N.
12	13	15		☿ Inf. ☌ ☉
13	19			♀ ☌ δ ♋
13	23	48		☾ Last Quarter.
15	6	22	54	☽ ☌ ε ♉ ☽ 16′ N.
17	15	42	17	☽ ☌ ν ♊ ☽ 66′ S.
20	15	57	0	☽ ☌ 1 α ♋ ☽ 28′ N.
20	16	59	55	☽ ☌ 2 α ♋ ☽ 4′ N.
21	3			♀ ☌ ♂
22				☿ Stationary.
22	2	31		● New Moon.
22	15			♄ ☌ δ ♊
23	11	42		☉ enters ♍
23	23	29	42	☽ ☌ υ ♌ ☽ 31′ S.
26	3	45	1	☽ ☌ α ♍ ☽ 39′ N.
27	3	17	54	☽ ☌ λ ♍ ☽ 45′ S.
27	17	28	38	☽ ☌ 2 α ♎ ☽ 7′ N.
28	10	56	26	☽ ☌ 4 ζ ♎ ☽ 54′ S.
29	0	45	22	☽ ☌ 1 β ♏ ☽ 60′ N.
29	0	46	42	☽ ☌ 2 β ♏ ☽ 60′ N.
29	3	20	34	☽ ☌ ν ♏ ☽ 30′ N.
29	9	21		☽ First Quarter.
30	19			♀ ☌ α ♌

SEPTEMBER.

D.	H.	M.	S.	
2	6	50	35	☽ ☌ β ♑ ☽ 27′ N.
3	13			☿ ☌ ♂
5	0			♀ ☌ ρ ♌
5	2	36		○ Full Moon.
5	18			☿ ☌ α ♌
6	1	24	48	III. Sat. ♃ enters disc.
7	1			♃ ☌ ϑ ♍
7	12	39	46	☽ ☌ β ♑ ☽ 47′ N.
9	2			♂ ☌ α ♌
11	14	23	29	☽ ☌ ε ♉ ☽ 2′ N.
12	17	44		☾ Last Quarter.
13	5	23	52	III. Sat. ♃ enters Disc.
16	8			☿ ☌ σ ♌
16	23	59	18	☽ ☌ 1 α ♋ ☽ 21′ N.
17	1	2	27	☽ ☌ 2 α ♋ ☽ 2′ S.
18	7	13	2	☽ ☌ π ♌ ☽ 54′ N.
18	12			☿ ☌ ♀
19	7			♂ ☌ ξ ♌
20	9	22		III. Sat. ♃ enters Disc.
20	15	31		● New Moon.
20	18			☿ ☌ β ♍
21	17			♀ β ♍
22	10	17	30	☽ ☌ α ♍ ☽ 46′ N.
23	9	23	44	☽ ☌ λ ♍ ☽ 36′ S.
23	23	20	19	☽ ☌ 2 α ♎ ☽ 17′ N.
23	8	24		☉ enters ♎
24	9	30		☿ Sup. ☌ ☉
24	16	34	41	☽ ☌ 4 ζ ♎ 44′ S.
25	4			☿ ν ♍
25	6	16	38	☽ ☌ 1 β ♍ ☽ 71′ N.
25	6	17	58	☽ ☌ 2 β ♍ ☽ 71′ N.
25	8	51	6	☽ ☌ ν ♍ ☽ 41′ N.
27	15	14		☽ First Quarter.
28	3			♀ ☌ ν ♍
29	13	38	47	☽ ☌ β ♑ ☽ 36′ N.

Times of the Planets passing the Meridian.

JULY.

D.	Mercury. h.	′	Venus. h	′	Mars. h	′	Jupiter. h	′	Saturn. h	′	Georgian. h	′
1	1	35	22	9	0	15	5	44	0	3	13	16
7	1	46	22	15	0	7	5	21	23	39	12	40
13	1	49	22	22	23	58	4	59	23	17	42	6
19	1	45	22	30	23	50	4	38	22	57	11	40
25	1	33	22	38	23	43	4	17	22	36		

AUGUST.

D.	Mercury. h.	′	Venus. h	′	Mars. h	′	Jupiter. h	′	Saturn. h	′	Georgian. h	′
1	1	6	22	47	23	35	3	53	22	13	11	6
7	0	32	22	55	23	28	3	33	21	52	10	44
13	23	45	23	3	23	21	3	14	21	32	10	20
19	23	10	23	11	23	14	2	55	21	13	9	54
25	22	52	23	18	23	7	2	37	20	54	9	33

SEPTEMBER.

D.	Mercury. h.	′	Venus. h	′	Mars. h	′	Jupiter. h	′	Saturn. h	′	Georgian. h	′
1	22	54	23	27	22	59	2	17	20	31	9	6
7	23	9	23	33	22	52	1	59	20	12	8	40
13	23	29	23	40	22	45	1	42	19	53	8	22
19	23	49	23	46	22	38	1	25	19	33	8	0
25	0	4	23	52	22	31	1	8	19	19	7	40

Declination of the Planets.

JULY.

D.	Mercury. °	′	Venus. °	′	Mars. °	′	Jupiter. °	′	Saturn. °	′	Georgian. °	′
1	21	29 N.	21	19N.	23	51 N.	1	5 S.	22	38 N.	21	20 S.
7	18	40	22	16	23	28	1	19	22	35	21	23
13	15	39	22	52	22	58	1	36	22	31	21	27
19	12	46	23	4	22	22	1	54	22	28	21	31
25	10	23	22	53	21	40	2	14	22	24		

AUGUST.

D.	Mercury. °	′	Venus. °	′	Mars. °	′	Jupiter. °	′	Saturn. °	′	Georgian. °	′
1	8	50 N.	22	8N.	20	43 N.	2	39 S.	22	19N.	21	34 S.
7	9	4	21	6	19	49	3	2	22	15	21	36
13	10	46	19	41	18	51	3	26	22	11	21	40
19	13	7	17	55	17	47	3	51	22	6	21	41
25	14	4	15	52	16	40	4	17	22	2	21	44

SEPTEMBER.

D.	Mercury. °	′	Venus. °	′	Mars. °	′	Jupiter. °	′	Saturn. °	′	Georgian. °	′
1	15	1N.	13	7N.	15	16N.	4	49 S.	21	58N.	21	45 S.
7	13	3	10	32	14	1	5	17	21	54	21	46
13	9	31	7	46	12	43	5	45	21	50	21	47
19	5	6	4	53	11	22	6	19	21	47	21	48
25	0	24N.	1	54	9	59	6	43	21	43	21	50

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a globe, and to determine their risings and settings.

ART. XLII.—*Summary of Meteorological Observations made at Kendal in March, April, and May* 1827. By Mr SAMUEL MARSHALL. Communicated by the Author in a Letter to the EDITOR.

State of the Barometer, Thermometer, &c. at Kendal for March 1827.

Barometer.	Inches.
Maximum on the 26th,	30.03
Minimum on the 8th,	28.40
Mean height,	29.36

Thermometer.	
Maximum on the 21st, 24th, and 25th,	56°
Minimum on the 10th,	23°
Mean height,	42.93°

Quantity of rain, 8.676 inches.
Number of rainy days, 22.
Prevalent wind, S. W.

The month of March has proved a very stormy one. Sudden gusts of wind before and after the equinox, the currents of the atmosphere rushing from almost every point of the compass in a few hours. Rain has fallen 22 days out of the 31, and most of the month has been very dull and wet. The thermometer has been rarely below the freezing point; indeed the weather generally has been mild, as will appear from the mean for the month.

The barometer has fluctuated continually, frequently nearly an inch in the course of twenty-four hours.

State of the Barometer, &c. at Kendal for April 1827.

Barometer.	Inches.
Maximum on the 8th,	30.13
Minimum on the 12th,	29.42
Mean height,	29.77

Thermometer.	
Maximum on the 30th,	70°
Minimum on the 11th,	30
Mean height,	47.23°

Quantity of rain, 2.553 inches.
Number of rainy days, 14.
Prevalent wind, S. W.

Though the weather during this month has been very variable, yet the range of the barometer has been trifling. The N. E. wind, which generally prevails in the latter part of this month, and the beginning of the next, has been very severe, and attended with frequent snow showers. The quantity of rain is trifling. The last five days of the month have been remarkably mild and genial to vegetation, and the beginning of the month was equally so. The swallow made its appearance above a fortnight earlier this year than the last. It was seen on the 5th.

State of the Barometer, &c. at Kendal for May 1827.

Barometer.	Inches.
Maximum on the 21st, - - -	29.94
Minimum on the 25th, - - -	29.10
Mean Height, - - -	29.56

Thermometer.	
Maximum on the 21st, - - -	69
Minimum on the 7th, - - -	32°
Mean Height, - - -	52.87°

Quantity of Rain, 3.483 inches.
Number of rainy days, 15.
Prevalent wind, W.

The beginning of this month was marked by dry and cold E. and N. E. winds, prevailing mostly till the 19th. The wind from the N. E. is perhaps the only periodical wind which we have in our island, and which sometimes prevails from the middle of April to the middle of May, though seldom so long. A very plausible hypothesis to account for this phenomenon might be adduced. In the present month the prevalence of this wind exceeded its usual limit. Since the 19th the air has been generally humid, and soft genial showers have promoted vegetation to an extent most cheering to the agriculturist. Though the thermometer was never but once so low as the freezing point, yet the winds from the E. and N. E. checked the progress of vegetation very materially during their continuance. The range of the barometer has been trifling, amounting to .84 of an inch. The rain has generally fallen in slight showers, (and excepting .056 of an inch,) after the 16th, the greatest quantity taken at one time fell on the 28th, which amounted to .868 of an inch.

ART.

ART. XLIII.—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 instruments is 300 feet above high water-mark at Leith. The morning and evening observations were made about 10 A.M. and 10 P.M.

MARCH 1827.

D. of Week.	Day of Month.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	45	34	39.5	45	46	45.5	28.56	28.88	.07
F.	2	34	32	33	31	39	35	28.81	28.82	
S.	3	33	32	32.5	31	35	33	28.95	28.69	
S.	4	32	29	30.5	31	33	32	28.57	29.05	2. 4
M.	5	35	39	37	18	37	27.5	29.18	28.50	
T.	6	42	34	38	35	43	39	28.28	28.62	.18
W.	7	34	29	31.5	28	40	34	29.13	28.86	.80
T.	8	32	26	29	28	35	31.5	28.42	28.78	
F.	9	37	35	36	23	39	31	29.03	29.23	
S.	10	37	37	37	26	42	34	29.39	29.12	.07
S.	11	45	42	43.5	33	48	40.5	28·81	28.51	.15
M.	12	45	39	42	38	48	43	29.12	29.28	
T.	13	45	37	41	34	49	41.5	29.46	28.57	
W.	14	42	36	39	34	44	39	29.26	29.35	.31
T	15	37	35	36	32	42	37	29.36	29.66	.20
F.	16	40	46	43	30	43	36.5	29.72	29.05	.05
S.	17	42	37	39.5	37	45	41	29.26	29.86	
S.	18	40	36	38	33	45	39	29.96	29.94	.15
M.	19	50	49	49.5	35	54	44.5	29.78	29.78	.10
T.	20	48	41	44.5	46	54	50	29.84	29.85	
W.	21	48	48	48	39	54	46.5	29.51	29.55	
T.	22	50	50	50	45	54	49.5	29.46	29.55	
F·	23	52	49	50.5	47	55	51	29.58	29.58	
S.	24	52	38	45	47	54	50.5	29.50	29.68	
S.	25	42	32	37	33	47	40	29.75	29.90	
M.	26	43	41	42	29	47	38	29.93	29.75	
T.	27	52	39	45.5	39	56	45.5	29.31	29.28	
W	28	39	36	37.5	36	47	41.5	28.80	28.46	.27
T.	29	38	39	38.5	32	44	38	28.56	28.77	
F.	30	44	38	41	33	48	40.5	28.88	29.73	
S.	31	44	41	42.5	31	58	44.5	29.85	29.93	.11
	Sum,	1299	1176	1237.5	1059	1425	1242	905.62	906.26	4.84
	Mean.	41.90	37.94	39.92	34.16	45.97	40.06	29.213	29.234	

APRIL 1827.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer,		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
S.	1	50	50	50	39	58	48.5	29.81	29.80	
M.	2	52	47	49.5	47	57	52	29.71	29.79	
T.	3	55	43	49	41	59	51.5	29.75	29.58	
W.	4	51	47	49	37	58	47.5	29.75	29.63	
T.	5	53	50	51.5	39	56	47.5	29.65	29.59	
F.	6	57	41	49	46	58	52	29.56	29.74	
S.	7	47	40	43.5	36	53	44.5	29.58	30.01	.04
S.	8	50	41	45.5	38	57	47.5	30.08	29.90	.06
M.	9	52	38	45	33	56	44.5	29.58	29.56	
T.	10	45	40	42.5	29	54	41.5	29.68	29.74	
W.	11	47	43	45	28	52	40	29.68	29.52	
T.	12	50	43	46.5	42	55	48.5	29.26	29.43	.16
F.	13	50	44	47	40	55	47.5	29.70	29.88	
S·	14	50	46	48	41	55	48	29.86	29.82	.31
S.	15	51	44	47.5	41	55	48	29.87	29.88	.05
M.	16	48	42	45	41	51	46	29.92	29.96	
T.	17	47	38	42.5	35	51	43	29.96	29.88	
W·	18	47	40	43.5	35	51	43	29.80	29.72	
T.	19	49	39	44	37	52	44.5	29.57	29.49	.05
F.	20	41	42	41.5	38	45	41.5	29.52	29.55	
S·	21	41	39	40	40	42	41	29.64	29.77	
S.	22	41	37	39	37	44	40.5	29.78	29.67	
M.	23	36	32	34	31	37	34	29.48	29.35	.30
T.	24	33	31	32	30	36	33	29.24	29.16	1·30
W.	25	41	32	36.5	27	47	37	29.28	29.59	
T.	26	45	40	42.5	30	48	39	29.72	29.96	.09
F.	27	49	46	47.5	37	51	44	29.98	29.92	
S.	28	54	46	50	42	57	49.5	29.95	29.83	
S.	29	55	55	55	38	64	51	29.82	29.82	
M.	30	60	49	545.	48	63	55.5	29.85	29.83	.35
		1447	1265	1356.6	1126	1577	1351.5	890.95	891.31	2.74
		48.23	42.17	45.20	37.53	52.57	45.05	29.698	29.710	

MAY 1827.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	50	45	47.5	45	54	49.5	29.87	29.82	
W.	2	55	53	54	44	61	52.5	29.73	29.61	
T.	3	53	52	52.5	49	57	53	29.55	29.48	
F.	4	55	53	54	50	61	55.5	29.35	29.13	
S.	5	54	44	49	50	58	54	29.05	29.12	
S.	6	49	40	44.5	40	53	46.5	29.17	29.40	
M.	7	45	41	43	38	49	43.5	29.57	29.65	
T.	8	53	44	48.5	39	57	48	29.68	29.66	
W.	9	47	42	44.5	39	53	46	29.63	29.54	
T.	10	40	36	38	35	46	40.5	29.58	29.63	.06
F.	11	45	37	41	31	50	40.5	29.74	29.82	
S.	12	54	42	48	31	61	46	29.86	29.83	
S.	13	60	44	52	40	64	52	29.81	29.80	
M.	14	50	55	52.5	33	56	44.5	29.85	29.76	
T.	15	47	47	47	44	53	48.5	29.56	29.53	.03
W.	16	54	47	50.5	47	54	50.5	29.46	29.58	
T.	17	54	50	52	45	60	52.5	29.28	29.50	.29
F.	18	56	47	51.5	47	57	52	29.50	29.56	.27
S.	19	63	47	55	45	65	55	29.66	29.77	
S.	20	58	52	55	40	62	51	29.80	29.87	.01
M.	21	61	54	57.5	49	69	59	29.83	29.70	
T.	22	58	50	54	51	63	57	29.76	29.71	
W.	23	58	51	54.5	44	61	52.5	29.41	28.88	·12
T.	24	53	44	48.5	47	58	52.5	28.98	29.08	
F.	25	54	44	49	39	59	49	29.04	29.05	
S.	26	55	50	52.5	40	60	50	29.16	29.26	.05
S.	27	55	51	53	46	58	52	29.26	29.27	.15
M.	28	56	55	55.5	46	60	53	29.28	29.16	.05
T.	29	60	50	55	51	63	57	29.22	29.29	.09
W.	30	58	53	55.5	47	63	55	29.53	29·34	.11
T.	31	60	53	56.5	47	64	55.5	39.10	29.10	.05
		1670	1475	1571.5	1339	1809	1574	914.27	913.90	1.28
		53.87	47.52	50.69	43.19	58·35	50.77	29.493	29.481	

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ART. I.—*Historical Notice of the Life and Works of M. Breguet.* By BARON FOURIER, Secretary of the Academy of Sciences.

M. LOUIS BREGUET, a celebrated artist, and a man of the most exalted character, occupied in the academy one of the situations reserved for those distinguished individuals who, by discoveries of the first order, have improved the applications of science. Never had this distinction been more justly conferred. His career exhibits a long series of ingenious and useful inventions. He has elevated in an extraordinary degree the art of measuring time with precision,—an art which is perhaps the most difficult, and doubtless the most important which human industry has produced. He has enriched with a number of new methods the trade of clock-making, navigation, astronomy, and physics.

The Abbé Marie, a professor in the university of Paris, observed in young Breguet all the indications of a remarkable intellect, and he persuaded him to devote himself with ardour to the study of geometry. His family, however, though once opulent, had from their profession of the reformed religion been driven from France, and had lost a great part of their fortune. Domestic afflictions were added to the calamities of civil dissensions. His father died in a foreign land. His mother married a second time, and destined her son to the profession which he has so successfully pursued.

France and the arts are deeply indebted to the generous individual who protected his youth, and directed him in the study of the sciences,—to him from whom he received the first counsel, the first instructions, and the first marks of interest.

It is honourable to attract by brilliancy of talent a numerous auditory, to propagate important knowledge, and discoveries of national utility; but to distinguish in a crowd a youth unprotected,—to recognize in him the first marks of genius,—to predict what his country and the sciences would one day owe him,—to welcome, to encourage, and to instruct him, is, in the order of good deeds, one of those that should occupy the first place, and there is none more becoming a man of letters.

The first researches of M. Breguet had for their object that part of his art which relates to civil purposes; and he afterwards brought to perfection that which concerns the sciences.

The question of the measure of time which the moderns have so well resolved, consists in producing a rotatory motion perfectly uniform, which renews and preserves itself without any change. The moving body is submitted to two opposite actions: the one, which is the moving force, constantly tends to accelerate the motion: the other, which is opposed to it, destroys at each instant with a rigorous accuracy all the excess of the new impulse, so that the velocity remains always equal to itself. This perpetual collision is the dynamical principle common to all instruments which measure time.

But how many difficulties must be overcome to gain this object! We must, in some degree, withdraw the instrument from the action of those external causes which tend to disturb the uniformity of its motion. The friction of the different parts continually changes their form, and may change the velocities. Changes of temperature, too, render their dimensions and the elastic forces variable. If the common use of the instrument expose it to irregular agitation, or to great changes of position, there arises from it other causes of inequality. The resistance of the air is not constant, but varies with its density. Art has opposed to one another all those causes of perturbation, so as to make them reciprocally destroy each other. The mean effect of changes of position becomes insensible; variations of temperature compensate each other; external and accidental agitations do not alter the motion, and they are used to maintain and renew it. That, in short, which was once an obstacle is now an useful auxiliary.

The name of perpetual watches has been given to those which are always wound up by the motion of the persons who carry them. This invention is an old one, but it continued too imperfect to be used. M. Breguet has given to such watches all the precision and stability which they require. In order to make them go three days, it is necessary only to shake them a few minutes; and there are some of them which have preserved their motion regular for ten years without having been opened.

We may even construct watches so that they may be wound up by the sole effect of the natural changes in the temperature, or weight of the atmosphere, or by the effect of a current of air. Several instruments of this kind have been made; but they are not connected with the essential part of the art, the true object of which is to maintain an uniform motion, notwithstanding the external causes which tend to disturb it.

The most important parts of the interior mechanism of a watch, and which form, if we may so speak, its principal organ, are the escapement and the balance. It is here that the regulating power resides, and the least irregularity in its action will occasion a sensible disturbance. But the balance is subject to take very different positions, and its weight does not always act in the same manner. One of the most ingenious inventions of M. Breguet is that for preventing this kind of inequality. He has contrived to give to this part of the mechanism a circular motion, which, in the interval of each minute, nearly renews all possible positions. The errors of eccentricity, the variable effects of friction, all the inequalities which depend on position thus compensate one another, and disappear in the mean result.

The arts have their principle and their models in nature, and this is particularly true of the science of the civil division of time. The regular motions of the celestial bodies have given us the idea of an uniform duration. According to the expression of the most eloquent of philosophers, the stars are the instruments of time; but it belongs only to science in its most perfect state to recognize the constancy of nature in the spectacle of so many various phenomena. The apparent course of the sun is subject to very sensible inequalities. It is not the motion of this star, but the daily revolution of the terrestrial globe which can regulate time: it is the immoveable model of an uniform motion. The most perfect time-piece, therefore, would be that which gives us the precise representation of this revolution. But this model is inimitable, and our art could never attain that end,—for we are certain that in the course of two thousand years the duration of the earth's revolution has not varied the one-hundredth part of a second.

M. Breguet has improved successively all the branches of his art. The most important are those which owe to him the greatest advancement; and what is remarkable, they have received from his hands almost always an unexpected simplicity.

He has suppressed that part of the wheel-work called the *fusee*, a very ingenious mechanism, the origin of which is unknown. It was impossible to preserve to this piece its primitive simplicity. The chain which surrounds it is formed of several thousand parts, and this is not the only cause of the multiplied and inevitable accidents to which this very complicated apparatus gives rise. M. Breguet replaces it by elastic forces, regulated and constant, which act in a very simple manner. The frictions are more equal, more gentle, and the number of pieces much less. Experience has sanctioned this happy alteration, and many eminent artists have imitated it. We may remark, without a contradiction, that it required an ingenious talent to invent that mechanism, and a perfect talent to suppress it.

The method of elastic suspension is not less remarkable. The object of it is to prevent the fracture of the most delicate and important parts of the apparatus, viz. those which contain the balance. This piece is sustained by pivots of extreme tenuity, and one would think that the least accidental shock would break it. An ingenious contrivance is opposed to this accident. M. Breguet has invented a method of suspension which completely defends this principal part of the instrument against the effect of a sudden percussion. If we allow the piece to fall, or even if we throw it against an obstacle, we shall be surprised to find the pivots unhurt, though their thickness is that of the most delicate wire. It happens that during the continuance of the shock the pivots support nothing. Their place is supplied by a stronger mass, which comes into use at the instant of danger, and soon after re-establishes them in their former place.

Every person knows what advantages the nautical sciences, geography, and astronomy have derived from instruments for measuring time. The most enlightened governments have encouraged researches for perfecting marine watches. In England, at the suggestion of Newton, the Parliament had offered and awarded premiums to inventors. Harrison received about 500,000 francs, after having devoted to these researches more than forty years. In France, honour, academical prizes, &c. roused two great artists, Peter Leroy, and Ferdinand Berthoud, the contemporaries and rivals of Harrison. They had no knowledge of the English inventions, which were for a long time kept secret; and both of them succeeded at the same time, and by different methods, in resolving the question proposed, with a precision greatly superior to that which had been pointed out in England as sufficient for obtaining the promised rewards.

The public suffrage, and the zeal of individuals, have promoted in this country the progress of that art. We have seen one of the members of this academy, the Marquis de Courtanvaux, equip a frigate at his own expence, to try, during a long navigation, the marine chronometers of Peter Leroy.

The works of the two French artists were not rewarded till they had been submitted to the most extraordinary trials. It was found that in the middle of the agitations of the sea, of vicissitudes of temperature, and of the most violent commotions of the air produced by three successive discharges of all the artillery of the vessel, these admirable instruments preserved their going regular in voyages of very long duration.

The wishes of the two governments have been at last accomplished, and we may readily conceive how difficult it has become, after such efforts and discoveries, to give to marine chronometers a higher degree of perfection. Ferdinand Berthoud, his pupils, and those chiefly who have extended his talents and his name, have made fresh progress in this art. It is also by this kind of success that M. Breguet has been placed in the first rank of European artists. Among the great number of experiments which have served to direct his researches, we may mention those which have established the mutual action of two pendulums attached to the same support.* Each of these instruments has its own proper motion, and if they are placed in separate places, they will assume nearly the same motion, because they are supposed to be regulated with great care. Sometimes, however, we observe in them continual differences, arising from the inevitable imperfection of workmanship. But if we attach them to two different points of a common support fixed in a wall, all their variations disappear;—the two pendulums assume insensibly the same motion;—they soon agree with each other with the most rigorous precision, and will always preserve this common motion.

This communication of two oscillatory motions had been long ago observed in France † and England. M. Breguet has made numerous and accurate experiments on this point, and they have led him to construct double pendulums, the two parts of which perpetually agree. They compose an unique instrument, the going of which being more constant and better regulated, resists the more all external agitations and accidental irregularities. He has constructed, on the same principle, double chronometers, which have the same property.

The reciprocal action of two parts of an apparatus suspended on the same support, and sufficiently remote from each other, is not the effect of the ambient air, as we might be led to believe from the acoustic experiments of Sauveur. The principle of this influence resides in the mass of the support, and it is from the same cause that the vibrations of sonorous bodies are communicated to the hardest substances;—they penetrate the most solid bodies, and rapidly agitate all their parts. Within the sphere in which musical sounds are heard, the most compact masses become sonorous;—they resound in all their depth, and they repeat the regular and symmetrical vibrations of the particles of the air.

* See the article HOROLOGY in the *Edinburgh Encyclopædia*, vol. xi. p. 162, for some interesting details on this subject.—ED.

† We believe that it was first observed by our countryman, Mr John Ellicott.—*Edin. Encycl. loc. cit.*—ED.

If the eye could discern well all these movements, it would discover that they mixed with, and succeeded one another in an admirable order, and our senses would be not less charmed with the sight of these regularities, than with the liveliest impressions of harmony.

The knowledge of the moral character of those men who have advanced the arts belongs to history. We delight to follow in common life those who have received from nature the germ of great talents. We are anxious to recognize the relation between their genius and studies, and their manners, or the habits of their mind; but these relations are so perplexed and various that we can scarcely seize some of the most general features. With respect to that celebrated man whose labours are under our consideration, we may say with truth that he was no less remarkable by the disposition of his heart than by his sagacity and talents. All who were acquainted with him know that he was actuated by the most singular benevolence: He took the most unreserved interest in the success of others, and he felt all their misfortunes. In his relations with those persons who merited his attachment, he discovered every day new motives for loving them, and in that he showed as much ingenuity as in his mechanical inventions.

Contemporary events presented to him too many occasions for the exercise of this natural benevolence. It was sufficient to excite his interest that the person was unfortunate; and were we to enumerate all those to whom he offered an asylum, we must record the names of the most opposite parties.

In the practice of so many generous deeds it was impossible that he himself should escape the dangers of civil discord. Uneasy respecting his own fate, he fled from France, and in his turn became the object of the anxieties and kindnesses of friendship. When the political events, which rapidly succeeded, had appeased the horrors of discord, M. Breguet returned to Paris with his family. His establishments had been abandoned and destroyed; but talent, method, and perseverance supplied every thing. He continued his former labours, and gave to his undertakings greater extent and new forms. In England, in Russia, and throughout all Germany, the productions of his workshop were eagerly sought after, and acquired an extraordinary value. Numerous artists felt themselves honoured by being ranked among his pupils, and he was placed, by unanimous suffrage, in the list of the most celebrated inventors.

His works were imitated or copied, for there are plagiarists in all professions. They even made use of his name, a circumstance which induced him to invent a very remarkable process for engraving on enamel in extremely small characters. Every thing became in his hands the occasion of a discovery. His reputation was, so to speak, formed without his knowledge; the productions of his establishment have alone extended it throughout all Europe. He took no care to describe and publish his inventions, but he communicated them with freedom.

The works of Montucla, of Lalande, the treatise of Ferdinand Berthoud, but particularly that of M. Jurghensen, a celebrated Danish artist, have communicated information respecting his early researches, but the interests of the arts required that his inventions should be brought together and fully described in one work. M. Breguet and his son undertook this difficult task. The death of the former has interrupted this difficult task, but it was already far advanced. These valuable MSS. exist: the friends of science eagerly desire their publication, and we may announce that their wishes will not be long unfulfilled.

His productions were not only distinguished by new and happy combinations, but also by extreme perfection of workmanship, and a singular example occurred of the impression which the sight of his works occasioned. The celebrated Arnold, one of the best English artists, was struck with astonishment, when he examined one of Breguet's watches, which the Duke of Orleans had sent to him. He resolved instantly to go to Paris. He called together his family, and as it were without turning his eyes from the object of his admiration, he informed them that he would set out that evening. Welcomed by Breguet, he established himself for some time in his vicinity, and their art was extended by their reciprocal communications. It was then that M. Louis Breguet, his son, was put under the care of Mr Arnold. He spent several years in London under that great master, and it was there that he learned to become the co-operator and successor of his father, by uniting the study of rational mechanics and physics to the precepts and examples of the two first artists in Europe. On his return to Paris he shared in all the labours, and in all the success of his father; and historical truth requires us to state, that from that time their names should no longer be separated in enumerating the services which they have rendered to the sciences.

When the Institute of France was newly organized, M. Breguet, who had previously been admitted into the board of longitude, was appointed a member of the Royal Academy of Sciences.

He had long before invented an escapement, entirely free, and with a constant force, a fundamental question, which comprehends all that is important and difficult in the art, but which we cannot now explain, without multiplying technical terms. He improved also the use of rubies and sapphires, which contribute greatly to the precision and regularity of motions; and it is to him that we owe the methods of cutting hard stones for this purpose.

By a happy arrangement of the different parts, he succeeded in simplifying the mechanism of repeating-watches, and in reducing them to the smallest compass. It was then that he substituted in place of large and inconvenient bells elastic plates, which, when struck at one end, emitted a soft and continued sound. The apertures became useless, and the sound was better heard when the case was more completely shut. We may give to these vibrating plates such dimensions, that the effect becomes equal to that of the most sonorous instruments. The mixture and the concord of the harmonic sounds give to these vibrations a particular character. This invention of spring-bells, due to M. Breguet, has found many applications. In France, and in England, it has given rise to a new and productive branch of trade, which has extended itself to all countries under the most varied forms. *

An attempt had been made to measure high temperatures,

* The editor of the *Bibl. Universelle* remarks, that this art had its origin in Geneva, and that it was brought out in the fabrication of musical boxes. An account of the mechanism of these boxes will be found in the article Horology, in the *Edinburgh Encyclopædia*, vol. xi. p. 175.—Ed.

by observing with precision the changes in the volume of a solid metal. Graham and Peter Leroy * had succeeded in procuring pendulums of an invariable length, by the compensation of the unequal expansions of two different metals. Harrison is the first, if I am not mistaken, who proposed to employ a plate formed of two others, inequally expansible, and fixed together in all their points. Ingenious applications have been made of this method in measuring the degrees of heat, and in making the vibrations of a balance isochronous, notwithstanding the variations of temperature. This invention has been greatly improved by M. Breguet. He has employed it in making a thermometer much more quick and suitable than those which had hitherto been used. The compound plate is composed of platina, gold, and silver. Its total thickness is only the fiftieth or the hundredth of a line, and it has the form of a spiral. One of its extremities is fixed, and the other, which is free, and of extreme mobility, carries the index which points out the temperature. The sudden and successive variations in the heat of the air show themselves as rapidly as they could be felt by a living being. Effects of this kind, which other thermometers indicate slowly and slightly, thus become instantaneous, and much enlarged.

Other researches of the same artist have enabled us to measure with extreme precision the duration of phenomena. He introduces, for example, into an astronomical telescope a chronometer, whose hands follow the motions of the star in the field of view, and one may count the tenths, and even the hundredths of a second. But what is particularly remarkable in this instrument is the perfect continuity of the motion of the hands. He has also constructed watches, the needle of which marks suddenly, and at pleasure, a visible point upon

* Why is Leroy mentioned here along with Graham, without the reader being told that Graham is the original inventor of the compensation pendulum? His mercurial pendulum, the best yet known, was invented before 1726, whereas Leroy's comparatively clumsy contrivance was, according to Biot, (*Traité de Physique*, i. p. 173,) invented in 1738, and has besides no resemblance whatever to the beautiful method of Graham. The association of Leroy's name with that of Graham is no more called for than that of Ellicott, Cuming, and Smeaton, who afterwards proposed new methods of compensation.—Ed.

the dial, without producing any change on the motion of the instrument. * We may measure, also, with rigorous exactness, the duration of observed effects, which is the object of a great number of physical researches. We ought to add, that a French artist, M. Rieussecq, first employed a process of this kind for civil purposes. M. Breguet changed the character of the instrument, and has given it a new degree of precision.

We may mention also a singular instrument formed of a lens, which oscillates continually without any external impulse. At the *Conservatoire des Arts et Metiers*, there is a clock of this kind, which was made for the Duke of Orleans. The body which oscillates is suspended by a long rod to a single fixed point, and is otherwise entirely insulated. The total mass vibrates without any renewal of the impulse by an external cause. The oscillation of the lens is the effect of the moveable apparatus which it contains. The changes of temperature are compensated by the variation in the form of the suspension rod. We may enumerate, also, the valuable clocks possessed by the King of France, the Dauphin, and the sovereigns of countries where the arts are best appreciated;—the admirable works which adorn the museum of M. de Sommariva; those which have been made for the Duke of Cambridge, the Duke of Bedford, and other wealthy individuals; and in short, other objects destined to mark the last progress and superiority of French clock-work.

The works of M. Breguet have indeed a very high value, and to possess them has become a mark of opulence. But while he has enriched the apartments of royalty with the wonders of art, he applied himself with the same care to discover

* The following ingenious inventions of M. Breguet, including those above-mentioned, are described in the *Edinburgh Encyclopædia,* article SCIENCE Amusements in, vol. xvii. p. 576.

1. Breguet's Eye-piece Chronometer, for counting fractional parts of a second.
2. Breguet's improvement on Rieussecq's Chronograph.
3. Breguet's Chronometer, with Double Seconds.
4. Breguet's Double Sympathetic Chronometer.
5. Breguet's Sympathetic Clock.—ED.

the most simple combinations, and those most accommodated to public use, and of a correct and easy execution, so that they might be acquired at a moderate rate. It was with this view that he invented the repeaters to the touch, and particularly the watches with a single hand, simple, solid, and exact, and uniting to extraordinary precision all the conditions of a long duration.

The peculiar character of his works, and what eminently distinguishes him even among skilful inventors, is that of having enhanced and improved all the branches of his art.

He paid particular attention to the selection of external forms the most commodious, the most agreeable to the eye, and the most easily ornamented; and he always succeeded, by an exquisite taste, and by an ingenious arrangement, in satisfying the conditions which he wished to unite; for he had received from nature, and from long experience, so prodigious a talent for transforming at his will all the portions of the mechanism, that he resolved without any effort the greatest difficulties.

Clock-making, considered as a branch of commercial industry, owes to him one of the most important steps in its progress, viz. that which consists in making workmen of inferior talent, and even his pupils, attempt the most difficult and exact work, reserving the last efforts of the art for finishing and arranging all the parts.

In this manner he has cultivated his profession in all its extent, and he has given to it, or preserved for it, all the advantages which belong to it, for he has combined together accuracy, solidity, good taste, the interests of commerce, and the applications to the sciences.

To have placed himself in the first rank of a difficult profession;—to have invented and improved in an art which had been long studied by Huygens, Leibnitz, and Daniel Bernouilli;—to guide navigators;—to give to science new instruments;—to create his own fortune, by founding it on public utility;—to enjoy friendship;—to be unacquainted with ingratitude, and to escape envy, is a happy and an honourable destiny. Long may the arts reserve such high rewards for those who cultivate them.

M. Breguet preserved even at the most advanced age the tranquillity and gentleness of his character. The changes of fortune had not altered the simplicity of his manners, and he was as modest at the end of his career as when he was the disciple of the Abbé Marie. His death was as calm as his life. At the end of a tranquil and gay conversation, where, according to his custom, he praised all the persons whom he had met with during the day, he went to rest, and having fallen asleep, he was some moments afterwards seized with a sudden illness, and expired on the 26th September 1823, at the end of his 76th year.

To his family and friends he left the tenderest recollections;—to his successors, useful lessons and great models;—and to this academy a name celebrated, and a memory justly honoured.

Art. II.—*Account of a French Locality of Vauquelinite.* By William Haidinger, Esq. F. R. S. E., &c. Communicated by the Author.

Among a lot of minerals, acquired last autumn from M. Roussel in Paris, for the collection of Mr Allan, there was a specimen bearing the ticket: *Plomb phosphaté arsénifère mammelonné de Pont-Gibaud, Puy de Dôme.* It is chiefly formed of two strata of the rhombohedral lead baryte, the lower one gray, and with a crystalline surface; the upper one green, with a rough reniform one. Upon the latter are disposed small groups of flat crystals, of a blackish pistachio-green colour, yielding the characteristic siskin-green streak of Vauquelinite. The small crystals were so much fractured that their form could not be made out sufficiently. They appeared, however, to be nearly similar to the individuals, which, in the Siberian varieties, are generally joined in twins, like Fig. 6, Plate III.

The hardness, being between 2.5 and 3.0, exactly agrees. The specific gravity, which I found = 5.986 in the Siberian variety, it was impossible to ascertain in the variety from France, on account of the quantity of the mineral being too inconsiderable.

The indications of the mineral when acted upon by the blowpipe are the same as those of Vauquelinite. Lead in globules is obtained by exposing it alone, and a globule green in the oxidating, and red in the reducing flame, with fluxes, when properly managed, showing the presence of the copper. When melted with soda on platinum wire, and then immersed in a drop of water, it gives a yellow solution of the alkaline chromate.

It is always curious to find a rare species, hitherto confined to only one well-authenticated place, in a new locality. In the present instance there is an additional interest attached to an observation of this kind, as the mineral is found in the native country of the distinguished chemist in whose honour it is named, and who discovered the metal which forms its most remarkable ingredient.

Art. III.—*Description of a remarkable Bronze Relic found on the Sand Hills of Culbin, near the estuary of the River Findhorn.** By Sir Thomas Dick Lauder, Bart. F.R.S.E.

The curious antique was found three or four years ago on the sand hills of Culbin, on the western side of the estuary of the River Findhorn. These hills owed their origin to the prevailing winds from the W. S. W. which, in process of time, brought clouds of sand from the sandy country lying to the westward of the town of Nairn, and heaped it up there, to the destruction of a valuable estate. Some of these hills are a hundred feet in perpendicular height; but the material composing them being an extremely comminuted granitic sand, is so loose and light that, except in a dead calm, it is in eternal motion, so that parts of the original soil are often laid entirely bare. There is one small spot among the sand hills where flinty fragments are often picked up; and as elf-bolts or flint arrow-heads have been not unfrequently found on this spot, it is supposed

* This notice is an abstract of Sir Thomas Dick Lauder's paper read at the Society of Scottish Antiquaries, which will appear in the next part of their *Transactions,* illustrated with an engraving of the full size. Ed.

that a manufactory of those rude aboriginal weapons may have once existed there. A man, who accidentally lost his gun flint, went to the spot in question to look for a flint to replace it; and in his search he discovered the bronze relic under consideration. He carried it to a shopkeeper in Forres, to whom he sold it for half-a-crown; and Lady Cumming of Altyre, who purchased it from the shopkeeper at a much higher price, and in whose possession it now is, was so kind as to permit me to take a sketch of it.

The bronze relic stands $3\frac{1}{2}$ inches high, and is $3\frac{1}{2}$ inches in diameter, and its diameter *within* is $2\frac{1}{2}$ inches. Its weight in air is 2 pounds $9\frac{1}{2}$ ounces avoirdupois. It is of bronze; but the metal is of the very finest and richest Corinthian sort. I had not by me instruments for ascertaining accurately its specific gravity; but I did so with all the correctness I could command, and the result was, that I found it to be about $9\frac{1}{2}$. Now, as zinc is only 7.190, and copper 7.78, and their compound metal, brass or bronze, is set down in the tables at about $8\frac{1}{3}$, whilst gold is nearly about $19\frac{1}{3}$, it follows that a very large proportion of gold must enter into the composition of the antique. My calculations would give about 14 ounces 5 drachms of gold.

The workmanship of this curious relic is highly beautiful, the taste exquisite, and the detail is executed with the greatest delicacy. It is formed like a coiled up snake, having rather more than three complete convolutions lying spirally on each other. The spirals, though very close, are yet so far separated as every where to admit of the insertion of the edge of a thin sheet of paper, except at one place, near one extremity of the coil, where about an inch and a half of the head seems to have been broken off, and again joined so perfectly as not to be visible from without, except on a very close inspection; but, on looking at it within, the joining appears where the application of a ruder soldering of brass, used in repairing the fracture, has, at the same time, been the means of uniting the upper convolution to that beneath it. I must remark, however, that it was in this condition when first discovered. The whole coil is hollowed out on the inner side, a wide hemispherical groove running round the interior of the spiral from the one extremity to the other. The whole seems to have been formed at length, and then twisted up into the coil; a circumstance which indicates the fineness and ductility of the metal.

The snake seems to have been the model for the construction of this very interesting antique; but it has not been servilely and awkwardly copied, as one might expect a workman in an infant state of society would have done. The snake's form has been employed only in assisting the tasteful invention of the artist. The serpent's heads at the two extremities are only to be recognized from the carving of the hoods, the faces, and the eyes, in which last are inserted prominent eyeballs of a deep blue enamel or glass. About 3½ inches from each extremity, there are somewhat similar indications of snakes heads, with eyes also filled with similar globules of the same blue glass. On the other side of each extremity there is a perfect circle of nearly an inch in diameter, surrounding and enclosing a flat hollow space of about a sixth part of an inch in depth, having a deeper and minute hole in the centre of each; and from the appearance of the metal there, I have not the least doubt that the circular cavity was filled with some gem, or artificial stone, perhaps of the same nature as those now forming the eyes.

From the sacred serpent being introduced into it, this antique has all the characters of being a druidical relic. The very small diameter of the interior forbids the possibility of its having been a bracelet; and from its form, which renders it incapable of being placed on a table so as to stand without inclining to one side, it could not have been employed, as might have otherwise been fancied, as a prop or support to some of the sacred appendages of the Druidical altar. I am indebted to the joint work of Dr Meyrick and Charles Hamilton Smith, Esq. for the only clue to my explanation of it, which I find in the sixth plate of that splendid and learned book, where we have depicted the costume of the Druids, taken from a bas relief found at Autun. On the left shoulder of the figure crowned with oak leaves, we see the robe fastened, by having its folds gathered together, and drawn through an ornament of precisely similar form to that of the antique which is the subject of this communication That in the plate, indeed, appears to be somewhat smaller than the antique found among the sand hills of Culbin ; but this is not to be wondered at when we consider the probably rude and ill-defined copy from which the plate was taken.

The antique seems to be in itself perfectly unique. Since I have been engaged in drawing it, it has occurred to me that some of the ornaments have reference to the form of the misletoe.

Relugas, 31*st January* 1827.

Art. IV.—*A Metallurgic Memoir on the Nature and History of the Argillaceous Carbonate of Iron.* By Hugh Colquhoun, M. D. Communicated by the Author.

Upon commencing the metallurgic investigation of the argillaceous carbonate of iron, it was natural to expect that in an age in which science is so generally diffused, and a spirit of investigation is so actively exerted, there would remain little to be done, except the digesting and compiling of the most approved works on so important a subject. This might seem especially probable in a country like Britain, whose greatness and prosperity are so intimately dependent upon the ore which furnishes the most essential material for all those engines and machinery, by which she is enabled to cover the seas with the vessels that bear her manufactures abroad, and to enrich her merchants at home with the products which they import from all the quarters of the globe in exchange. But the fact is far otherwise. Paradoxical as it may appear, the truth is, that in Britain, a complete chemical history of this ore has not hitherto been attempted; and it is in France, where practical metallurgy is yet in its infancy, that the most scientific treatises are to be found.

It would be perhaps difficult to account for this, were it not that daily experience informs us, how often the most useful and familiar of all processes are those, whose nature and history excite the smallest reflection. Yet, even with all the allowance which can be made for this well-known fact, it is not easy to conceive how the most important of the ores of iron should have attracted so little regard among men of science. For there seems to be scarcely any branch of art, to which the metallurgic products of this ore are not either immediately or remotely essential. In almost every mechanical trade, iron forms the tools, without which the labourer might forsake his craft; and in all our manufactories, where the power of a thousand hands is condensed within a few pieces of machinery, the want of iron would paralyze the enterprise of the merchant.

In the following memoir it is proposed to give a connected view of the nature and history of the argillaceous carbonate of iron, and of the principles and practice of the metallurgic art, as far as relates to the manufacture of this metal. And as such a course of investigation evidently embraces a variety of subjects, each of which, in order to be fully elucidated, will require to be discussed with considerable minuteness of detail, we shall find it convenient to divide the memoir into several distinct parts. The first of these will be devoted to an examination of the composition of the crude materials employed in the manufacture of iron, and will comprise a short account of the various opinions which have been entertained respecting the ore of iron in the progress of modern chemistry.

Part I.—*Description and History of the Crude Materials employed in the manufacture of Iron.*

These materials may be conveniently divided into two classes; first, the ore of iron; second, the fuel and fluxes which are applied in order to separate the metal from the ore. We shall consider them separately in corresponding sections of this first part of the memoir.

Section 1.—*On the Argillaceous Carbonate of Iron.*

This ore is a chemical compound of the protoxide of iron and carbonic acid, and is the source from which almost the whole of the iron manufactured in Britain is extracted.

The history of the ore from its first appearance in the works of mineralogists, down to the period when its true properties were accurately discriminated, and its just place assigned to it in the mineral kingdom, is not without interest. As it is our design to give, as far as possible, a complete view of the various progressive stages by which a knowledge of its true constitution was acquired, as well as of the manner in which it is made to perform so important a part in the manufactures of the country, we shall begin by taking a rapid glance at the different opinions which have been entertained respecting it by successive mineralogists down to the present day.

When we consider the ardour with which metallurgic chemistry had already been cultivated, at the commencement of the present century, by many distinguished chemists and mineralogists, and reflect on the comparative accuracy with which they had determined the composition of many of the more rare and curious among the native compounds of iron, it cannot fail to excite surprise that other ores of that metal, and those the earliest known, the most widely distributed, and the most valuable in commerce, had been examined by them so superficially. The composition of the hydrates of the peroxide of iron remained unknown till their nature was determined in 1810 by the researches of D'Aubuisson; and the argillaceous carbonate of iron was for even a longer period neglected. It was generally considered a mere mixture of clay and the peroxide of iron, and was classed in mineralogical systems along with the hydrates of the peroxide of iron, or, as they were commonly termed, the iron ochres and hematites. This erroneous arrangement was countenanced by some superficial chemical analyses, but it was principally founded on a loose examination of the general external appearance of the ore, together with the analogies suggested by its geological position and by the nature of the minerals with which it was found associated.

Werner was the mineralogist who made the first important, though still very imperfect step, towards the extrication of this mineral from a mass of others of an essentially distinct nature, with which it had previously been confounded. His acute discrimination could not fail to detect the marked differences in external character, which separate the argillaceous carbonate from the native peroxide, and hydrated peroxide of iron; and accordingly, after describing these two latter ores under the appellations of Brauneisenstein and Rotheisenstein, he constitutes the former a distinct species, under the names of Gemeiner Thonargiter-eisenstein, Thoneisenstein, Eisenthon, &c. But Werner laboured under the popular error of considering that the argillaceous carbonate consisted of a mixture of clay with the oxide of iron, and he was therefore led in many cases to confound it with other ores differing essentially in their chemical constitution, but possessing a strong analogy in their physical properties. Thus, in describing the several varieties of his Thoneisenstein, he assigns to them mineralogical characters, and even geological situations, which can only be referred to minerals containing the peroxide of iron.

Werner's high reputation caused his classification to be implicitly adopted by almost all the mineralogists of Germany, for a period of twenty years, and established it also in the systems of many distinguished men in other countries. The ore is accordingly to be found arranged, with little variation from his method, in the systems of Breithaupt, Hoffman, Brochant, Kirwan, Brogniart, Jameson, and others.

Among these followers of Werner, there was one, however, Kirwan, who, in his *Elements of Mineralogy*, published in 1794, had the merit of advancing somewhat towards ascertaining the distinct character of the argillaceous carbonate of iron. It is true that he still classed it under the "calces of iron, mixed with a notable proportion of clay," and termed it *common argillaceous ironstone.* But, although ignorant of the real composition of the ore, he nevertheless gave an accurate account of its mineralogical characters, and separated it from the numerous varieties of oxide and hydrated oxide of iron, with which it had previously been confounded.*

Jameson, in the third edition of his *System of Mineralogy*,

* Vol. ii. p. 173. Mr Kirwan's description was drawn up principally from the minerals which were at that time smelted in the Iron Founderies of Carron. "Of which," says he, "as Mr Jars (in his *Voyages Métallurgiques*) gives no particular account, though he says that in all his travels he met none like it, I hope a detailed description will not be unacceptable." That he had not the slightest suspicion, however, of the true chemical constitution of this ore is clearly evinced in a subsequent paragraph, where he classes along with it the "trappose ore used in Sweden, of which the whole mountain of Taberg is said to consist, and which, by Chevalier Napion's account, is a trap overloaded with iron."

published as late as 1820, does not appear to give any account of the common compact argillaceous carbonate of iron as a distinct mineral, although he describes the varieties of it which Werner had enumerated under the heads of reniform, lenticular, and jaspery ironstone. But even in his description of these varieties the professor has ascribed to them characters which can only belong to ores consisting essentially of the peroxide of iron. *

A predilection in favour of characteristics deduced from external form, was probably the cause why this eminent mineralogist, whose system has long been the manual of the British student, allowed himself to overlook the most interesting feature of this important mineral compound. A similar cause appears, in the case of this ore, to have misled the illustrious French mineralogist Haüy. For in the second edition of his *Traité de Minéralogie*, (published in 1822,) he refers it, (under the names of *fer oxidé massif*, *fer oxidé massif argilifère*, *fer oxidé géodique*,) together with an incongruous assemblage of other minerals, for example, cubic and octohedral oxide of iron, hydrated oxide of iron, eisensinter, &c., to one common species *fer oxidé*. These errors are in Haüy the less excusable, because at the period when his system was published, the constitution of our ore must have been familiarly known among the French metallurgists. And they evince in a striking manner the paramount importance of a close attention to the *chemical* constitution of minerals; and how imperfect a substitute for the want of this is, on some occasions, supplied to the systematic mineralogist by any scrutiny of their external characters, even though it may be conducted with consummate skill.

All those writers whom we have just enumerated may be regarded as mere followers in the track of Werner, not one of whom has correctly explored the nature of the argillaceous carbonate of iron. And it becomes the more extraordinary that this should be the fact, since, as far back as the year 1796, the distinguished German chemist Richter, published an account of the analysis of six specimens of the ore, from

* Vol. iii. p. 222, 224, 238.

which mineralogists might have deduced with certainty its peculiar chemical constitution. It is possible, however, that a discovery so interesting may have escaped the notice of contemporary and succeeding chemists, owing to the circumstance, that in Richter's publication, entitled *Analyse der Eisensteine zu Bielschowitz in Oberschlesien, nebst Bestimmung des quantitativen Verhältnisses ihrer Bestandtheile*, * his main object was not to establish the existence of a new and important mineral, but to describe a novel and very unsatisfactory method of determining the proportions of oxide of iron and alumina which might exist in any solution. He precipitated both simultaneously, weighed and calcined the precipitate, then by computation from the loss of weight sustained in the calcination, he eliminated the respective amount of each substance by his peculiar system of stoechiometric calculation. Engrossed with the investigation of this useless novelty, Richter seems to have entirely lost sight of the interesting and important nature of the results of his analyses; and other chemists, in their just dislike to the general object of his memoir, improperly overlooked some of the truly valuable details which it furnishes. From these, however, Dr Thomson must be excepted; he has quoted these analyses of Richter in his *System of Chemistry*, and deduced from them the right conclusions regarding the chemical constitution of the ore. †

The specimens of the ore analyzed by Richter had been procured from Bielschowitz in Upper Silesia. He denominates them, in general terms, Eisensteine, or Ironstones, but it is evident from the details of his analyses that they must have been the argillaceous carbonate of iron. He found the same ingredients existing in all the specimens, though variously proportioned, and he ascertained them to be the black oxide of iron, alumina, silica, traces of the oxide of manganese, carbonic acid and water; the last two ingredients amounting from about 28 to about 32 per cent. He discovered that none of them contained lime, and that, nevertheless, they effervesced strongly during solution in muriatic acid. From the details which he gives it is apparent that he

* Crell's *Chemische Annalen*, 1796, i. 540.

† Sixth Edition, iii. 485.

overrated the quantity of alumina at the expense of the oxide of iron, but it is also established, that the ores consisted essentially of carbonate of protoxide of iron, and that the carbonate was argillaceous. As the results of the analyses only occupied a subsidiary place in the chemist's attention, he has not given any description of the mineralogical characters of these specimens, or of the minerals with which they had been found associated in their natural deposits.

After the period when Richter published his essay, the nature of the argillaceous carbonate of iron seems to have met with little regard until the year 1812, when it was excellently illustrated, both as to its chemical and mineralogical characters, by M. Collet-Descostils. * This acute chemist, who held the situation of director of the *Ecole des Mines*, had frequent occasion to examine specimens of the ore collected from different quarters of France, and also from England. In his *Notice sur une des Espèces de Minerai de Fer, réunies par plusieurs Minéralogistes sous le nom de Fer Argileux*, † he fully developes the true chemical constitution of the ore, he accurately describes its external and physical characters, and he gives a correct account of the geological positions which it usually occupies, and to which it seems to be confined.

The result of Descostils's researches was very important to mineralogy, in clearly establishing the distinct and peculiar nature of the chemical composition of the argillaceous carbonate of iron; but it was still more so in a geological point of view. For he discovered, to his surprise, that the country of France, in many of its districts, abounded as much in this most valuable ore of iron as the island of Great Britain itself. Upon examining a variety of specimens which were collected from different localities in France, and one that had been procured from Colebrook Dale in England, Descostils found, that, notwithstanding their dull earthy aspect, they all possessed exact-

* It is true that before that period both Drappier, (1805, *Journal des Mines*, xviii. 50. Note,) and Berthier, (1809, *Annales des Mines*, iv. 359,) had made a correct analysis of certain specimens of the ore. But Descostils was the first who gave to the public a complete account of its nature, composition, and geological history.

† *Annales de Chemie*, lxxxiv. 188.

ly the same constitution as the sparry iron ore, and were composed of the protoxide of iron united with carbonic acid. The principal difference between the sparry ore and the others was a mechanical one, deducible probably from some local circumstance incident to their original formation, which may have caused their intermixture with a variable quantity of clay in addition to those ingredients which they possessed in common with the former ore. But as the amount of this clay was often very inconsiderable, Descostils proposed that the ore should no longer be termed an *argillaceous* ironstone, but simply *carbonate of iron*, distinguishing it, however, by the less definite epithets of *earthy* or *amorphous*. He was induced to suggest this nomenclature, not merely as being less inaccurate in itself, but also because the term argillaceous might prove injurious to practical men, as he states that he had often known iron smelters introduce a large supply of siliceous and calcareous minerals into their smelting furnace, in order to flux the imaginary quantity of clay with which they supposed the ore to be contaminated. The appellation thus suggested, however, has never found its way into general practice.

Another result of great interest was deduced from these inquiries of Descostils. Although the specimens of iron ore examined by him had been collected from very different localities in France, and also from England, they all agreed in one respect, that they had been found in districts abounding with coal. And the whole of his researches led to the conclusion, that there subsisted a very intimate geological connection between coal and the argillaceous carbonate of iron; a connection so close that the miner might almost with certainty regard the presence of the one mineral as a proof of the vicinity of the other. But it is difficult to overcome the force of a rooted prejudice. Although the memoir of Descostils must at once have carried the conviction to the minds of men of science, that the most useful ironstone was co-existent with the beds of coal in the various coal-districts of France, yet the nation at large for a long period refused to believe that they possessed such a treasure within themselves, and obstinately persisted in regarding the island of Britain as the envied and exclusive depository of that ore. Even after many of the *élèves* of the

Ecole des Mines, stimulated to research by the discoveries of Descostils, had verified all his views and reduced his opinions to certainty, it still continued to be maintained that the ores on which they made their experiments did not properly represent any strata, or masses of materials sufficiently extensive to be of importance in a national point of view. But in a matter of such moment to their country, the most eminent chemists, and *ingénieurs des mines* in France were resolved that truth should prevail over prejudice. And it is perhaps to the existence of this powerful prejudice that at least one good effect is to be traced, since the investigations of her men of science have procured for France, where the art of metallurgy is yet in its infancy, the best account at present extant both of the chemical constitution, and also of the general history of the argillaceous ironstone. The fact at least is undoubted, that within a small number of late years, there have been published in France not fewer than fifty different analyses of various specimens of this ore, although there do not appear to have been more than two similar notices printed in any other country, and just one of these in Great Britain. The German chemist Freyssmuth, (in Schweigger's *Journal für Chemie*, *) has related a very careful analysis to which he submitted one specimen of a nodular argillaceous carbonate of iron, and has given at the same time an exact account of the nodule, and of the situation (in a coal formation) in which it had been found; and Mr Richard Phillips, in the *Annals of Philosophy*,† has stated the result of an analysis of a compact variety of the ore from Yorkshire, distinguished by the provincial appellation of "Black Ironstone."

The labours of the French chemists, however, amply compensate this deficiency. Among their works the most distinguished are, the *Essais et Analyses d'un grand nombre de Minerais de Fer, provenant des Houillères de France*, by M. Berthier, in which this ingenious and indefatigable chemist has given us the chemical composition, and at the same time a summary description of the external characters of all the specimens of this ore, which, previously to the year 1819, had been analyzed in the laboratory of the *Ecole des*

* Vol. xx. p. 1. † New Series, viii. 92.

Mines, either by himself, or by the *élèves* of that establishment. *

Next in importance to the multiplied labours of Berthier, a memoir published by M. de Gallois in 1818, and entitled *Sur les Minerais de Fer des Houillères, ou Fer Carbonaté Lithoïde*, deserves to be mentioned. The author gives in it a short, but excellent history of the mineralogical and geological habitudes of this ore, and exhibits, in one collected view, many important characters of the mineral, which had only been described previously in short and detached notices. It must be admitted, however, that his classification of the varieties of the ore is defective and inaccurate; neither can we approve of the change which he has proposed in its nomenclature. He suggests, that, instead of an *argillaceous* carbonate, it should be designed *lithoïde*, or *stony*; but the latter term has not been adopted by succeeding writers, and is indeed still less descriptive and less accurate than the appellation of *argillaceous*.†

* *Annales des Mines*, iv. 359. The same chemist has also published an *Analyse de quelques Carbonates natifs, à bases de Chaux, de Magnésie, de fer et de Manganèse*, (*Annales des Mines*, viii. 887;) *Analyse d'un fer Carbonaté fibreux pseudo-morphique*, (*Journal des Mines*, xxvii. 477;) *Sur les Minerais de fer des Houillères d'Anzin*, (*Annales des Mines*, iv. 353;) *Sur un Nouveau Gisement du Fer Carbonaté*, (*Annales des Mines*, iv. 633;) *Sur les Minerais de fer appelés Mines Douces*, (*Annales des Mines*, ix. 825.)

† *Annales des Mines*, iii. 517. Other memoirs besides these might be cited, which have contributed to extend the knowledge of this ore among the French metallurgists. Thus the ingénieurs MM. Thirria and Lamé, in their *Mémoire sur le Mine de Fer de la Voulte*, (*départment de l'Ardèche*), published in 1820, have given an account of an argillaceous carbonate of iron, which was at that time smelted by means of coke at Vienne. (*Annales des Mines*, v. 325.) And the ingénieurs MM. Combes and Lorieux, in a note, *Sur le fer Carbonaté argileux de Lasalle (Aveyron)*, published in 1823, (*Annales des Mines*, viii. 431,) have given an account of that mineral, and have pointed out the advantages of establishing a smelting furnace in the district where it occurs. The *Richesse Minerale*, (vols. i. and iii.) of the learned and laborious Héron de Villefosse, a work of much originality and replete with valuable information on every topic relating to metallurgy, deserves also to be mentioned, as containing a number of notices of this ore and its metallurgic treatment. The account which he gives of it is indeed very defective, his information having evidently been derived more from report than from personal observation. But he was fully aware of its extreme importance, and expresses

Besides the names already alluded to, and those more briefly referred to in the note, there are many other chemists in France, as Boullanger, Ramus, Clere, who have occupied themselves in the prosecution of the same researches. But it would be inconsistent with the scope of this memoir to enter into any details regarding their merits.

Of all these distinguished individuals Berthier is unquestionably the man to whose labours his native country is mainly indebted for the illustration of the nature and properties of the argillaceous carbonate of iron. From the time when the ore was first discovered in France, he saw its vast importance to the nation, and has zealously persevered in disseminating a knowledge of it among his countrymen, compelling their obstinate prejudices to give way before the truths suggested by science, and demonstratively confirmed by extensive experience. It is a proud result of Berthier's exertions that the French metallurgist now owes more real instruction to him alone, than to all the other chemists and mineralogists who have investigated the same subject.

We have now given a brief historical sketch of the progress by which the argillaceous carbonate of iron has at length attained its proper station in the science of mineralogy, and we have offered a very short notice of those whose names have been most distinguished in bringing the light of science in aid of the manufacturer of iron. It has been necessary to admit that the chemists of Great Britain have borne a very insignificant share in these investigations, although it is undoubtedly in their country that the metallurgic treatment of this ore is practised in greater perfection, and carried to an infinitely greater extent than in all the rest of the world together. But it would be unjust to omit in such a notice the labours of Mr Mushet, a gentleman whose long acquaintance with the details of metallurgy has enabled him to publish a series of memoirs of the highest value to the iron manufacturer.* These memoirs, which are very numerous, contain a minute discussion of every topic connected with the metallurgic treatment of the

a hope that France would speedily imitate the example of those countries where its metallurgic value was duly appreciated.

* See the *Philosophical Magazine*, from vol. ii. to vol. xxxiii. *passim.*

ore, as well as an account of the history of the art and an exposition of its principles. It is true that Mr Mushet's theories, when he indulges in them, are often more ingenious than solid; but in regard to everything which a penetrating observation, and ready apprehension, aided by a most extensive experience, can furnish to a practical man, his works are unrivalled in this country and on the continent.

We shall now proceed to examine the nature and constitution of the ore of iron. This is a subject which presents itself under various interesting views, and it is material that none of these be overlooked. Thus, the design of this treatise requires that we should fix the precise mineralogical rank of the ore of iron; yet, as our leading object is to convey metallurgic instruction, it is not enough to detail the external and physical characters of the mineral, or to divide it into all its different varieties, so as to assign it an accurate place in the cabinet of the natural philosopher. It is not enough to explain in what geological situations it occurs, although this also is an interesting part of its history. For it is far more material to the smelter of iron to be informed of the chemical composition and affinities of the various constituents which form the ore, and distinguish its varieties, in order that he may be aware under what treatment he is most likely to be successful in compelling it to yield up the metal which it contains.

In considering the nature of the ore of iron under these different views, we shall adopt the following order.—In the first place, we shall examine the ore by its external and physical characters, so as to be able to submit a mineralogical arrangement of all the various forms under which it is found. In the next place, we shall consider its geological character. And, in the last place, we shall distinguish the ore into the classes which are suggested by a regard to its chemical composition and affinities, the properties which exclusively engross the attention of the iron smelter.

The argillaceous carbonate of iron consists essentially of the protoxide of iron united to carbonic acid, and it bears the same relation to the crystallized carbonate of iron or sparry iron ore, which common compact limestone has to calcareous spar. Its rank in a mineralogical system must be along with the native crystallized carbonate of protoxide of iron. It is characterized however by too many peculiarities, both chemically and geologically, to be classed otherwise than as a distinct sub-species. The geological characteristics of the sub-species we shall defer examining, according to the order which has just been laid down, until the mineralogical history shall have been disposed of.

That we may be able to appreciate what are the properties which truly distinguish the argillaceous carbonate as a separate sub-species, it will be necessary to keep in view the characters of the general species to which it belongs. These are, in the type of the species, a regular crystallized form, reducible to an obtuse rhomboid, transparency, and absence of colour. The less pure specimens are translucent and sometimes opaque, and their colour varies from pale yellow to deep brown; but even when occurring in mountainous masses, it almost invariably possesses traces, more or less decisive, of crystallization.

The most palpable peculiarity of the argillaceous carbonate of iron is that it never occurs crystallized, and never exhibits even the most remote indication of a crystalline structure.

Another important characteristic is to be observed in attending to those substances which are found to enter into its composition, and which are of a nature completely foreign to the carbonate of iron. These substances are very various, both in their kind, and in their proportions; but they may be divided into two general classes, the earthy or argillaceous, and the carbonaceous or bituminous. We shall consider each of them separately.

In respect to the first, the argillaceous constituent, it is believed that no specimen of our ore has yet been discovered, which did not contain a notable quantity of earthy matter. The average amount of this ingredient ranges from 10 to 20 per cent.; though an ore containing so little impurity as the first mentioned quantity is rarely met with, while, on the other hand, it may sometimes be found in a much larger proportion, occasionally amounting to 25 or 30 per cent. But whenever it goes beyond 12 or 15 per cent., the iron smelter cannot use it with any advantage, unless he mixes it in the furnace with ores of a richer quality.

The earthy matter is always found to exist in the ore in a state of mere mechanical intermixture. Analogous intermixtures of foreign ingredients are common in other minerals belonging to the coal formations; and the constantly varying proportions in which the earthy matter and the ore occur united, can be ascribed only to a mechanical cause of conjunction. Accordingly, if the ore be treated with an acid, the results are quite decisive of the question. If it be taken either in mass, or in the state of powder, and digested for several hours in moderately diluted muriatic acid, the carbonate of iron will pass into solution, but nearly the whole of the earthy portion will remain undissolved, the liquid containing mere traces of silica and alumina. The matter which thus remains insoluble, and which has been detached from the carbonated protoxide of iron, is of a variable composition, being sometimes siliceous, and consisting of minute quartose grains, but more frequently of an argillaceous nature. In the latter case, it is found to consist of both the kind and the general proportions of those ingredients which characterize the ordinary clays, containing silica and alumina, which form the principal constituents, and generally, also, a notable quantity of peroxide of iron, and variable traces of lime and magnesia. From this simple analysis it is evident that the original appellation of argillaceous iron ore which had been suggested by its external appearance, and with which M. Descostils was so much offended, was far from being entirely inappropriate. The name of argillaceous carbonate of iron seems to be correctly applicable to the constitution of the ore, and we have therefore adopted it in the present treatise.

A certain portion of water is also very generally found in the ore, which probably exists in union with the clay, and may be proportioned to its quantity. The amount of this ingredient would seem to be seldom less than 1 per cent., for this much was extricated by distillation from an ore which contained an uncommonly small proportion of argillaceous matter, and which, moreover, for some time after having been raised from the pit, had been dried by a free exposure to the atmosphere.

The carbonaceous or bituminous constituent occurs almost as universally as the clay, and in proportions which, in different specimens, are susceptible of a similar variation. Its amount is generally limited in its range from 0.5 to 1.5 per cent. In one remarkable instance, to be afterwards more particularly noticed, coal existed in the proportion of 3 per cent.; but this was a solitary exception to the general results, so far as my experience has gone. After the soluble portion of the ore has been dissolved out by digestion in a dilute acid, the carbonaceous ingredient is found to remain behind, in a state of intermixture with the earthy matter. This residue possesses more or less of a black colour, according to the amount of carbonaceous matter that may be present. When calcined under free exposure to the air, it changes its hue entirely, and, according to the quantity of iron which it may have happened to contain, it becomes sometimes pure white, sometimes yellowish white, and sometimes reddish yellow.

The state in which this carbonaceous or bituminous matter exists in the ore seems indisputably to be, for the most part, that of coal rather than pure charcoal. Indeed, from the composition of the minerals with which it generally occurs associated, it could hardly happen otherwise; and the fact is put beyond doubt by the bituminous smoke and thick bituminous liquor, which are found to pass off when many of the ores are submitted to distillation. Some ores have even come under our observation which threw up a sensible oily scum when immersed in alcohol.

The extraneous ingredients which may be next considered in this mineralogical analysis of the ore are sulphur and phosphorus. Sulphur is frequently found in the state of iron pyrites, which is disseminated sometimes in masses of various sizes, and sometimes in veins through a stratum of iron ore. But as it is an ingredient so prejudicial to the iron smelter as to warrant the rejection of any ore in which its presence is discoverable by the naked eye, we shall limit our examination of the mineral to that range within which its employment by the iron smelter is confined. And here its occurrence is by no means uncommon. After analyzing eight different specimens, in order to determine how far they might be affected by the presence of sulphur, four proved to be completely free from it, and in the remaining four, the quantity varied from 0.62 to 0.02 per cent. All these specimens had been taken from different strata of working ores, and the pyrites existed interspersed through them in a state of so minute division, that its presence could not be detected by the aid of a magnifying glass.

Phosphorus appears never to exist in the ore but in the state of phosphoric acid. It is of much rarer occurrence than the sulphur, and is a still more injurious ingredient. The acid is reduced in the operation of smelting, and the phosphorus thereby developed unites with the metallic product, and renders it so excessively brittle that its most valuable properties are thereby destroyed. But it is fortunately so seldom seen, that, with the exception of three specimens found in different parts of France, and described by M. Berthier,* containing respectively 0.3, 0.8, and 6.1 per cent. of phosphoric acid, there seems to be no notice of any phosphorised ore upon record. The last specimen, in which so large an amount of the acid existed, was brought from St Etienne, (département de la Loire,) where it was found in the very remarkable state of large continuous beds that were several feet in thickness.

There are still some occasional ingredients of the ore, which, on account of their closer analogy with the carbonate of iron, we have delayed mentioning, until all the other extraneous substances were discussed. These are the carbonates of lime, of magnesia, and of oxide of manganese. In upwards of a dozen analyses of different ores, the results indicated an amount of carbonate of lime, varying from 1 to 15.4 per cent., and of carbonate of magnesia from 3.75 to 14 per cent. But in those localities where the principal strata are of a calcareous nature, the proportion of lime is frequently so superabundant as to make the mineral rank rather among the ferruginous limestones than among the ores of Iron. The carbonate of manganese is also occasionally met with in the ores, but for the most part only in very small quantity. We have never seen it exceed 0.32 per cent., though the analyses of Descostils and Berthier show it to exist sometimes to an amount that varies from 4 to 7 per cent.

From this very general view of the constitution of the ar-

* *Annales des Mines,* iv. 376, 381, 383.

gillaceous carbonate of iron, and of those extrinsic bodies which are commonly found mechanically associated with it, it appears that there is no principle of relation discoverable among the ingredients, but that they always vary according to accident or locality. It could furnish, therefore, neither pleasure nor instruction to group together the details of all the numerous analyses of this ore, which are supplied by the researches of Descostils and others in the pages of the *Annales des Mines*, and in some of the later volumes of the *Journal des Mines;* unless, indeed, we were at the same time to recapitulate the mineralogical description, and geological history of each particular specimen analyzed. Such a compilation could only prove a tedious exemplification of the general facts already stated, respecting the composition of the ore. But as only two analyses of any British specimen of this ore have ever been published, one of an ore from Colebrook Dale in Shropshire, examined by Descostils, and one of an ore from the vicinity of Bradford in Yorkshire, examined by Mr Richard Phillips, there seems to be a want of detail upon this subject, which it cannot fail to prove desirable in some measure to remove. Had this, the most important of all our minerals, only been as rare as it is common, or had it been brought from a great distance abroad, instead of being found in a happy profusion at home, it is hardly to be doubted that long ere now the pages of our scientific journals would have exhibited an accurate exposition of its nature and history. But since the fact is so, it is at least an agreeable task to furnish some materials towards supplying the deficiency, and therefore the following mineralogical analyses are subjoined from an examination of nine specimens, which were taken from regular strata in the great coal-field that lies around Glasgow. *

* It may be proper to notice, that, excepting in the second example, no experiments were made for the purpose of determining the precise quantity of water contained by the several specimens.

	(a.)	*(b.)*	*(c.)*	*(d.)*	*(e.)*	*(f.)*	*(g.)*	*(h.)*	*(i.)*
Water, - -	—	0.99	—	—	—	—	—	—	—
Carbonic acid, -	32.53	33.63	31.86	30.76	26.35	33.10	32.24	35.17	34.27
Protoxide of iron,	35.22	45.84	42.15	38.80	36.47	47.33	43.73	53.03	42.35
Protoxide of manganese,	0.00	0.20	0.00	0.07	0.17	0.13	0.00	0.00	—
Lime, - -	8.62	1.90	4.93	5.30	1.97	2.00	2.10	3.33	3.78
Magnesia, - -	5.19	5.90	4.80	6.70	2.70	2.20	2.77	1.77	4.95
Silica, - -	9.56	7.83	9.73	10.87	19.90	6.63	9.70	1.40	
Alumina, - -	5.34	2.53	3.77	6.20	8.03	4.30	5.13	0.63	
Peroxide of Iron,	1.16	0.00	0.80	0.33	0.40	0.33	0.47	0.23	12.70
Carbonaceous or Bituminous matter,	2.13	1.86	2.33	1.87	2.10	1.70	1.50	3.03	
Sulphur, -	0.62	0.00	0.00	0.16	0.00	0.22	0.02	0.00	
Moisture and loss,	—	—	—	—	1.91	2.26	2.34	1.41	1.95
	100.37	100.68	100.37	101.06	100.00	100.00	100.00	100.00	100.00

(a.) From Crossbasket, about seven miles south-east from Glasgow. Colour, light-greyish, or greenish-black. Fracture, from fine-grained, even, to coarse-grained, uneven. Very easily frangible; soft; easily scratched by the knife. Specific gravity, taken in distilled water at the temperature of 60°, 3.1793.

This is the highest and also the least valuable of the Crossbasket strata of ironstone, which are at present raised for the use of the blast furnace. The thickness of the stratum is from three to three and a-half inches.

(b.) From Crossbasket. Colour, light greyish-black. Fracture fine-grained, earthy, slightly uneven. Rather tough. Not particularly soft. Sp. gr. 3.3801.

This ore is found at a distance of four feet under the preceding one. It constitutes a stratum of about nine inches in thickness, and is esteemed the purest and the most valuable of the Crossbasket ores.

(c.) From Crossbasket. Colour, light greyish-black. Fracture fine-grained, earthy, slightly uneven. Rather tough, but more easily frangible, and softer than the last mentioned ore. Sp. gr. 3.2699. The average thickness of the stratum is from six to eight inches.

(d.) From Crossbasket. Colour, brownish-black. Fracture, earthy, fine-grained, uneven. Easily frangible and soft. Sp. gr. 3.1175. This stratum of ironstone is situated next under that from which the preceding specimen was taken, and forms the lowest which is at present wrought at Crossbasket.

It varies in thickness from ten to fourteen inches. Both it and the preceding ore are reckoned of good average quality. This ore furnishes a curious instance of the capricious and seemingly unaccountable alterations that are liable to take place in every chemical manufacture whose fundamental principles are little understood, and in none, perhaps, does this happen more frequently than in the smelting of iron. Although it forms the thickest of all the Crossbasket strata, and therefore holds out powerful inducements in an economical point of view to the iron-smelter, it was at one period regarded at the Clyde Iron Works as an ironstone totally unfit for the manufacture of good iron, and having once received an unfavourable character, it was allowed to remain unworked for a long course of years. It is only of late that its employment has been again resumed; but, so far from being held in low estimation, it is now considered to be little inferior in quality to any of the Crossbasket ores, and is used very extensively in the blast furnace.

Immediately above this stratum there is situated a bed of schist, containing a regular stratification of very large nodules of ironstone. Being extracted by the miner simultaneously with the subjacent ore, they are used to a considerable extent in the blast furnace, and are esteemed an ironstone of uncommonly fine quality. The black bituminous substance, which will be mentioned hereafter as occurring occasionally in nodular ironstone, exists very generally distributed throughout this stratification of balls.

(e.) A specimen found in the neighbourhood of the Clyde Iron Works, which are situated about four miles south-east from Glasgow.* Its mineralogical details are the following: Colour, pale, between broccoli-brown and clove-brown. Fracture, rather fine-grained, uneven. Not particularly hard; easily scratched by the knife. Sp. gr. 3.1482. The thick-

* I beg leave to take this opportunity of expressing how much I feel indebted to Colin Dunlop, Esq. the proprietor of this smelting establishment, for the valuable information which he has communicated to me respecting this ore and its metallurgic treatment, and for the liberal permission which he gave me both to examine every process of art at the Clyde Iron Works, and to make the freest use of the knowledge thereby acquired in the course of the present memoir.

ness of the stratum is about $2\frac{1}{2}$ inches. It is considered at the works to be an ore of very inferior quality, and is seldom smelted.

Immediately above this ore there is situated a bed of schist, which contains an immense number of petrifactions of different kinds of bivalve shells. They consist of *a very pure ironstone*, resembling in appearance the subjacent band *(f.)* Their forms are remarkably perfect, and they contain no visible remains of the original shell.

(f.) An ore lying under the last mentioned stratum, and in close contact with it. Colour between yellowish-grey and hair-brown. Fracture, fine-grained, earthy, even. Rather hard; scratched with some difficulty by the knife. Sp. gr. 3.2109. The stratum to which it belongs is situated above the splint coal, with the intervention of only four inches of schist, and both minerals are therefore worked out together with great advantage to the smelter. It is the most valuable ore in all the fields around Glasgow, except that called the *Black Ironstone*, which is at present smelted at the Clyde iron works. The thickness of the stratum is between one and a half and two inches.

(g.) This specimen was procured from Easterhouse, near the line of the Monkland Canal, and about six miles east from Glasgow. Colour, clove-brown. Fracture, fine-grained, rather uneven. Somewhat tough and hard, but easily scratched by the knife. Sp. gr. 3.3109.

This ore exists in precisely the same relative situation with regard to all the other accompanying minerals, as the two ores from Clyde Iron Works which have just been described; and wherever it makes its appearance it seems to have been produced by the coalescence of these two strata. This compound stratum has always a uniform texture and composition throughout. Its average thickness is two and a half to three inches. It is used pretty extensively in the blast furnace, and is esteemed an ore of good average quality.

(h.) From the neighbourhood of Airdrie, about ten miles east from Glasgow. Colour, clove-brown, the intensity of the shade varying considerably in streaks which are parallel to the direction of the stratum. When reduced to powder the co-

lour is brown. Fracture, fine-grained, earthy; rather uneven. Tough, and difficultly pounded; communicating a feeling of elasticity under the pestle. Rather hard; scratched by the knife. Adheres slightly to the tongue, a property which did not appear to be possessed in a sensible degree by any of the seven ores already described. Sp. gr. 3.0553. Numerous bivalve shells, of a pale wood brown colour, occur scattered through the mass of this ore, and form a strong contrast with its darker shade. This is one of the most valuable iron ores of Scotland, where it is familiarly known under the name of *Black Ironstone*, or *Mushet's Black Band.* The latter appellation has been given from the circumstance that it was first smelted by Mr Mushet, to whom we have already referred as the metallurgist most distinguished for his practical skill. *

It lies about fourteen fathoms below the fifth Glasgow coal bed, or splint coal; and constitutes a layer about fourteen inches in thickness. It is remarkable that it has hitherto been found nowhere except in the neighbourhood of Airdrie: although several attempts have been made in other localities to reach it by boring. At the Clyde Iron Works it is justly regarded as the richest and most valuable ore which they at present possess.

(i.) From a stratum situated in the vicinity of Crossbasket. Colour bluish-grey. Fracture in the great even; in the small very fine-grained, earthy. Rather hard.

Such was the composition and the mineralogical details of various specimens of ironstone which were obtained from component strata of the independent coal formation around Glasgow. But it is well known that this ore presents itself not only in uninterrupted strata or *bands,* as the the miners term them, but also in the form of independent nodules or *balls,* imbedded in a stratum of some foreign mineral. We shall subjoin a few analyses of these nodules. The analyses were made with a less scrupulous accuracy than those of the band-ironstones, but still, it is hoped, with sufficient care and attention to permit the results to be relied on as exhibiting the true mineralogical character of this variety of the ore.

* He has also given a particular account of this ore in the *Philosophical Magazine,* vol. iii. p. 254.

1. A very flat nodule, found imbedded in schist at Crossbasket. Colour of the fractured surface, hair-brown. Fracture fine-grained, somewhat uneven. Hard: scratched by the knife. The nodule is enveloped by a thin yellowish-coloured ochraceous looking crust, which has evidently been produced by the decomposition of the carbonate of iron. It was composed of

Carbonate of protoxide of iron, . .	80.70
Argillaceous matter, with a little carbonaceous matter, ...	10.45
Carbonate of lime, ...	2.19
Carbonate of magnesia, moisture, and loss,	6.66
	100.00

This nodule was found in the immediate vicinity of a regular stratum of ironstone. The ore composing this stratum had a greyish-black colour; it broke with a fine-grained, earthy, somewhat uneven fracture; and consisted of

Carbonate of protoxide of iron, .	60.34
Argillaceous matter, with a little carbonaceous matter, ...	30.80
Carbonate of lime, . . .	1.87
Carbonate of magnesia, moisture, and loss,	6.99
	100.00

2. A nodule brought from the vicinity of Crossbasket, where many similar ones occur in a stratum of indurated clay *(fire-clay)* from which this specimen was taken. They are generally small, and vary from an inch to four inches in diameter. They are smooth and rounded externally. They break with a fine earthy fracture, and the colour of the fractured surface is yellowish-grey. The specimen proved to be composed of

Carbonate of protoxide of iron, . .	90.15
Insoluble clayey matter, . . .	6.30
Carbonate of lime, ...	1.09
Loss, ...	2.46
	100.00

3. This nodule was also found in the vicinity of Crossbasket, imbedded in argillaceous schist. Specimens of the same kind are found very plentifully distributed throughout the stratum, and all of them are remarkable for an extremely irregular shape. They are of rather a small size, varying from three to six inches in diameter. It broke with a fine-grained fracture. The colour of the fractured surface was dark-greyish black; but it was variegated in consequence of the presence of white coloured specks and veins of carbonate of lime. It was composed of

Carbonate of protoxide of iron, . .	81.22
Insoluble clayey matter, . . .	12.30
Carbonates of lime and of magnesia, moisture, and loss, ...	6.48
	100.00

The following was the result of the analysis of an ore which constitutes a pretty thick stratum in the vicinity of Crossbasket, and we state it as furnishing a striking example of the excessive proportion in which the carbonate of lime is occasionally intermixed with the carbonate of iron, or *vice versa.* Its colour was dark-bluish black; and it possessed all the external and physical characters of the common argillaceous carbonate of iron, excepting that its specific gravity was necessarily low.

Carbonate of lime, ...	53.50
Carbonate of protoxide of iron, . .	22.33
Clay, carbonaceous matter, carbonate of magnesia, moisture, and loss, .	24.17
	100.00

Thus there was little more than one-fifth part of the mass composed of the carbonate of protoxide of iron, while the one-half consisted of the carbonate of lime.

From the details which have been just stated respecting the composition of these various specimens, we shall now endeavour to deduce the general mineralogical character of the varieties composing this distinct sub-species of the carbonate of protoxide of iron. In doing this, however, it must be remembered that the ore is found to be incorporated by an intimate mechanical union, with so many of the minerals whose strata lie in juxtaposition, or in near contact with it, that it is often difficult to mark the proper mineralogical territory of the ironstone. It is found to exist intermixed with carbonate of lime, with argillaceous schist, with coal, and with sandstone in every variety of proportion; and as it is not in a state of crystalline aggregation, it of necessity assumes the external characters of those extraneous substances, precisely according to the extent of their intermixture. Thus, it is not only destitute of the most decided and certain characteristic of minerals, a crystalline figure, but the remaining external characters, such as colour, hardness, fracture, texture, and specific gravity are subject to the greatest irregularity and variation. It is in such a case perhaps impossible to draw any better line of distinction, separating what may be justly considered an argillaceous iron ore, from what may more properly be regarded as a ferruginous limestone, or clay, or coal, than just to take those specimens in which the iron ore is the predominating ingredient to form the one class, and those in which it forms a less prominent constituent to form the second. This principle of discrimination seems the more appropriate in a metallurgic treatise, since it will certainly embrace all the ironstones which are an object of interest for the metal which they yield. But even after adopting it as marking out the precise range of the ore within which the following classification will be confined, the more minute division of the field into the several sub-species and varieties that occupy it, will still prove somewhat embarrassing from the causes which we have just mentioned. We shall endeavour, in the first place, to state the general average of external character which they exhibit, and to mark the extremes within which the variation of each character is limited; and, in the next place, to group the different ores into such subdivisions as may be suggested by their leading chemical variations. The genuine mineralogical character of the sub-species of the carbonate of protoxide of iron, the argillaceous carbonate of iron, is the following:—

The predominating *colour* of the ore is *grey*, of various shades, as *light ash-grey*, *bluish-grey*, *blackish-grey*, *yellowish-*

grey. Frequently, also, it is *red, brownish-red,* and *brown;* and when this is the case it probably contains a certain quantity of the peroxide of iron. The presence of bituminous matter darkens the shade of all these colours; and when this substance exists to any considerable extent, it often deepens the hue into a perfect *black.*

The *texture* is most commonly *compact,* but sometimes, also, it is *tabular* or *slaty.* Even the nodular varieties of the ore, although they occasionally consist of concentric layers, are in general quite compact and uniform in their composition.

The *fracture in the large* is *compact,* and more or less *uneven;* sometimes, also, *imperfect conchoidal* or *slaty. In the small* it is generally *even, fine-grained, earthy;* but sometimes *coarse-grained,* and *slightly uneven.* It frequently happens that the nature of the fracture differs in different parts of the same specimen, a variation which is probably caused by a different state of mechanical intermixture with other bodies.

The *aspect* of the *fractured surface* is *dull* and *earthy.* The *fragments* are rather *blunt edged,* and have *no determinate form.*

The ore varies much in *hardness*: being sometimes *hard* and *tough,* and *difficultly frangible;* at other times, *soft,* and easily reduced to powder. In general, it is easily *scratched by the knife.* It feels *meagre to the touch,* and sometimes *adheres slightly to the tongue.* Its *specific gravity* varies from 2.8 or 2.9 to 3.4 or 3.5.

A frequent distribution of foreign bodies occurs in the mass of the ore, consisting partly of organic, and partly of inorganic substances. Of the former, the most common are shells, generally of the bivalve description, and impressions of vegetables. Impressions of fishes are also similarly discovered, though these remains of organized nature are much more rarely met with. Of the latter, the most frequent are carbonate of lime and iron pyrites, which are sometimes disseminated through the ore in small pieces, and at other times penetrate it in the form of slender veins. Sulphate of lime, blende, galena, and copper pyrites are also occasionally observed: but these latter bodies, especially the metallic sulphurets, are of infrequent occurrence.

When the ore is calcined, its grey colour changes to red, brown, or blackish-brown, and it loses from 20 to 50 per cent. of its weight. Before the blowpipe it instantly blackens, and becomes susceptible of magnetic influence. When immersed in muriatic acid, it dissolves slowly, with effervescence, and leaves a residue composed of a mixture of argillaceous and bituminous matter. This solution, which is of a greenish-yellow colour, on receiving the addition of nitric acid, becomes for a few seconds of an intense olive-brown, and almost immediately after loses this appearance, turning yellow, and giving off at the same time copious nitrous fumes. When smelted in the blast furnace, the ore yields, on an average, about 30 per cent. of cast iron.

(To be continued.)

ART. V.—*On Sternbergite, a New Mineral Species.* By WILLIAM HAIDINGER, Esq. F. R. S. E. &c. Communicated by the Author.*

I. DESCRIPTION.

FUNDAMENTAL form. A scalene four-sided pyramid. P=128° 49′, 84° 28′, 118° 0′. Plate III. Fig. 1.

$$a : b : c = 1 : \sqrt{1.422} : \sqrt{0.484}.$$

Simple forms. $P - \infty\,(a)$; $P\,(f)$; $P + 1\,(g) = 122°\,17', 68°\,22', 146°\,34'$; $(\breve{P}r)^3\,(d) = 92°\,28', 107°\,17', 131°\,17'$, $\breve{P}r + 1\,(b) = 61°\,35'$, $\frac{5}{4}\,\breve{P}r + 8\,(c) = 13°\,36'$, $\breve{P}r + \infty\,(i)$; $\frac{4}{3}\,\overline{P}r - 3\,(h) = 153°\,2'$.

Various combinations among these forms have been observed, one of them is represented, Fig. 2. They have all more or less the aspect of rhombic plates, with angles of 119° 30′, and 60° 30′, which is the base of the fundamental pyramid; often the acute angle is truncated.

Cleavage highly perfect, and easily obtained parallel to the face *a*. No trace of cleavage in other direction of the lamellæ, which may be torn asunder like thin sheet-lead.

Surface of *a* delicately streaked parallel to the edges of combination with *h*, that is parallel to the long diagonal of the rhombic plates. Lustre more considerable upon these than

* Abstract of a paper read before the Royal Society of Edinburgh on the 4th of December 1826.

upon the remaining faces, which are deeply streaked parallel to their intersections with *a*.

Lustre metallic. Colour dark pinchbeck-brown, rather darker than the colour of magnetic pyrites. Streak black. Tarnish, often violet-blue on all the faces except *a*.

Very sectile. Thin laminæ perfectly flexible. Hardness = 1.0...1.5, little superior to talc. Specific gravity = 4.215.

Compound varieties. Twin-crystals, joined parallel to a face of P + ∞, similar Fig. 3. Generally several crystals are joined in an irregular manner, and implanted together, being fixed to their support with one of their sides, so as to produce rose-like aggregations and globules, with a drusy surface. Massive varieties usually present the aspect of a coarse-grained mica.

II. Observations.

1. The two specimens from which the preceding description is drawn up I first saw when in Prague in March 1826. They were pointed out to me as something not agreeing in several respects with the known species, by Professor Zippe, one of them in the collection of the National Museum, the other in the collection of Gubernialrath Neumann; the latter specimen was designated on the ticket as a pinchbeck-brown problematical fossil, crystallized in six-sided tables. Both these gentlemen entrusted me liberally with the specimens for examination, the only specimens then known to exist. I am happy to learn that Mr Zippe has succeeded in finding out a few more specimens, in rummaging over some old store of minerals.

2. There exists a considerable deal of resemblance, as appears also from the characters given, between the Sternbergite, and the black tellurium, the flexible sulphuret of silver, and the rhombohedral molybdena-glance. As a species it is sufficiently distinct from all of them. On account of that resemblance it must receive its place in the order Glance of the system of Mohs; but whether as a genus of its own, or along with some one or the other of those enumerated, is as yet uncertain, while these species themselves are so imperfectly known. No systematic denomination can therefore be at present proposed for the new species. The name of Sternbergite, in proposing

which I concur with my friends Neumann and Zippe, is particularly appropriate, as the species to which it applies was first observed in a public collection, belonging to an establishment chiefly formed by the exertions of that learned and patriotic nobleman, Count Caspar Sternberg.

3. No chemical analysis has yet been given of this substance. When treated with the blowpipe it gives in the glass tube a strong odour of sulphurous acid, loses its lustre, and becomes dark-grey and friable. Alone on charcoal it burns with a blue flame and sulphurous odour, and melts into a globule, generally hollow, with a crystalline surface, and covered with metallic silver. The globule acts strongly on the magnetic needle, and before the blowpipe has all the properties of sulphuret of iron. It communicates to fluxes the ordinary colours produced by iron, red while hot, and yellow on cooling, in the oxidating flame, greenish in the reducing flame. Borax very readily takes away the iron, and leaves a button of metallic silver. It appears therefore to consist of sulphuret of silver, combined with a large quantity of sulphuret of iron.

4. The locality of this interesting species is Joachimsthal in Bohemia. It must have been found at a rather remote period, as the specimens were discovered in old collections; and it is likely enough, on account of the economical value of Sternbergite as an ore of silver, that most of it has been melted down long ago. Moreover, it is chiefly accompanied with other ores of silver, as the red silver, the brittle silver, or prismatic melaneglance, and others.

ART. VI.—*Description of a plant used in Bengal as a common green vegetable,* (Olus,) *and of another nearly allied to it.* By FRANCIS HAMILTON, M. D. F. R. S, &c. Communicated by the Author.

IN Gangetic India this plant is called Palak or Palanki, names that have been given to the spinach of Europe, when this was introduced, both being cultivated in a similar manner, and having similar alimentary qualities. Dr Roxburgh considered it as a species of Beta, and called it *B. Bengalensis,* which name I have retained in the catalogue of specimens presented to the India House, although I doubt much of the propriety of including it in this genus, as will appear from the following description. In its general appearance it strongly resembles the spinach.

Radix annua, recta, descendens, crassitie digiti minoris. Caulis herbaceus, duos vel tres pedes longus, primo erectiusculus, demum prostratus, ramosus, obtusangulus, glaber. Folia alterna, caulina deltoideo-oblonga, glabra, obtusa, venosa, basi integerrima, apices versus erosa. Petiolus mediocris, marginatus. Stipulæ nullæ.

Spicæ terminales, longissimæ, foliis floralibus minutis basin versus comosæ; supra nudæ, bracteis alternis linearibus flore brevioribus indutæ. Flores e foliorum floralium vel bractearum singularum axillis gemini, sessiles, divaricati, herbacei.

Calycis quinquephylli foliola linearia, concava. Petala nulla. Filamenta quinque calyce breviora, calycis foliolis opposita, basi coalita in discum hypogynum cyathiforme. Germen magnum, planum, superum. Stylus nullus. Stigmata tria.

Bacca depressa, calyce carnosiusculo tecta. Caro tenuis, mollis. Semen unicum, crustaceum integumento interiore membranaceo. Albumen centrale, farinaceum. Embryon incurvum, teres, horizontale.

The Nunika (salina) of the Hindwi dialect, which grows on the saline plains near Agra, has nearly similar generic characters, although I suspect that it may be the Salsola Indica, (Willd. Sp. Pl. i, 1317; *Enc. Meth.* vii. 290,) and the specimens sent to the India House have been marked with this name. I am, however, very uncertain whether this is the plant meant by Willdenow, and I doubt very much of its being a Salsola. Of this, however, the reader may judge from the following account:

Frutex statura tamarisci, ramis diffusis, sparsis, teretibus, glabris. Folia sparsa, intervallis longiora, subsessilia, carnosa, ancipitia, apice inermi acutiuscula, pilis destituta, sed squamulis quasi minutis punctata, avenia, divaricata, non stipulacea.

Flores axillares 3—5, sessiles, e ramulis novissimis pullulantes, ebracteati, parvi, herbacei.

Calycis quinquepartiti laciniæ concavæ, patulæ. Corolla nulla. Filamenta quinque, calycis laciniis opposita, hisque duplo longiora, subulata, glabra. Antheræ magnæ, rufescentes, cordatæ, emarginatæ. Germen superum, ovatum. Stylus nullus. Stigmata tria acuta.

Calyx fructiferus orbiculatus, clausus, depressus, quinquesulcus, carnosiusculus. Receptaculum totum fere calycem implens, carnosum. Semen unicum in receptaculo nidulans horizontale, suborbiculatum, nitidum, margine acuto hinc mucronato cinctum. Albumen centrale. Embryon teres, incurvum, horizontale. Cotyledones semiteretes. Radicula centrifuga.

The habit or general appearance is very different from that of the Palak; and, as the seed is only immersed in a pulpy receptaculum, and not entirely covered by it, the Palak and Nunika may be placed in different genera. The leaves and tender shoots of the latter have an agreeable saline taste; but it is not used by the natives.

Art. VII.—*On Polyhalite.* By William Haidinger, Esq. F. R. S. E. &c. Communicated by the Author.

The species of polyhalite was established by chemical analysis from such varieties as would not allow of a complete determination according to the principles of natural history, since they presented nothing but fibrous masses, without a trace of regular structure or crystallization. It is not to be wondered, therefore, that it should have been hitherto considered as a more or less problematical substance, and exhibited as such in the appendices of most of our systems, even in those which pretend to proceed according to chemical views, the only thing known in the present instance. It was doubted whether the many salts contained in it, from which circumstance Stromeyer derived the name polyhalite, were in actual chemical combination, or whether they formed but a mechanical aggregate, and we must allow that this is a fair enough view of the subject, if we consider the results which he obtained, viz.

Sulphate of potassa	27.7037	Muriate of magnesia	0.0100
———— lime	44.7429	Protosulphate of iron	0.2927
———— magnesia	20.0347	Water - -	5.9535
Muriate of soda	0.1910	Peroxide of iron	0.3376

The name of polyhalite was afterwards applied by Mr Berthier to several substances found at Vic in Lorraine, and of which he also published the following analyses :—

	Red massive.	Red crystallized.	Grey massive.
Sulphate of soda	44.6	21.6	29.4
Sulphate of lime	45.0	52.2	40.0
Sulphate of magnesia	0.0	2.5	17.6
Muriate of soda	6.4	18.9	0.7
Oxide of iron and clay	3.0	5.0	4.3

The first of these, if we may infer anything from the mixture, which is the only datum we have to proceed upon, appears to be massive glauberite. The other two so much differ from Stromeyer's polyhalite in regard to chemical composition, particularly as one contains soda and the other potassa, that it would have been better to have given them also a separate name, when it was impossible to establish their identity, founded upon an agreement in their physical properties.

It is only from crystallized, or at least from such crystalline varieties as are evidently homogeneous, that any thing like exact information can be derived, both as respects the physical properties, and the chemical constitution of a substance. I was fortunate enough, during my late stay in Vienna, to obtain two specimens of the polyhalite from Aussee for examination, whose very aspect and crystalline character precludes the possibility of their being mere mechanical aggregates of different species of salts. One of them was given me by Baron Leithner as a new species of salt, containing potassa ; for the other I am indebted to Mr Von Pittoni, who had got it as the glauberite from Aussee.

A hexahedral form has been sometimes ascribed to the polyhalite, said to be obtained by cleavage from certain colourless masses mixed up with the fibrous mineral. Such, however, when they occur will be found to be rock-salt, as in every instance within my knowledge, or perhaps anhydrite, whereas the actual forms of polyhalite belong to the prismatic system of Mohs, and are broad six-sided prisms, similar to Plate III. Fig. 4. The angle produced by two adjacent faces *o* is about 115°, the intersection of them with r about $122\frac{1}{2}°$. There were crystals lining the cavities of some fissures in one of the specimens, but so small that their form could be made out only by means of a compound microscope. The massive varieties presented striated faces of composition, as it is marked in the figure of the crystals, the surface of which is also striated in the same manner. They also show cleavage, but not very perfect, parallel to the faces, and these yielded 115° as an approximate measurement.

The colour is a very pale flesh-red, almost yellowish.

The hardness, given in books as greater than that of calcareous spar, I found only 2.5 greater than rock-salt, but considerably inferior to calcareous spar; this is also the hardness of the darker red fibrous varieties, which I examined for comparison's sake.

The taste of polyhalite, in every one of its varieties, is very faint, and has more of the bitter and astringent than of the saline, which, when it is perceived, is owing to an admixture of rock-salt. The solubility in water is also very inconsiderable.

The specific gravity I found in one of the specimens, which consists of pretty large individuals, = 2.782; in the other, whose component individuals are more compressed between their faces r and r, and which possesses more lustre upon the faces of composition, I obtained 2.730; in another portion of the same 2.746. The specific gravity of the red fibrous variety was found = 2.770, very nearly the same as Stromeyer's result, 2.7689.

Whatever may be ascertained of the physical properties of the two specimens mentioned above, and the variety of polyhalite originally analyzed by Professor Stromeyer, tends to unite them within one species. Even the traces of cleavage inclined to the direction of the fibres visible in the latter agree with the position of the prism of 115°. A chemical analysis of the more crystalline varieties would be now very interesting, as it would no doubt perfectly establish the nature of this compound, and likely also somewhat reduce the number of salts found in the fibrous specimens.

ART. VIII.—*Observations on the Temperature of the Atmosphere made by means of Balloons.* By The Right Honourable the EARL OF MINTO.

WE have already had occasion to point out to our meteorological readers the importance of determining the decrease of temperature in ascending in the atmosphere, and we also recommended to their notice the method of ascertaining such temperatures by means of balloons, which had been successfully practised by the Right Honourable the Earl of Minto.* The introduction of such a method will, we are persuaded, be of immense benefit to science, and we are happy to have it in our power to publish the results which were obtained by his Lordship.

Hours. P. M. H. M.		Thermometer below.	Six's Thermometer attached to Balloon.
4 30	Sent up the balloon under Minto Hill,	60	60
	We followed the balloon to the top of the hill, and here gave out 1340 feet of line.		
5 5	We began to lower the balloon, -	59	
5 15	Whilst we were lowering it, - -	58.25	
5 25	The balloon down (on the top of the hill,) - - -		52
	During this time there had been no sun, and the balloon floated nearly perpendicularly above us.		
	Sent up the balloon again immediately; it rose rapidly.		
5 30	It had attained its full height, 1340 feet,	58	
	At first it floated nearly over us, and the sun did not appear. Soon, however, the sun broke out from the clouds, and shortly afterwards the wind rose a little, carrying the balloon a good way to the W. N. W. and of course lowering it very much.		

* See this *Journal*, No. xi. p. 146, and No. xii. p. 246.

Hours. P. M. H. M.		Thermometer below.	Six's Thermometer attached to Balloon.
6	We begin to haul in the line. Bright sunshine, and strong breeze, - -	59	
	We descended 150 feet to leeward, to escape the wind, which strained the line so much, we feared it might break.		
6 20	Here we got the balloon down. Still bright sunshine, - -	60	54
	We proceeded homewards, and on getting round under the shadow of the hill, I found the thermometer at, -	56	
7 15	Sent the balloon up in front of the house,	53	
	It floated immediately over our heads at the full extent of the line, 1340 feet. Although the sun was set to us there was sufficient light in the north-west to enable us to see it in the form of a crescent on one side of the balloon.		
7 40	No light on the balloon. We began to lower, - - -	52.5	
7 47	The balloon down, - -	52	51.25
	I then sent the balloon up 100 feet, and after some time found the thermometer	52	52.5
	The same experiments repeated gave the same result at 100 feet, for the register thermometer; it had become too dark to read off the lower thermometer accurately,		52.5

On this day the barometer stood unusually high, viz. at 30.1. The hygrometer indicated an atmosphere much charged with vapour in the forenoon,—in the afternoon it became obviously much dryer.

The register thermometer (Six's) attached to the balloon, hung freely in a cylindrical case of glazed pasteboard, open at each end. The thermometer below was suspended in a similar case of writing paper; and in the *second* experiment on the hill both appear evidently to have been very much affected by the heat of the sun.

The experiments at and immediately after sunset prove the rapid ascent of the heated air from below that takes place, and the descent of cold air from above that produces the sudden chill we feel at that time. I have frequently observed, that, on insulated heights, the thermometer appeared to rise a little about the time of sunset, and even when that was not the case, that it did not fall so soon nor so fast as on the plain below. So that it often happens where the difference of height between the two stations is not very great, that the air just after sunset is warmer above than it is below. I have observed this in hard frost, and in very warm weather.

The foregoing very meagre experiments are all that I have yet been able to make with my balloon, as I have in vain attempted to discover some means of protecting the thermometer from the influence of the sun. But I shall be very happy, if you will come here in the summer, to pursue them further with you.

You will observe, that, from a quarter after five o'clock, till three quarters after seven, the temperature of the air, at 1340 feet above the earth, was only lowered three-fourths of a degree in those two hours and a half. Whilst, in the same time, the thermometer below fell six and a fourth degrees. The difference between the height of the hill and of the ground before the house may in part explain the smallness of the change of temperature in that time, but this would apply equally to both thermometers.

MINTO, *5th April* 1827.

ART. IX.—*A short account of the results of recent Experiments upon the Laws of Light and its Theory.* By M. LE CHEVALIER FRAUNHOFER, Member of the Royal Bavarian Academy of Sciences at Munich. (Concluded from Vol. vii. p. 113.)

IT would be difficult for the most ingenious natural philosopher to derive immediately from the results of these experiments a *law* of the phenomena.

Let τ denote the angle which a coloured ray after the modification makes with the plane of the system of lines, (in vertically received rays therefore, the complement of ϑ,) and γ denote the straight line drawn from the micrometer wire of the telescope employed in the observation, perpendicularly on the plane of the system of lines, * the aggregate of all my observations may then, with all the accuracy to be attained in experiments of this kind, be represented by the following equation:

$$\text{(III.)}\ \tan \tau^{(\pm \nu)} = \frac{\sqrt{[\varepsilon^2 - (\varepsilon \sin.\sigma \pm \nu\omega)^2].[4\gamma^2 + \varepsilon^2 - (\varepsilon \sin.\sigma \pm \nu\omega)^2]}}{2\gamma\,(\varepsilon \sin.\sigma \pm \nu\omega)}$$

This equation I have developed without approximation after the principles of interference which were published in the year 1802 by Dr Thomas Young, and which were afterwards treated with merited attention for the first time by Arago and Fresnel. ω here generally denotes the length of a wave of light. Although this is an infinitely small magnitude, we may deduce it with a very high degree of accuracy, from the experiment which I have already described in my treatise "*on the New Modifications of Light*," &c. the results of which are there set down for the different coloured rays in general terms. From the experiments with the glass systems of lines we ascertain this magnitude so accurately, that for the lighter colours scarcely the thousandth part of ω can be uncertain. From the experiments with the finer systems of lines on glass, by means of the angle for the first spectrum, with the light received vertically, if ($C\,\omega$) denote the length of a wave of light, for the ray C, and ($D\,\omega$) for the ray D, &c. I obtained in parts of a Parisian inch, †

* If, therefore, a is the distance of the micrometer wire, (and consequently the distance of the place where the image of this phenomenon is produced,) from the system of lines, then we have $\gamma = a \sin \tau$.

† The fixed line B, towards the end of the red, was, on account of the great extension of the image, not so easily seen that its place could be determined with certainty. I shall endeavour to make a still greater number of fine systems of lines upon glass, in order to determine, if possible, still more accurately the value of ω for the various coloured rays. It is, however, already accurately enough known to be certain whether the experiments confirm the theory. If the value of ($D\,\omega$), ($E\,\omega$), &c. is deduced from the experiments with coarser systems of lines upon glass, they are

$$(C\ \omega) = 0{,}00002422$$
$$(D\ \omega) = 0{,}00002175$$
$$(E\ \omega) = 0{,}00001945$$
$$(F\ \omega) = 0{,}00001794$$
$$(G\ \omega) = 0{,}00001587$$
$$(H\ \omega) = 0{,}00001464$$

From the equation (III.) it will appear that the value of τ in some degree depends on γ, that is to say, on the distance at which the image of this phenomenon is formed, and that the light, therefore, thus modified after the principles of interference does not proceed in a perfect mathematically straight line but in a curved line. The equation for this curved line is developed without approximation, in this form,

$$\text{(IV.)}\ x^2 [4\,\varepsilon^2 - 4\,(\varepsilon\,.\,\sin\sigma \pm \nu\omega) = 4\,\gamma^2\,(\varepsilon\,.\,\sin\sigma \pm \nu\omega)^2 + [\varepsilon^2 - (\varepsilon\,.\,\sin\sigma \pm \nu\omega)^2]\ \varepsilon\,.\,\sin\sigma \pm \nu\omega)^*$$

Since these phenomena can only be observed with a telescope, which, if the divergences are to be determined with some accuracy, must have great power, and cannot therefore be very short, then γ is in comparison with ω and ε very large. In my instrument the distance of the micrometer thread to the systems of lines is $= 21{,}43$ inches. If γ, in comparison with ω, were not very large, the relative value of τ and γ might be found somewhat different; but if in the equation (III.) γ is once set down $\frac{1}{2}$, and then two or three times as large as it really was in my experiments, then the same value

obtained in the eighth decimal place somewhat larger than when they are obtained from the experiments with finer systems of lines upon glass. This small difference can only be looked for in the less accurate determination of the value of ε, which I am inclined to think more accurate with the finer systems of lines. It is unnecessary to remind the reader that the precision in regard to the determination of the value of ε has its limits to whatever extraordinary a height it may reach, with the aid of those means which I use; and I have hopes of extending them still further.

* The equations (III.) and (IV.) are developed for the case when the incident rays may be considered as parallel with each other. Where the distance of the luminous point in comparison with ε is not very large, then in both equations ε sin. σ is to be placed instead of $\frac{\varepsilon \sin. (\sigma + \frac{1}{2}\beta)}{\cos. \frac{1}{2}\beta}$ where β is expressed by the equation $\beta = \frac{\varepsilon \cos. \sigma}{\alpha}$. In the latter σ denotes the distance of the luminous point from the system of lines

is constantly obtained for τ.* Therefore, as the equation shows already clearly enough, the value of $\varepsilon^2 - (\varepsilon \sin. \sigma (\pm \nu\omega))^2$ disappears against $4\, y^2$, it may therefore be neglected; and thence we obtain corrected:

$$\text{tang}\ \tau^{(\pm\nu)} = \frac{\sqrt{(\varepsilon^2 - (\varepsilon . \sin. \sigma \pm \nu\omega)^2]}}{\varepsilon . \sin. \sigma \pm \nu\omega.} \text{ or}$$

$$(\text{V.})\ \cos \tau^{(\pm\nu)} = \frac{\varepsilon . \sin. \sigma \pm \nu\omega}{\varepsilon}$$

These equations represent the experiments with non-symmetric spectra stated in page 112 of last Number as accurately as the equation III. does. In both cases the sign + gives the position of the coloured rays on one side of the axis, and the sign — that of the opposite side in the various spectra. In the comparisons it must not be forgotten, that in the experiments the distances were measured from the axis; but τ expresses the distance from the plane of the system of lines. It is hardly necessary to remark that in those special cases, when, for instance, the above equation is employed for the ray C, instead of ω, (C ω) is to be put: thus also, when it is employed for the ray D, (D ω) &c.

In these cases I denote the magnitude τ for the ray C with (C τ), for the ray D with (D τ), &c. The equation (V.) accordingly in these cases is this:

$$\cos (\text{C}\ \tau)^{(\pm\nu)} = \frac{\varepsilon . \sin. \sigma \pm \nu\, (\text{C}\ \omega)}{\varepsilon}$$

$$\cos (\text{D}\ \tau)^{(\pm\nu)} = \frac{\varepsilon . \sin. \sigma \pm \nu\, (\text{D}\ \omega)}{\varepsilon} \text{ \&c.}$$

When the rays fall *vertically* on the system of lines, sine $\sigma = 0$, and the equation (V.) becomes:

$$\cos.\ \tau^{(\pm\nu)} = \frac{\pm \nu\omega}{\varepsilon}$$

* I had also measured these angles with a telescope of four inches focus; but, as was to be expected, conformably with the equation, I found no other differences but those which may be attributed to an inferior telescopic power, and which are sometimes positive, and sometimes negative. If a curvature of the modified ray were to be observed where the distance of the luminous point is not large, then these experiments are subject to many difficulties, and demand a different and extremely perfect apparatus.

As in this case, cos. $\tau = \sin. \vartheta$, we have the equation (II.) page 110 last Number, which is directly derived from the experiments, whence those experiments confirm the theory. In *another medium* than air I denote the exponents of refraction, for instance, for the ray C with (C n), for the ray D with (D n), &c. That for such a medium in the above equation, instead of (C ω,) $\frac{(C\ \omega)}{(C\ n)}$, is to be put, instead of (D ω) $\frac{(D\ \omega)}{(D\ n)}$, &c. may be concluded from the experiments with light modified by mutual influence in the refractive medium. *

When the second surface of the glass containing the system of lines is coated with a black resinous varnish, which in its refractive power nearly equals glass, then no light can be reflected from this coated side, and then only the etched surface reflects light. Then, if, from an apparently very small aperture in a shutter, light reflected *from the etched side* falls on the object-glass of the telescope, exactly the same phenomenon appears as when the light under the same angle of inclination passes *through* the system of lines, non symmetric perfect spectra of the *second* class are seen. The intensity of these spectra is still so great that the distances of the various fixed lines can be determined with great accuracy. I have made an extensive series of experiments on the distances of these spectra produced by *reflection* under various angles of incidence, of which I here omit the details. The equation (V.) represents the aggregate observations as satifactorily as can be expected. In the developement of the general equation for the phenomena produced by reflection after the principles of interference, the same term is obtained as for light passing through, namely, without correction, the equation (III.) Consequently, the theory is also in this way confirmed by experience.

It is very remarkable that, under a certain angle of incidence, a portion of a spectrum produced by reflection consists of *entirely polarised light*. This angle of incidence varies greatly for the different spectra, and even still very perceptibly for the different colours of one and the same spectrum.

* *New Modification of Light,* &c. page 59, French translation, p. 94.

With the glass system of lines, where $\varepsilon = 0{,}0001223$ the ray $(E\tau)^{(+\text{I})}$, is polarised, that is, the green part of this first spectrum, when, $\sigma = 49°$; $(E\tau)^{(+\text{II})}$, or the green part in the second spectrum on the same side of the axis is polarised, when $\sigma = 40°$. Lastly, $(E\tau)^{(-\text{I})}$, or the green part of the first spectrum lying on the other side of the axis, when $\sigma = 69°$.

When $(E\tau)^{(-\text{I})}$ is completely polarised the remaining colours of this spectrum are but imperfectly so. This is less the case in $(E\tau)^{(+\text{II})}$, and σ may be perceptibly altered while that colour still remains polarised. $(E\tau)^{(-\text{I})}$ is under no angle of incidence so completely polarised, as $(E\tau)^{(+\text{I})}$. With a system of lines, in which ε is larger than in that just now mentioned, the angles of incidence must be totally different, if the above-mentioned spectra are to remain polarised.* It is seen from the equation (V.) that, when ε becomes $< \varepsilon \,.\, \sin.\, \sigma + \nu\omega$, $\cos.\, \tau^{(+\nu)} > 1$, therefore is impossible. With vertically received rays we must have $\varepsilon > \nu\omega$, if $\tau^{(\nu)}$ shall be still visible, that is, possible. If $\varepsilon < \omega$, *no coloured ray remains visible*, however the light may fall, and it remains only the white light in the axis—namely $\cos.\, \tau^{(0)} = \sin.\, \sigma$. Were $\varepsilon = \omega$, there would be $\tau^{(\text{I})} = 90$. If therefore a system of lines is made, in which the distances of the intervals between any two parallel lines is smaller than ω, no spectrum can be produced by it in any case, but only a white ray (the axis) becomes visible.

It is not easy to imagine that the polish which art can produce upon glass, &c. should be mathematically correct. If

* It would be premature, from an inconsiderable number of observations, to form conclusions respecting the laws of this phenomenon, for it is only by a number of systems of lines, in which ε is greatly varied, that it can be deduced with any certainty. Since it is not necessary in these experiments that the fixed lines of the spectra should be well distinguished, systems of lines may be made, in which ε shall be still considerably smaller, as in the finest glass system of lines that I have hitherto used. It is not improbable that the principles of interference may perhaps yet lead to a theory of the polarisation of light. This is not the place, nor is the time arrived for communicating my view of this subject. Fortunately there are still experiments of another kind possible, which seem to have a reference to this object, but they are, like the greater part of all the experiments relative to this subject, of a very delicate kind.

that polish consists of inequalities which, in reference to their distances from each other, are smaller than ω, they will be no disadvantage either to the light passing through, or to that which is reflected, nor can colours of any sort arise from them. It would likewise be impossible, by any means, to render these inequalities visible.* If small inequalities had acted upon the light, for instance, according to the law of reflection, the rays would become in the highest degree irregularly dispersed, because the curved diameters of these small inequalities cannot be otherwise than very small, and the regular reflection would be impossible. If a reflecting surface consists of inequalities, the distances from each other being less than ω, then, as I have already said, no spectrum is posssible, and only the light in the axis can return, for this ray $\nu = 0$, in which case the equation (V.) at the same time also represents the *law of reflection*, namely cos. $\tau^{(0)} = \sin \sigma$. This law also follows from the interference, and it is unnecessary to assume a reflecting power, that is vertical to the reflecting surface.† That more light is reflected with a larger angle of incidence than with a smaller, follows as plainly, and corresponds with experience. It is remarkable, that, according to the uncorrected equation (III.) at distances, from the reflecting surface which in comparison with ω are not great; that is, at very small distances the angle of reflection may differ perceptibly from the angle of incidence. From a proper examination of this equation, it will be easily seen that at those distances where one still can observe accurately the differences so small that no one will think of finding it by an experiment, and that thence the usual experiments for determining the law of reflection will prove nothing against its derivation from the theory of interference.

From all the experiments with the different systems of lines, it is clear that the distances of the spectra from the axis are larger in proportion to the smallness of the distance between

* From this we may conclude what it is possible to see through microscopes. A microscopic object, for instance, the diameter of which $= \omega$, and consists of two parts, cannot be recognized as consisting of more than two parts. This shows us the limits which are set to vision through microscopes.

† See Note A in page 260.

any two intermediate spaces, namely ε; and that if the spectra are to be homogeneous these spaces ε must be perfectly equal throughout the system of lines. If these distances are unequal, the larger ε will produce smaller spectra, and, on the contrary, the smaller ε large spectra, which, according to the degree of irregularity, will mingle with each other with great irregularity; heterogeneous colours can be no louger seen; and the light in the white room must be white, as is confirmed by experience. It is, however, interesting to know what phenomena would arise if the magnitudes of the intervals were regularly unequal, that is, if the inequality of the distances, whatever it may be, is regularly repeated in equal parts. For this purpose I have etched parallel lines in various ways regularly unequal upon several plates of glass covered with gold leaf. I can in this place only mention briefly some of the results of these experiments, which must be further prosecuted. The spectra which are seen through this system of lines by means of a telescope, consist of homogeneous light, and their fixed lines are most clearly perceived, so that their distances or divergences from the axis can be most accurately measured. If the distances between the centres of the intervals of regularly uneven systems of lines are expressed by ε', ε'' and so forth, and if one of the equal parts which consist of unequal ε'*s*, is expressed by $\varepsilon' + \varepsilon'' + \varepsilon''' \ldots . + \varepsilon^n$ then, according to the results of the experiments with light incident vertically, the distances of the various spectra from the axis will be represented by the following equation:

$$\sin \vartheta^{(\nu)} = \frac{\nu\omega}{\varepsilon' + \varepsilon'' + \varepsilon''' \ldots + \varepsilon^n}$$

The spaces ε, however, in the division consisting of unequal parts, which is represented by the divisor of the equation, may succeed each other, even if some among them are equal, still the equation remains always the same, but only when this division cannot again be divided into smaller ones, in which the spaces ε succeed each other exactly in the same order. This phenomenon produced by irregularly unequal lines is remarkable on account of the proportional intensity of the various spectra, upon which, however, nothing general can be deduced in this place with sufficient brevity, and without diagrams. With some systems of lines of this kind several spectra or parts of them may be wholly wanting, or have so slight an intensity that they are not easily observed, whilst the succeeding ones again become very intense. This affords the great advantage that the fixed lines of these spectra may be observed; in systems of lines, consisting of equal spaces ε C^{xii} and F^{xii} can be seen; with a regularly unequal system of lines, however, where every division consists of three shades ε, different among themselves, and are as 25 : 33 : 42; C^{xii}, D^{xii}, E^{xii}, and F^{xii} are so distinctly seen that their distances from the axis can be measured with certainty. For with such systems of lines the tenth and the eleventh spectra are almost wholly wanting. With this system of lines I myself saw E^{xxiv} still so distinctly, that its distance from the axis could be measured. The proportion of intensity of the different spectra depends on the proportion of the spaces, as they follow each other in one division. This in many cases is very complicated.* Similar regularly unequal systems of lines are obtained when two different systems of lines, that is, two in each of which the spaces ε are equal to each other, but in one larger than in the other, are so placed with the etched surfaces together that the lines shall run exactly parallel.

It cannot be uninteresting to produce perfect spectra of the second class which form *concentric* circles, and in which the fixed lines consequently appear circular. From what is already known, it may be easily inferred that such spectra must be produced when the system of lines consists of accurate circular concentric etched lines, in which the distances of the spaces between any two lines are in a high degree equal. With a machine which does not allow of any doubt as to the requisite accuracy, I have executed such an etching of circular lines, that when it is placed before the object glass of the telescope the light entering through a circular aperture in the shutter, and falling perpendicularly upon it, it shows concentric spectra in the telescope, which exhibits the fixed lines.† Their distances from the axis are in the same proportion as in the spectra, which are produced through the

* See Note B in page 262. † See Note C in page 262.

system of lines, consisting of straight parallel lines, and can therefore be expressed by the same equation.

NOTES ON THE PRECEDING PAPER BY THE AUTHOR.

Note A, see page 257.—The same view might perhaps also be applied to the surface of every *fluid*. If the smallest particles of which a fluid consists (the atoms) are not infinitely small, and if they have, however small they may be imagined, some magnitude, the surface cannot be mathematically even, and light can only be irregularly reflected from that surface, according to the principles of interference. There is no occasion to assume, as applies also to artificial surfaces, that there must be level surfaces again between these unevennesses. Nothing further is required than that the waves of light diverge from every single point, and they must, by their mutual influence, produce that which the equation expresses. This supposition will not be thought hazardous, if we consider that, for instance, from both the knife-like edges of a small aperture, the waves of light must in one sense diverge according to the interference, in order to produce spectra which may be seen through a single aperture, and that the knife-like edges, as experience teaches us, need not to be mathematically true. The *colours also of thin layers*, (the Newtonian *coloured rings*) may, under the same supposition that the surfaces consist of minute unevennesses, be deduced from the theory of interference. I have made a number of new experiments respecting these coloured rings, which, however, are not suited to a communication in this short report, and must be still further prosecuted. It is not improbable that the *angle of polarisation* of a refracting medium may perhaps give some clue concerning the magnitude of the smallest particles of this matter, as the experiments have shown ω is smaller in the refracting media than in vacuo. From this the *law of refraction* may be very simply deduced, as it has been ere now already explained, according to the system of undulations, since the pulses of the waves of light of a determined sort must repeat themselves under all circumstances at equal intervals of time; but as these waves are smaller in a refracting medium, the light requires in a refracting substance, in the same proportion, more time for its propagation. According to every hypothesis in which the matter is represented either as attracting or repelling the light, it is difficult to explain why the surface of a refracting medium attracts one portion of the light, while it repells another proportion, and even the auxiliary hypothesis of fits of the particles of light to facilitate refraction (or reflection) leaves yet many difficulties, when it is considered that one and the same refracting surface reflects more light in proportion as the angle of incidence of the received rays is greater, and that every refracting substance, when the angle of incidence approaches to 90°, reflects almost all the light falling upon it.

That a level but otherwise *rough* surface, which irregularly disperses the light which falls vertically upon it, should, at great angles of incidence, reflect the rays regularly, is very simply explained by *the interference.* The *colours of mother of pearl* are of the same nature as those which are produced by the reflection of light from the surface of a system of lines upon glass. Even if they were not by other means easily recognised as such, Dr Brewster's discovery, that a good impression of mother of pearl shows the same colours, and that, consequently, the cause lies in the surface, would prove it.

It consists also of particles or layers, which in one direction are larger than ω, and their magnitude may be very nearly derived from the angle under which the colours of any sort are seen.

Even those who do not adopt the system of undulations, will acknowledge, if they consider the results of the experiments in themselves, that ω is a real absolute magnitude. Whatever meaning may be attached to this magnitude, it must follow in every case of that nature, that one-half of it, in reference to the effect, is opposed to the other half, so that if an anterior half combines accurately with a posterior half, or intersects it in this manner under a small angle, the effect ceases, while it becomes doubled, if, for instance, two anterior, or else two posterior, halves combine in one sense. This, laid down as fundamental to *interference,* will remain unshaken, because through it alone these extraordinary varied phenomena, which are so capable of accurate definition, can be satisfactorily explained.

It is very probable that in the sequel experiments will make us acquainted with other properties of ω than those here named, and to which, among others, the polarisation of light seems to point.

Note B, see page 259.—From what is here stated, as well as from several of the remaining experiments, it must be obvious that many of these phenomena, at least in appearance, are so very complicated that they cannot be conveniently mentioned with brevity, and on that account I must omit many things that would be interesting. The field which offers itself for new inquiries widens in proportion as we advance in these experiments.

It is to be regretted that they can be but rarely repeated by any one, as they require extensive, and in some measure costly apparatus, and much time. The circumstance of these experiments requiring a very favourable state of the sky occasions a much greater loss of time than might be easily imagined. This I feel the more severely, as my professional avocations leave me but a few fixed days in each month for these investigations.

Note C, see page 259.—Those who are familiar with the relation of these phenomena will excuse me for adding an observation which may appear superfluous to them, but it has so often happened to me, that those to whom I have shown the appearances through a system of lines of any kind imagined that the system of lines itself was seen in the telescope, (an opinion in which the circular etchings still more confirmed them,) that I think it necessary to say a word concerning this error. We have only to consider which is the way taken by the light coming from any object through the telescope, and what the cause of seeing by means of a telescope is, to do away the notion that it is the object standing at the object glass which we observe through the telescope. Such a notion would not be much better than it would be to imagine, that, in looking through a telescope, we behold the object glass. Nothing is perceived, in looking through a telescope, of a finger placed on the object glass, and no more can be seen of the system of lines. The above is partly connected with what is more fully detailed in the note, page 103 of last Number.

Art. X.—*Remarks on the Climate of Naples and its Vicinity; with an Account of a Visit to the Hot Springs of La Pisavella, Nero's Baths.* By a Correspondent.

From what I have heard and seen, I am inclined to believe that the climate of Italy, if extensively and accurately investigated, would do more towards giving an insight into the general meteorological principles of nature than perhaps most other countries. There appear to be more certain consequences produced here by natural means than in Britain at least, and they are such as I have for some time thought the best foundation for a general theory of the weather. I therefore think that it may not be altogether without advantage to state some hints on the climate of Naples, which I have either experienced or learned during a residence there in November and December 1826. The following is an account I had of the weather of the present year: January and February particularly fine; March stormy; April and May cold and rainy; June cold to the 15th, when quite suddenly great heats commenced. (The great heats in Scotland began almost at this time). The remainder of the season rather colder than the mean. The winds have a very uncommon influence at Naples. My observations have strongly confirmed the following facts, which I obtained from another source: wind north, healthy and cool. It blows off the interior of the country, and is the best winter wind, prevailing, as I understand, in December and January. When the wind is east it is very strong and in hurricanes; it then blows from Vesuvius, the side of the bay next Sorrento, and the southern parts of Italy. Till it reaches the south or south-west point it is good; but on coming into these quarters it blows in direct from the bay, and produces that scourge of Italy and many other southern climes, called the Sirocco. This extraordinary air has the most debilitating and unwholesome effect on man, and of which the east wind and fogs affecting the neighbourhood of the Firth of Forth seem slightly to partake. A most powerful sirocco occurred with a south wind, on the 26th of November. The day was dull, damp, and showery, the sun obscured by clouds. At only ten in the morning the thermometer was sixty-five, and, if I remember right, rose little during the day, whereas the general height at the same hour for some time before might be 57° or 58°. At three in the afternoon the coolness produced by evaporation on the bulb of a thermometer freely moistened and exposed was only $2\frac{1}{2}°$, indicating for that period of the day a great degree of moisture in the atmosphere, which indeed was sufficiently evident. The effect of this condition of the air on man is an indescribable state of relaxation of faculties, corporeal and mental, while you feel as if you could do nothing but recline on a sofa. I have frequently, and on this occasion particularly, endeavoured to throw off this sensation, by taking a smart walk in the open air; but out of doors it was worse than within. Strolling listlessly by the sea shore, I felt my whole body moist with perspiration, while my mouth was parched with want of moisture. But what is most extraordinary, and will not easily be believed, or rather conceived, by those who have not felt it, a smart breeze was blowing off the water, yet I felt panting for breath, like Tantalus for the delicacies that surrounded him on every side. The wind was literally *hot* and insalubrious, like what we breathe in a crowded room. It was immediately after this, finding no refreshment in the air, that I ventured to the house, and made the experiment on evaporation mentioned above. There were showers during the day.

On the evening of the 22d November there occurred the most tremendous storm of thunder, lightning, hail, and rain, I ever witnessed. The thunder was produced in a manner I believe quite unknown in Northern climates, not in long continuous rolls of greater or less strength; but after a faint introduction it *burst* with repeated explosions like a *feu-de-joie* of large artillery *right over-head*, with a most stunning noise, and an effect the most imposing. The lightning, or as it might be called the thunder-bolt, was not less striking; the flashes were amazingly vivid, and traversed the sky in bending and flexuous lines to a great extent, and likewise in all directions, horizontal, perpendicular, and oblique. From its quantity being so great and the night so dark, its dazzling effect was excessive, and the illumination of the landscape most astonishing. The evening advanced, the peals and flashes were more reiterated, so that before the sound of one thunder clap was over, another had commenced, rolling round the horizon like cannon re-echoed by a long chain of hills, now falling, then strengthened by a new echo, and finally, as it seems dying away in distance, renewed by another explosion of redoubled fury. During this, and especially succeeding it, the rain fell almost like a water-spout, and the lower part of the large street of Naples was rolling with turbulence like a swollen river. Before eight a tremendous hail storm began; and it is a fact, that in thirty-seven minutes about that hour *nine-tenths of an inch* of rain and melted hail fell. Some time after the storm had ceased I measured several of the hailstones, and observed one of them half an inch, and several one-third of an inch in diameter.

While speaking of meteorological subjects at Naples, I may note one or two remarks on La Piseravella and Nero's Baths, or the Stufi di Tritoli, two very singular hot-springs in the vicinity of that city. The former is near Solfaterra, and in the side of a limestone hill. It rises rapidly from the ground, discharging a great deal of gas, which gives it the appearance of ebullition. On the 7th December, by an excellent mercurial thermometer of Cary's, the temperature of the exterior air was $48\frac{1}{2}°$, the interior of the building by which the spring is enclosed $70\frac{1}{2}°$, and the hottest part of the water $112\frac{1}{2}°$. This fluid is impregnated with sulphur, alum, and vitriol; the latter predominating so much that by the simple addition of galls, and by evaporation, I found that it formed very tolerable writing ink. In small quantity the water is clear, though the basin into which it rises appears very muddy. The baths of Nero are far more worthy of notice, and I regret that I had not convenient opportunity for making a second visit to perfect my observations. On the 11th December we entered extensive passages cut in the solid rock out of the hill on the sea shore, between Baiæ and the Lucrine Lake. Having partly undressed, to avoid the effects of perspiration and excessive moisture, we went along a passage in the rock three or four feet wide, and nearly straight and level for perhaps forty yards. At this point the road turned sharply down to the right, and here the heat and the atmosphere prodigiously loaded with steam were almost insupportable; but as we descended the steep inclined plane for nearly the same distance, it became more tolerable; and when we came to the spring which was the source of all this high temperature, I found that by keeping my head pretty near the ground, the disagreeable sensations were so moderated that I could have staid a considerable time without much inconvenience. I had in my hand a mercurial thermometer of Cary's, with which I found the temperature of the water, taking care to immerse the column of mercury, to be 183½°; but from previous experiments with a standard instrument by the same maker, (mentioned above,) I found that at this point the height ought to be diminished one degree, giving the final temperature 182½°. But it is proper to mention that the experiment was made near the edge of a pool into which the spring rises; and it did not at the moment occur to me that the interior may possibly be hotter. However, this is the less probable, as the atmosphere above the water is so hot and vaporous as not to communicate much coolness to any part of the cistern. Our guide taking some of the water in a pail put in a few eggs, and immediately carried them to the outer air, where, in spite of this sudden and effectual cooling, they were found, after about four minutes immersion, to be very pleasantly boiled. The effects of the atmosphere of this place was less felt by several persons present than myself. I was amazed by the sudden effect on my body which it produced, and with the slight disagreeable sensations which I experienced. My hands felt exactly as if perspiring by an excessive heat, which yet the moisture prevented from being painful; and I am sure in one minute's time their whole surface was not only bedewed, but streaming with moisture, which, of course, was a union of the condensation of vapour with the internal juices of the body. But what convinced me that more is attributable to perspiration than some are willing to allow, is, that I felt those clothes next my skin adhere to it, as every one has observed after very strong exercise, which could hardly arise from any condensation of exterior steam. In spite of the sudden entrance into the chill of the open air, I experienced no unpleasant consequences whatever; but, on the contrary, on re-embarking, I felt a most delightful glow over the whole of my body. I mention this particularly, because several of the guide-books, &c. strenuously condemn the practice of going into the stove, from motives of mere curiosity.

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Rome, *29th December* 1826.

Art. XI.—*On the Domestic Economy of the Romans in the Fourth Century.** By M. Moreau de Jonnes, Member of the Institute.

As the historians of antiquity have chiefly transmitted to us the military history of the Romans, the greatest erudition will scarcely enable us to collect any certain information respecting the civil life and the domestic economy of that celebrated people, to whom we owe the origin of our institutions, of our laws, and of our social order. A recent discovery has added to our information the most extensive series of statistical data, which make known from an official act, and by numerical figures, the state of the Roman empire 1500 years ago; the price of agricultural and ordinary labour; the relative value of money; the abundance or scarcity of certain natural productions; the use, more or less common, of particular sorts of food; the multiplication of cattle and of flocks; the progress of horticulture; the abundance of vineyards of various qualities; the common use of singular meats, dishes, which we think betrays a corruption of taste; in short the relation of the value existing between the productions of agriculture and those of industry, from whence we obtain a proof of the degree of prosperity which both had reached at this remote period.

This precious archaeological monument is an edict of Diocletian, published in the year 303 of our era, and fixing the price of labour and of food in the Roman empire. The first part of this edict was found by Mr William Banks, written upon a table of stone, which he discovered at Stratonice, now

* The very interesting Memoir, of which this notice is an abstract, was read to the Academy of Sciences on the 2d April 1827. It is entitled, *Aperçus Statistiques sur la vie civile et l'economie Domestique des Romains dans le 4me siecle.*—See *Le Globe*, Avril 7, 1827.

called Eskihissar, in Asia Minor. The second part, which was in the possession of a traveller lately returned from the Levant, has been brought from Rome to London by M. de Vescovali, and Colonel Leake intends to publish a literal translation of it. This agreement of so many persons of respectable character, and known talents, excludes all doubts respecting the authenticity of the monument.

Although it was known from Aurelius Victor that Diocletian had made in the year 302 and 303 several laws in order to provide abundance of provisions in Italy, and particularly at Rome, they did not know that he had by an edict fixed a maximum price of labour and of provisions.

Nevertheless, there were many examples which showed that his predecessors and himself had believed it to be their duty to fix the price of things upon their own authority. M. Moreau de Jonnes quotes on this subject a great number of facts mentioned by historians, and which tend to show what wrong notions the most enlightened of the Cæsars entertained respecting the right of property, the liberty of commerce, and the prosperity of agriculture.

The imperial edict of Diocletian is composed of more than twenty-four articles. It is quite distinct from that delivered the preceding year for taxing the price of corn in the eastern provinces, and it contained no law upon the value of corn. It fixed for all the articles which it enumerated a maximum, which was the price in times of scarcity. For all the established prices it makes use of the *Roman Denarii;* and it applies them to the *sextarius* for liquids, and to the *Roman pound* for the things sold by weight.

Before the Augustan age, the *denarius* was equal to eighteen sous of our money; but it diminished gradually in value, and under Diocletian its value was not above nine sous of French money, and 45 centimes. The Roman pound was equivalent to twelve ounces, and the *sextarius*, which was the sixth part of a conge, came near to the old Paris chopin, or half a litre.

Proceeding on these data, M. Moreau de Jonnes has formed a table, showing 1. the maximum in Roman measures, the same as the established imperial edict; and 2. the mean price of objects *formed from* half the maximum, and reduced into French measures.

He has been led to adopt half of the *maximum* for the *mean price*, by the consideration that it has always been agreed upon that a state of scarcity begins when the price of provisions rises to double the value which they bear in ordinary times.

In our own times, for example, foreign corn is allowed to be imported by the corn laws of France and England, whilst in the former of these countries, the hectolitre of corn is worth twenty-six francs, instead of twelve or thirteen, and whilst in the British islands the quarter of corn rises to eighty shillings, instead of forty or fifty.

In 1793, on account of the price of provisions being already double, the convention chose, like Diocletian, to fix their value at this limit, and to hinder it from going beyond it.

If, in spite of these analogies, it should be thought proper to establish another ratio between the maxima and the ordinary price of labour and of provisions, this table will nevertheless be a faithful expression of the price of articles of that period; for as the imperial edict settled not only the prices of eatables, but also of labour, their reciprocal relation will always be the same, whether they raise or lower their nominal value, and the intrinsic value of commodities will be known by comparison with the value of labour, which is the most exact, and the most certain expression of it.

The following is the table drawn up by M. Moreau de Jonnes. The slightest inspection of it will enable us to appreciate the importance of this archaeological discovery, for no monument of antiquity has furnished so long a series of numerical terms, of statistical data, and positive testimony of the civil life and domestic economy of the Greeks and Romans.

I.—Price of Labour.	Maximum in Roman Money.	Mean Price in English Money. L.	s.	d.
To a day labourer, - -	25 Denarii.	0	4	8
Do. for interior works, -	50	0	9	4
To a mason, - -	50	0	9	4

	Maximum in Roman Money.	Mean Price in English Money. L.	s.	d.
To a maker of mortar, -	50 Den.	0	9	4
To a marble-cutter, or maker of mosaic work, - -	60	0	11	4
To a tailor for making clothes,	50	0	9	4
Do. for sewing only, -	6	0	1	1½
For making shoes for the Patricians, *(calcei,)* - - -	150	1	8	1
Do. shoes for workmen, *(caligæ,)*	120	1	2	8
for the military,	100	0	18	8
for the senators,	100	0	18	8
for the women,	60	0	11	4
Military sandals, *(campagi,)* -	75	0	14	0½
To a barber for each man,	2	0	0	4½
To a veterinary surgeon, *(mulo-medicus,)* for shearing the animals, and trimming their feet,	6	0	1	1½
Do. for currycombing and cleaning them, - - -	20	0	3	9
For one month's lessons in architecture, - -	100	0	18	8
To an advocate for a petition to the tribunal, -	250	2	6	9
For the hearing a cause,	1000	9	7	6

II.—Price of Wines.	Maximum of the Sextarius.	Mean price of the English Pint, Wine Measure. L.	s.	d.
Picene, Tiburtine, Sabine, Aminean, Surentine, Setinian, and Falernian wines, -	30 Den.	0	5	4
Old wines of the first quality,	24	0	4	2¾
Do. of second quality,	16	0	2	10
Country wine, - -	8	0	1	5
Beer, *(camum,)* -	4	0	4	2¾
Beer of Egypt, *(Zythum,)*	2	0	0	2
Spiced wine of Asia, *(carœnium Mœonium,)* - -	30	0	5	4

	Maximum of the Sextarius.	Mean Price of the English Pint, Wine Measure.		
		L.	s.	d.
Barley wine of Attica, -	24 Den.	0	4	$2\frac{3}{4}$
Decoction of different raisins, *(decoctum,)*	16	0	2	10

III.—PRICE OF MEAT.	Maximum of the Roman Pound.	Mean price of the French Pound.		
		L.	s.	d.
Flesh of oxen, - -	8 Den.	0	2	0
Do. of mutton or of goat, -	8	0	2	0
Do. of lamb, or of kid, -	12	0	3	0
Do. of pork, - -	12	0	3	0
The best lard, - -	16	0	4	0
The best ham from Westphalia, from Cerdagne, or from the country of the Marses, - - -	20	0	5	0
Fat fresh pork, -	12	0	3	0
Belly and tripe, -	16	0	4	0
Pig's liver *(ficatum)* enlarged by being fattened upon figs, -	16	0	4	0
Pig's feet, each, - -	4	0	0	9
Fresh pork sausages, *(isicium)* weighing one ounce, - -	2	0	0	$4\frac{1}{2}$
Do. of fresh beef, *(isicia)* -	16	0	2	$9\frac{1}{2}$
Pork sausages and seasoned, *(lacanicae)*	16	0	4	0
Do. of smoked beef, -	10	0	2	$9\frac{1}{2}$

IV. POULTRY AND GAME.	Maximum of each in Roman Money.	Mean Price of each in English Money.		
		L.	s.	d.
One fat male peacock, -	250 Den.	2	6	9
One fat female peacock, -	200	1	17	9
One male wild peacock, -	125	1	3	$4\frac{1}{2}$
One female wild peacock, -	100	0	18	8
One fat goose, - -	200	2	6	9
Do. not fat, - -	100	0	18	8
One hen, - -	60	0	11	4
One duck, - -	40	0	7	4
One partridge, - -	30	0	5	8
One hare - -	150	1	8	1
One rabbit, - -	40	0	7	4

V. FISH.	Maximum of each in Roman Money.	Mean Price of each in English Money. L.	s.	d.
Sea fish, first quality, -	24 Den.	0	4	6
Do. second quality, -	16	0	3	0
River fish, first quality, -	12	0	2	3
Do. second quality, -	8	0	1	6
Salt fish, - -	6	0	1	1½
Oysters per hundred, -	100	0	18	8
VI. CULINARY VEGETABLES,				
Lettuces, the best, five together,	4	0	0	9
Do. second quality, ten together,	4	0	0	9
Common cabbages, the best, single,	4	0	0	9
Cauliflower, the best, five together,	4	0	0	9
Do. second quality, ten together,	4	0	0	9
Beet root, the best, five together,	4	0	0	9
Do. second quality, ten together,	4	0	0	9
Radishes, the largest, -	4	0	0	9

VII. OTHER PROVISIONS.	Maximum of the Sextarius in Roman Money.	Mean Price of in English Money. L.	s.	d.
Honey, the best, -	40 Den.	0	15	0
Do. second quality, -	20	0	7	6
Oil, the best quality, -	40	0	15	0
Oil, the second quality, -	24	0	9	1
Vinegar, - -	6	0	2	3
A stimulant to excite the appetite, made of the essence of fish, (*liquamen*) - -	6	0	2	3
Dried cheese, the Roman pound,	12	0	3	4 Fr. lb.

We are much surprised at the very high prices in this table. Labour and provisions cost ten and twenty times as much as with us. But when we come to compare the price of provisions with the price of labour the dearness of all the necessaries of life appears still more excessive. M. Moreau de Jonnes makes this comparison. He brings together from the edicts of Dicocletian a great many facts given by historians, and he shows, that, if the abundance of the precious metals has any influence on raising the prices, the want of labour, industry, and of produce, must cause it also.

These considerations point out in the strongest manner the poverty of this royal people, of whom two-thirds, if not three-fourths, were reduced to live on fish and cheese, and drink piquette, when the expence of the table of Vitellius amounted, in a single year, to 175 millions of francs.

ART. XII.—*Account of the Periodical Comet of* 1819 *that revolves within the orbit of Jupiter with a period of* $3\frac{1}{3}$ *years.* *

TILL lately there had been but one comet whose return to its perihelion has been observed, and whose periodical time is known. This is the comet of 1682, which occupies about seventy-six years in performing its whole revolution. Halley discovered it to be the same with one which had already been observed, at two other epochs, in 1531 and 1607, and he predicted its return in 1758 or 1759. At this latter epoch, and before the comet had become visible, Clairaut calculated the instant of its passing its perihelion, having regard to the disturbances in its elliptical motion. The result of that immense labour differs only a few days, as is well known, from the time of the observed passage, which took place on the 12th of March 1759. This remarkable phenomenon of the re-appearance of a comet at its perihelion, after one or more revolutions, has also occurred in our time with respect to the comet discovered in 1818 by M. Pons, who at that time observed it at Marseilles. The comparison of its parabolic elements with those of a comet observed in 1805 leads to the suspicion that the two bodies are the same. The remark was made at the Bureau des Longitudes, by M. Arago, when the discovery of the new comet was there announced; it was also made in Germany by M. Olbers, who thought, moreover, that this comet must be the same with that which had been observ-

* This Article is composed of part of the Report of MM. Laplace, Legendre, and Poisson, upon M. Damoiseau's Memoir on this comet, and part of the Memoir itself.

ed in 1795 and 1786. According to this conjecture its time of revolution can be only a very short period, and it is indispensably necessary to have regard to the ellipticity of its orbit in the calculation of its elements; this is done by M. Encke, astronomer at Gotha. The elliptic elements which he determined, either from the observations of 1805, or those of 1818, differ from each other still less than the parabolic elements, and there is no longer any doubt that they belong to the same body, the periodic time being nearly three years and a half. It has performed since its first appearance in 1805 four entire revolutions, and returned to its perihelion at the commencement of 1819. If we regard only the shortness of its successive revolutions this body might be considered a planet; but it has continued to be classed among comets on account of the appearance it presents, and its not being visible to us in all parts of its orbit. To facilitate the observation of its return in 1822, M. Encke proposed to calculate an ephemeris relative to that epoch; but as the comet was for a great part of this new revolution at a very small distance from Jupiter, he was obliged to calculate the perturbations produced by the disturbing force of that planet, and he found, in fact, that, in consequence of this principal action, the time of anomalistic revolution, the mean duration of which had been about 1204 days, from 1805 to 1819, would be augmented by about nine days in the following revolution. He announced that in 1822 the comet, in consequence of its declination, would not be visible in Europe, and that, in order to observe it, it would be necessary to go into the southern hemisphere. The event has completely verified this prediction. The comet returned to its perihelion in the latter part of May 1822. The elliptic elements deduced from this re-appearance agree in the most satisfactory manner with those calculated by M. Encke before the appearance of the comet, according to former observations, making allowances for irregularities produced by disturbing forces. Although this important calculation of M. Encke was well known, the academy which awarded to him, three years ago, the astronomical prize, founded by La Lande, we have thought it proper to mention the principal results before we make known what M. Damoiseau has added in the memoir we have submitted to your examination.

The first part of this memoir was presented to the academy the 16th of February last, and the second part the 26th of April. In the first part, M. Damoiseau, speaking of the elliptic elements calculated by M. Encke for the epoch of 1819, determines the perturbations which they have undergone from that epoch to 1822. The elements which he has deduced for this last epoch differ but little from those of M. Encke, which we have already cited; and it could not be otherwise, because, having both adopted the same data, the difference in their results must be owing to the difference in the methods they pursued. The duration of the anomalistic revolution of 1819 and 1822 being nevertheless known by observation, M. Damoiseau has made use of it in order to rectify the daily motion of 1819, of which he had already availed himself. He decided at the same time the mean daily motion of 1822, which was necessary to enable him to calculate the perturbations of the comet, from its first appearance to its next return to its perihelion. In this new calculation, M. Damoiseau makes use of the elements of 1822, deduced from the observations at Paramatta. The perturbations of this revolution are much less considerable than those that happened before, and the duration between two consecutive passages through its perihelion will be about 1212 days like the preceding. M. Damoiseau fixes the next return of the comet to its perihelion on September 17, 1825. He gives for that epoch its elliptic elements, and he assigns the places which it will occupy in the heavens during the time of its appearance; but thinking that it will then be too near the sun to admit of observations being taken, he has proposed to calculate the epoch of its following return, and its ephemeris for that epoch. These calculations are the subject of M. Damoiseau's second memoir. The second return to the perihelion which he has determined will take place January 10, 1829; and the author announces that the comet, according to his ephemeris, will be visible in every part of Europe. The time between this passage through the perihelion and that of 1825 will be very nearly 1211 days, or only one day less than the period of the preceding revolution.

The second part of the memoir of which we have been speaking contains also the calculation of the perturbations of the comet from its appearance in 1805 to its return in 1819. Thus the entire interval of twenty-four years, which the author has embraced in his calculations, comprehends three observed passages through the perihelion, and the two nearest returns to that point. The comparison of the three observed passages furnishes, for the epoch of each one of them, three values of mean daily motion, which differ but little from each other. The author has concluded for the last appearance upon the mean of these three values, by uniting with this the other elliptic elements calculated according to the observations at Paramatta. He has formed a table which may be regarded as containing the definitive results of all his labours, and in which he has collected the elliptic elements answering to five passages through the perihelion, comprehended in the twenty-four years which he had been considering. If we compare these elements, relative to the years 1805 and 1819, with those which are derived from actual observation made at those epochs, it will be seen that they agree in such a manner, that the greatest deviations are but one minute in the longitude of the perihelion, five in that of the node, and two in the inclination of the orbit; but this comparison is not the best means of ascertaining the degree of exactness in the results obtained by M. Damoiseau. To judge of it properly, it will be necessary that the author should calculate according to the elements, the places of the comet in these two epochs, in order to compare them with the places which have been directly observed.

M. Damoiseau has followed, in the calculation of the perturbations, the known method which consists in dividing the entire curve described by the comet, into portions, for each one of which we determine the effect produced by the disturbing forces of the planets. In the first part of his memoir these portions answer to angles of 10° of eccentric anomaly. In the second part he has preferred to take intervals of time nearly equal to each other, and each about thirty days; but in both cases he is confident that he can, without any sensible error, observe in each portion of the orbit the variations of the mean motion as proportional to the square of the time, and those of the other elements as proportional to its first power. However, we should observe that, if it were necessary to have regard to higher powers of this variable quantity, that the formulas which the author has given for this purpose in the beginning of his memoir would not be exact, and that it would be necessary to recur to the ordinary formulas of quadratures. Although the interval of time comprehended between the appearance of 1805 and that of 1819 comprises four revolutions of the comet, M. Damoiseau, in calculating the disturbances which have taken place in the course of that period, has always retained the same values of the primitive elements. It would nevertheless have been proper to change them, at least every revolution, taking into consideration each time the preceding disturbances. This is a point which it will be sufficient merely for us to mention to the author, if he proposes to review and complete his work.

In the period of twenty-four years which the author has observed he has constantly computed the action of Jupiter, and the action of the Earth and Venus only in that part of the period in which the comet is so near that this action is perceptible. As to the other planets, he has thought he might neglect their action, which he has regarded as imperceptible on account of their distance, or the smallness of their size. He thought, moreover, that he had no occasion to extend his calculations to the epochs of 1795 and 1786, in which the same comet had been observed, because he considered those observations not very exact, or not sufficient to determine the elements of the orbit. M. Encke, on the contrary, was desirous to represent these early observations; but he discovered that in the observed right ascensions and declinations, it would be necessary to suppose errors, the mean of which would amount to twenty-four minutes, and this he judged to be inadmissible. To explain these differences between the results of calculation and observation, M. Encke thought that it would be necessary to recur to the resistence of ether; and he has announced in a late number of M. de Zach's Astronomical Correspondence, that by taking into account this tangential force, and making a suitable supposition in relation to its intensity, these great differences might be made to disappear, or at least be so far reduced, as to be attributable to errors in the observations. There is no doubt, that, if the celestial bodies moved in a resisting medium, the effect of that resistance would be more sensible in the motion of comets than in that of the planets, as at the surface of the earth we perceive that the resistance of the air has most effect upon the motion of those bodies having weight, whose density is least; and it actually is known that the density of comets is incomparably less than that of the planets; but if the comet, which has been the subject of consideration, is destined to exhibit to us in the heavens the effects of a force, of the necessity of which no other phenomenon has ever yet made us sensible, it must require a great number of revolutions of that body to establish with any probability so delicate a point in astronomical science.

The calculations to which M. Damoiseau has devoted himself, with a zeal worthy of all commendation, have already given, with a great degree of exactness, the motion of the comet of 1819.

The following are the general results which he has obtained.

Passage to Perihelion.	Eccentric.	Longitude of Perihelion.	Longitude of Node.	Inclination of Orbit.	Mean daily Motion.	Semi-major axis.
1805 Nov. 22,006	0,8464567	156°43′ 0″	334°18′29″	13°35′44″	1073″4877	2,218912
1819 Jan. 27,752	0,8484517	156 59 1	334 27 36	13 38 33	1076 7791	2,214388
1822 May 24,494	0,8445479	157 11 29	334 19 32	13 22 25	1069 4158	2,224542
1825 Sept. 17,084	0,8449784	157 14 30	334 22 8	13 23 29	1070 0866	2,223611
1829 Jan. 10,867	0,8446862	157 18 35	334 24 15	13 22 34	1069 5462	2,224360

In order to facilitate the discovery of the comet in 1828, when it will be visible throughout all Europe, M. Damoiseau has computed the following ephemeris.

	Right Ascension.	Northern Declination.	Distance of the Comet from the Earth.	Distance of the Comet from the Sun.	Intensity of Light.
1828. Aug. 28,159	26°35′	23°17′	1,487	2,175	0,096
Sept. 7,175	25 47	24 58	1,276	2,073	0,143
17,161	23 30	26 29	1,089	1,967	0,218
27,183	19 24	27 50	0,920	1,855	0,344
Oct. 7,191	12 57	28 43	0,774	1,737	0,552
17,162	3 52	28 36	0,658	1,614	0,886
27,157	352 33	26 51	0,574	1,483	1,380
Nov. 6,173	340 23	23 13	0,521	1,345	2,033
16,171	329 1	18 13	0,494	1,198	2,851

Art. XIII.—*Observations on Caverns containing Bones, with an account of the Grotto of Oiselles, near Besançon.** By Baron Cuvier.

The existence of caverns containing bones constitutes one of those natural phenomena which are the most curious and interesting in science.

The cavern of *Oiselles* is of the same description as many of those which are found in the mountains of Hungary, Germany, some parts of France and England, and all of which contain more or less immense quantities of the bones of terrestrial animals, the greater part of which are foreign to our climate.

Since the middle ages the caverns of *Harsh* have been always celebrated both on account of their magnitude, and for the great quantities of bones found in them.

These bones are sold to the druggists by the name of *unicorn fossils*, and they make use of them in medicine under the name of *powder of fossil unicorn.*

The caverns in the mountains of Crapack in Hungary were described in the seventeenth century. Towards the middle of the eighteenth century, those of *Friehleberg* in Franconia became objects of inquiry amongst several learned men, who have described the bones with some accuracy. At the beginning of the present century the caverns of Westphalia became known, and still more recently many have been discovered and described in Carniola. Within the last few years several have been found in England and Wales, and which having been examined with more care than any of the others, they have furnished an astonishing quantity of bones of different species. Professor Buckland, who has studied the English caverns and the remains of the animals they contain with the most particular attention, wished to give an account of this great phenomena in all its generalities. For this purpose he travelled through different parts of Germany and inspected all the grottos,

* This interesting paper, translated from *Le Globe,* was read at the Academy of Sciences on the 16th July 1827. It is the report of a commission, composed of MM. Brongniart, Beudant, and Cuvier on the bones collected in the grotto of Oiselles, and sent to the Academy by the prefect of the department of Doubs.—Ed.

drew plans and outlines of them, and published upon the subject a work full of interest, which he has called *Reliquiæ Diluvianæ.*

It is to this profound geologist we are indebted for the discovery of the bones in the cavern of *Oiselles.* It was indeed natural to suppose that the Jura would contain the remains of these animals, as it is a continuation of the Alps of Suabia, and the cavernous mountains of Franconia, and contains itself many of these excavations, and is also as celebrated for its stalactites as any of the mountains of Germany. They had already collected in a cleft of a rock at *Fouvent*, in the department of the upper Saone, the bones of several of the animals found in the English caverns; but nobody having continued to follow up this discovery, all this was a matter of conjecture.

Mr Buckland, while visiting the cavern of *Oiselles*, which had long been an object of curiosity, both on account of its magnitude, and of the brilliant stalactites with which it is adorned, observed that it had all the appearances of the caverns of bones in Franconia. He even thought he observed a part where the bones were very near the surface, and, upon trying it with the hammer, he had the pleasure to find his conjecture verified.

The prefect of Doubs took all the interest in this natural curiosity which it justly deserved, and the examination which he ordered, and which was conducted with the greatest zeal by *Mr Gévril*, keeper of the cabinet of Besançon, has proved that this cavern contains a quantity of bones as surprising as any of those of Franconia.

A certain quantity of these fossils was sent to the Museum at Paris, and it was easy to determine to what species they belonged. "That which has surprised us," says M. Cuvier, "is not that they belong to the great bear with the protuberant forehead (*front bombé*) which naturalists particularly call the bear of the cave (*Ursus spelæus*) because they have never found their remains anywhere but in similar grottos to that of *Oiselles*, but that they should *all* belong to that species."

M. Cuvier presented some of the specimens to the academy. They consisted of two heads quite entire, one humerus, a part of the scapula, a cubitus, a radius, a pelvis nearly entire, a femur, a tibia, an astragalus, one os calcis, several bones of the carpus and of the tarsus, the bones of the metatarsi and of the phalanges. All these bones evidently belonged to the genus *Ursus*. With respect to determining the particular species, it was not difficult, because they possessed an entire skull of the *Ursus spelæus* taken from the cavern of Westphalia, and which M. Cuvier exhibited also to the academy. This skull differed only from those of *Oiselles* by being rather larger.

This grotto presents the very remarkable exception that no remains were found along with the bones of tygers, hyenas, nor any of those herbivorous animals contemporary with these ancient races, whose usual presence in these sort of caverns has been attributed to the voracity of the hyenas, who had dragged them there for the purpose of devouring them.

Without entering into any discussion respecting the formation of these caverns, or of the manner in which they account for the presence of the bones found there, M. Cuvier is of opinion that the bones belonged to animals who lived there and died peaceably.

The undisturbed state of the remains prevents the supposition, that they have been brought there by any currents of water, or by any other means. These remains must have been accumulated for a long time, and at last were buried in the mud which has been thrown there by some great inundation It is impossible to doubt this, when we see that the bones have preserved all their sharp and delicate points, and if some few of them are otherwise, it is those which have been broken by the teeth of similar animals, or injured by the tools of the workmen. The thin flat bones are almost always broken in these caverns; but this is owing to their being so fragile that the weight only of the animals walking or lying upon them would be sufficient to break them.

It seems very certain that at some time or other the water has penetrated into the cavern of Oiselles, and carried there some fossil bones, which are found mixed and buried along with some rounded flints; but this peculiarity is only to be seen at the entrance. Gradually as you advance the bones are in better preservation; and at 400 yards from the opening they are found in a state perfectly undisturbed. Those which were sent to Paris were collected at this distance. They have not extended their researches beyond this; but it is to be hoped, for the interest of science, that they will not stop there. The cavern is 700 yards deep; we may then expect from the interior works an additional mine of geological riches.

The report concludes by stating, that it will be proper for the Academy to request the prefect of the Doubs, and the Minister of the Interior, to have the goodness to give the necessary orders to continue the excavations, and that the Academy should itself propose to defray part of the expence.

Art. XIV.—*Notes regarding a Cavern containing Fossil Bones, situated on the property of M. Gautier, in the Commune of Lunel-Viel.* * By Dr Alphonso Menard. Communicated in a Letter from Mr Exshaw of Bourdeaux to John Robison, Esq. F. R. S. Ed.

Near the west end of the village of Lunel-Viel there is a quarry of building stones, the working of which has been given up about thirty years, immediately above on the rising grounds which produce the Lunel wine. The villa of M. Gautier is situated on the verge of the quarry, and a part of his garden is laid out in the hollow made by the excavations. There are two principal cavities in the face of the rock. The greatest extends about 130 or 140 metres. It is naturally formed in calcareous masses of shells, coarse and friable, mixed with globular fragments, scattered in abundant beds towards the outer surface, and enveloped in a cement of the same nature.

The floor of the cavern is encumbered by large blocks, which have long since fallen from the roof. The soil is formed by the deposition of an argillo-siliceous matter, spread in distinct layers from one to several inches thick. This sediment, the produce of repeated alluvion, is evidently of posterior formation to the surrounding limestone. It lies above the primitive soil, which is again found at a depth of 10 or 15 feet, and which is a gravelly sand, containing shark's teeth, and remains of sea and river shells. It is in the bed above the last mentioned stratum that we find, in a confused and disorderly manner, a

* Numerous specimens of the bones accompanied this communication. They are now in the possession of Thomas Allan, Esq. F. R. S. E.

considerable quantity of fossil bones, which have belonged to animals contemporary with the last great catastrophe which has overturned the globe. All of them may be ranked with existing species, mostly of Europe, and many of the province itself.

The opening into the cave is the only one which gives access to its interior. Is about 20 feet below the upper vegetable soil.

In 1824 the opening was very confined, and gave access only to a small square space hollowed out of the bed containing the fossils. It is not probable that the animals whose remains we are about to describe could ever have taken this way to get to the interior. M. Gautier has caused this opening to be widened and cleared.

In 1825 the process of digging for bones caused some falling in of stuff, in consequence of which access was obtained to the cavern. It is now reached by means of a stair of twenty steps, formed of calcareous blocks.

When first discovered, the ground was found slightly moist, uneven, and furrowed near the sides to unequal depths. Remains of the skeleton of a domestic dog rested on a block of stone; near it lay a fragment of a leather collar and an iron ring. Here and there also were bones of animals of the order Rodentia (gnawers) which had died at different periods, and several remains of the bony frame of carnivorous mammalia evidently fossil. A small portion of them was covered with irregular crystallizations, which rendered them slightly adherent to the ground. All these objects have been destroyed and scattered.

There was no indication of the cave having been entered by man previous to this period, or of the blocks of stone or the bones having been accumulated by human agency.

The cave extends from N. W. to S. with some slight bends. The roof appears solid throughout, and towards the middle is arched with a certain degree of elegance. The side walls are irregularly fashioned in unequal projections, sometimes deeply furrowed and penetrated by oblique or vertical chimnies, from which has issued a reddish, soft, argillaceous paste, (a sort of Armenian bole,) of which the upper parts seem exhausted, as it has ceased to flow.

In some places, and principally at the south end, the soil is formed of a thick layer of fine yellow sand, free from clay or pebbles; it is very loose, and affords no animal deposit, except a few spiral and bivalve shells of fresh water origin. This cave does not abound in crystallizations. At its south extremity there are a few horizontal bands of stalactites, which offer nothing remarkable, and terminate when they approach the ground in acicular crystals, of a beautiful milky white when inspected closely, but adding nothing to the general effect of the surrounding masses.

The air of the cavern seems to have no other outlet than that first mentioned, yet one breathes freely all over it, and the flame of a lamp is every where full and bright, but always vertical. The interior temperature has no sensible variation, as throughout the year the thermometer stands between 13° and 14° Reaum.

Everything in this cavern attests the presence of a fluid solvent, of which the action has been powerful and continued. Indications are likewise found of a current of water. Its existence is proved by an evident slope from N. to S., and a sandy soil. At the supposed origin of this current the rock is bare, and washed for the length of some metres. The current does not appear to have been strong, for in the *cul de sac* which I examined there is no appearance of its impulse having raised the argillaceous deposit.

The air in the cavern is moist. To this may be attributed the abundant efflorescence which is found on the surface of the vault. This is of an earthy colour, and falls into powder on the slightest touch. The fossils are imbedded in fresh water alluvium,—at least the deposit offers nothing but some *Helices*, one or two land-shells, and some fragments of river bivalves. There are also some vegetable matters completely carbonized, and of which the species cannot be distinguished. Below this, as we have said, is found the primitive soil, which, along with some rare debris of marine shells, contains teeth of a small sort of shark.

The bones appear to exist in one part only of the cave, on the left of the entrance. They are heaped confusedly together, sometimes entire, often broken and mutilated, but never worn or rounded. The operation of digging for them, though difficult on account of the great softness of the clay, has been successful. A superficial examination has already allowed us to recognize more than twenty species. At the moment of uncovering the bones, they are singularly soft. Even teeth which appear well preserved do not resist a slight pressure. Exposure to the air soon hardens them. The earth in which they lie is reddish, and is formed of horizontal layers of clay and sand. It extends about twenty-five or thirty feet in length, with a depth of nine or ten, and its breadth a little less. The bones are most abundant near the rock. A further proof of the current of water before spoken of is a branch of twenty feet long, with an opening of three feet, containing a great quantity of bones, and but little mud.

It is worthy of remark that not the smallest fragment of human bone has been found.

Subjoined is a note of the species hitherto recognized.

Hyena, (two varieties,)	Bat,	Deer,
Lion,	Rabbit,	Ox,
Wild Cat,	Hare,	Sheep,
Bear,	Mouse,	Shark,
Dog,	Rhinoceros,	Sea Tortoise,
Fox,	Horse,	Tarsus of a Wading bird.
Badger,	Wild Boar, (two varieties,)	

In all twenty-one species.

M. Marçel de Serres possesses lions' teeth got in the first search. A young man, who is publishing a work on fossil bones, says he has a lion's lower jaw from the same source. I have not seen these specimens, and feel surprised that the careful searches made under my own direction have not discovered any similar ones.

The hyenas' bones are numerous. They consist in skulls and jaws (upper and under) nearly entire, long bones, teeth, vertebræ, &c. The heads display the prominent sagittal crest peculiar to this animal, a zygomatic arch of great strength, and a corresponding depression for the reception of an enormous masseter muscle. The appearance of this part gives a high idea of the masticatory power of the hyena.

The bones of the bear are more rare. They have been principally found in a cavity situated in the same calcareous mass as the principal cavern, but having no communication with it. They consist of grinders and canine teeth, and parts of jaws.

The insectivora are Vespertilios, of which one variety is remarkable from its small size, and for the number and shape of its teeth.

Of gnawing animals, (*Rodentia*,) there is a species of hare, which, (judging from a head which has been found) is smaller than that of our hills and plains.

Of the rhinoceros we possess only a fragment of an upper jaw with three grinders attached, separate teeth mostly broken, a broken humerus and femur, and some astragali, which their peculiar hardness has preserved from destruction

Boars' tusks of 11 and 12 inches long, (Fr.) bespeak a powerful animal. Others, on the contrary, only 2 or 3 inches long, show, by the marks of use, that they belonged to individuals which had attained maturity.

A horse's head is remarkable for its large proportions, and for its teeth of uncommon size.

We have found several foreheads of deer with the antlers, which could not be removed entire, on account of their extreme fragility; some teeth, some long bones, and skeletons almost entire; they belong to the *Cervus elaphus*, L.

An under shell of a land tortoise, 7 inches long by 4 wide, preserves nothing but its shape, its polish and natural appearance being gone. Near it were found several fragments of the upper shell of the same animal.

It will be observed from what precedes, that our collection does not contain any of those large antediluvian animals described by M. Cuvier, and which are found in many other natural cavities. We have no indications of the great Saurians, the mastodon, not even of the tapir or the elephant, which are common in other places. This collection, however, does not the less deserve to fix the attention of the naturalist.

I conjecture that, at a very distant epoch, the rising grounds of Lunel-Viel were covered by vast forests. I shall be allowed this hypothesis, which is deducible from circumstances in the primitive constitution of our vegetable soil. All the animals of which we find the remains may have lived on the skirts or in the interior of these forests. It is true that the lion, the hyena, and rhinoceros, no longer inhabit Europe; but the considerable collections of their bones which are found in France, in Germany, and in England, seem to attest their having formerly existed there. All these animals die where they have lived. Many of them at the approach of death betake themselves to hidden retreats, as if to withdraw themselves from the rapacity of the carnivorous ones. Such, for instance, are the deer, of which nearly entire skeletons are found, although the parts be disseminated; such also are the great carnivorous animals, as the lion, the bear, the hyena, which seize their prey in the dark, and carry them away to devour them in the cavities which serve them for dens. Everything in the Gautier cave attests the prolonged stay of these large Carnivoræ. Among the heaps of bones of every kind, some show the marks of sharp teeth which have bruised and ground them; others appear only indented, their harder consistence having protectéd them. Another proof of much weight is the great quantity of fossil excrément of hyenas, and which would not have been collected in such abundance, in a situation where the remains of some ten hyenas may be found, if these hyenas had not dwelt there. I conclude from these summary observations,

1*mo*, That this cave has been a den of carnivorous animals.

2*do*, That the cavern has been traversed by a stream of water, which has deposited mud on the bones which it found on its passage.

LUNEL, 20*th January* 1827.

ART. XV.—*Observations on the History of the Developement of Magnetism by Rotation.* By S. H. CHRISTIE, Esq. M. A. F. R. S. &c. In a Letter to the EDITOR.

DEAR SIR,

HAD the tenor of Mr Barlow's letter in your last Number been in accordance with its professed object, the terminating of the correspondence, that object would have been attained. But since, instead of leaving "whatever may be in dispute to be judged of from what has been already stated," Mr Barlow has given loose statements of particular circumstances, the real object appears to be very different; and I cannot avoid making some remarks, which, however, shall be as few and as concise as possible.

The origin of the correspondence, which I regret has occupied so many pages of your valuable Journal, was, that in an *anonymous* report of some philosophical discoveries, the reporter had endeavoured to assign the chief merit of these discoveries to Mr Barlow, to the exclusion, in a great measure, of other claims. Mr Barlow does not admit that he is the "author of the entire paper in the form in which it appears in your Journal;" but as he wishes, "with the exception pointed out in his former letter,"* to be considered "responsible for the accuracy of the several points," we must conclude that he furnished the materials, and that he considered an *anonymous* communication no unfit vehicle for advancing most prominently his own claims. My feeling is so decidedly different on this point, that, had I been enabled to draw this conclusion in the first instance, I should only have considered it necessary to point out, without comment, that Mr Barlow was, in fact, the author of the communication complained of, without having given it the sanction of his name.

After what had been stated, no one could doubt but Mr Barlow was "willing to believe" that the results he "obtained by the rapid rotation of the shell form an important link in the chain of phenomena." But though it has generally been admitted that the first is the most important step in discovery, the question agitated was not which was the most *important*, but which was the *first* link in that chain.

As in his last letter Mr Barlow again refers to experiments "begun in 1819, and continued in the construction of his correcting plate to the present time," still, I suppose, pertinaciously wishing them to be considered as "the first experiments in which iron was put in rotation for magnetical observation," and we are not in possession of these experiments, I can only ask what must have been their accuracy, when the effects of rotation, supposing the plate to have been turned on an axis, were not observed?

Mr Barlow says that I consider my "idea of referring the positions of a ball, by means of an imaginary sphere circumscribing the needle, is quite original;" whereas, in my letter in your Number for January, I have expressly stated, that *neither* of us can claim any originality by so referring them.

* The exception I suppose to be this, "These experiments were not a repetition of mine; and *it was certainly not my wish they should have been so represented.*"

I shall abstain from making any other remark on Mr Barlow's gratuitous assumption, that during four years I took no steps to observe the effects of rapid rotation, than that such was not precisely the fact, though, from my not having the means of keeping up the motion, I certainly did not detect the effect. Mr Barlow has farther stated, that he waited *five* months for me to complete my paper before he sent his own. I must reply to this, that his paper was read to the Royal Society on the *5th May*, and of course sent to the secretary some time before; and that, by the account of his experiments, published in the *Edinburgh Philosophical Journal* for July 1825, which, though bearing the signature of another person, must be supposed, having been transmitted by him, to have had his sanction, it appears the experiments described in that paper were not completed before *February*.

As Mr Barlow appears to be under some misapprehension as to the nature of my general argument, when he supposes I can imagine it will derive support from minute distinctions, I shall state clearly that the principle for which I contend is, that in any account of philosophical discoveries, where it may be necessary to assign to several their respective shares in those discoveries, the strictest impartiality should be observed; that this ought especially to be the case where the account is anonymous; but, above all, when one who claims a share in them ventures so to become the author: And I further hold, that such impartiality does not characterize the article which was the origin of this correspondence. However averse Mr Barlow may be to admit the necessity of this correspondence, I am disposed to think it may possibly lead to the exercise of greater caution in future communications.

I remain, Dear Sir,

R. M. Academy, Yours very truly,

16*th May* 1827. S. H. Christie.

P. S.—I beg you will do me the favour to accept the accompanying copies of papers in the *Transactions*. That on the repetition of my experiments by Mr Foster at Port Bowen exhibits the effects of the rotation of an iron plate in the most striking manner; and if any thing were wanting to show, not only how early I had observed these effects, but how much anterior to the publication of any other experiments on rotation, I communicated my discovery to others, it would be proved by the absolute manner in which the date of my communication to Mr Foster must thus be fixed. S. H. C.

ART. XVI.—*On certain Phenomena of the Great Lakes of America.* * By DE WITT CLINTON, LL. D. President of the Lit. and Phil. Society of New York.

IT has been until within a few years generally understood that there are no tides in the Great Lakes of America; and that the Mediterranean, Black, Caspian, and Baltic Seas, and other great waters of the old world, are also exempt from their influence. More accurate observation has, however, indicated that this opinion is in some respects erroneous, and it is now considered doubtful whether it is not altogether so. It is confidently said that there are tides in the Mediterranean. At Toulon, three hours and fifteen minutes after the moon has passed its meridian, the tide rises one foot; and in the highest spring tides, augmented by the concurrence of other causes, it swells as high as two feet.† The Lake of Geneva and the Lake of Constance are subject to an occasional rising and falling of their waters three or four feet, several times in succession, by a sort of oscillating motion, which phenomenon is denominated Seiches. ‡ There are certain appearances connected with our lakes that resemble the operation of tides, and there are others of a character entirely dissimilar. As the Western Lakes contain the greatest collections of fresh water in the world, all the phenomena connected with them are deeply interesting in relation to geography, agriculture, trade, and natural science: I shall therefore devote this memoir to this subject.

1. In our lakes there is apparent to every observer a sort of flux and reflux, which we would naturally attribute to the

* From the *Transactions of the Literary and Philosophical Society of New York*, vol. ii. part i. p. 25.

† Forster's *History of the Voyages in the North.*

‡ De Saussure's *Voyages dans les Alpes;* Kinlock's *Letters from Geneva and France;* Coxe's *Switzerland;* Simond's *Switzerland.*

wind, and might therefore pass it over without particular attention. But a more discriminating view has resulted in a conviction with many accurate and distinguishing observers, that the peculiar motion of the waters is entirely independent of the winds; that it occurs within stated periods; that it is not subject to the irregularities of occasional or accidental causes, but that it depends for its existence upon a power operating with unceasing vigour, and with unintermitted regularity at the same place, although varying as to the quantum of its influence at other places. On the other hand, it is supposed by some that these appearances are occasional and irregular, and do not result from uniform causes. I shall now refer to some prominent authorities on this subject.

La Hontan is the first writer who touches on this phenomenon.* "On the 29th of May 1689 we came," said he, "to a little deep sort of a river, which disembogues at a place where the water of the lake (Michigan) swells three feet high in twelve hours, and decreases as much in the same compass of time. Our tarrying there three or four days gave me an opportunity of making the remark." An appearance of this nature could not escape the observing eye of Charlevoix, the most sagacious, able, and learned of the French writers on America. Speaking of Lake Ontario, † "I observed," said he, "that in this lake, and I am told that the same thing happens in all the rest, there is a sort of flux and reflux almost instantaneous, the rocks near the banks being covered with water and uncovered again several times in the space of a quarter of an hour, even if the surface of the lake was very calm, with scarce a breath of wind. After reflecting for some time on this appearance, I imagined it was owing to the springs at the bottom of the lakes, and to the shock of their currents, with those of the rivers which fall into them from all sides, and thus produce those intermitting motions."

Pownall‡ says, "Lake Ontario, like the Mediterranean, the Caspian, and other large invasated waters, has a small rising and falling of the water, like tides, some twelve or eighteen inches perpendicular."

* La Hontan's *North America,* vol. ii.

† *Journal Historique d'un Voyage de L'Amerique,* Letter 13.

‡ *Topographical Description of part of North America.*

These are the only authorities of an old date to which I have had access. Those which I now refer to are of recent observation, and some are derived from oral communication. Mr Benjamin Wright, a very judicious and intelligent gentleman, and one of the principal engineers on the Western Canal, informs me, that at a place called Mexico, about twenty miles from Oswego, Lake Ontario ebbs and flows every hour and a half about six inches, and that the flood is highest when the wind is from the shore.

A gentleman of veracity and intelligence, who resides at the mouth of Genesee River, says that this lake rises and falls four times each in every hour, whether there be a wind or not: that the smallest rise is four, and the highest twenty-eight inches, and that this occurs during a perfect calm.

A similar appearance occurs on Lake Champlain. Captain Winans, one of the proprietors of the steam-boats, who resides at Burlington, in Vermont, assures me that in summer, when there has been a perfect calm for several days, he has observed at that place a flux and reflux of the lake four times every hour, with great regularity, and at every access rising four inches, as was obvious from a mark made on a log.

Captain Storrow, a gentleman of talents, says, in a printed letter to General Brown, "while at Green Bay I made observations on the ebb and flow of a lake tide. At eleven o'clock A. M. I placed a stick perpendicularly in the water,—at half past nine P. M. the water had risen five inches,—at eight next morning it had fallen seven inches,—at eight same evening it had risen eight inches. During this period the wind was in the same direction, blowing generally against the flow of the tide."

Judge Woodward, of Michigan, in a letter to Doctor Mitchill, states, that Mr Benjamin F. Stickney, who resides on the Miami River of Lake Erie, some miles below the rapids, and a few miles from the mouth of the river, made observations on this subject for more than a fortnight, in June 1820; the result of which is a conviction in his mind that there is a regular tide in Lake Erie—that it flows and ebbs twice in twenty-five hours, at intervals of about six hours and eleven minutes, and that it is greatest at the new and full moons, and least at the quarters. The minimum of rise within the period during which the observations were made was as much as eight inches. The maximum of rise within the same period was as much as forty inches. Mr Lecuyer, a gentleman equally intelligent, expressed the same opinion as to a tide at Green Bay.

If these exhibitions of a flux and reflux of the lakes were only occasional and incidental, not uniform and periodical, there would be perhaps no great difficulty in assigning satisfactory causes. The *Seiches* of the Lake of Geneva have been ascribed by Mr Bertrand to the influence of electrical clouds which attract and raise the waters of the lake, and he supposes that this water afterwards falling, produces those undulations of which the effect, like that of the tides, is most sensibly felt where shores are most approximated.

A more probable cause may be the unequal pressure of the atmosphere on the waters, which will of course rise higher as the weight of the incumbent air is less, and fall as it becomes greater; and these changes being almost always in operation may account for the almost continual ebb and flow of the lakes.

The cause assigned by Charlevoix is entirely unsatisfactory; and it is premature to form a theory on the subject. Facts and experiments ought to precede speculations; and we must leave it to future inquirers to ascertain the facts in extenso—to investigate the causes, and to determine whether this phenomenon be owing to the pressure of the atmosphere—the influence of the moon—the attraction of the clouds—the convexity or motion of the globe, or any other assignable agency.

2. There is an annual rise and fall of Lake Erie. The rise generally commences in March, and terminates about the middle of July; and this is the case sooner or later with the other lakes. It is owing to the great accession of water produced by the melting of snow and ice, and by the vernal rains; and the fall is occasioned by the failure of most of these sources of supply in summer.

3. There is, besides the annual rise of the lakes, a more extended periodical one, at least every three years, and then a correspondent declension. Some extend the time to five, and others to seven years. Some say that the highest rise is seven

feet, and others differ as to the exact altitude; but there can be no doubt of the general certainty of the fact. Lake Erie began to rise in 1811, and continued to increase until 1815, when it was two feet higher than was ever known. The overflowing of the waters destroyed trees on the low lands more than two hundred years old, and the inhabitants of Detroit, which is an ancient settlement, had never seen or heard of such a rise before. It fell a little in 1816, rose again in 1817, and decreased until 1822. It was in June last on the rise, and one and a half feet higher than usual. In 1810 I walked on Bird Island; an island situate at the outlet of Lake Erie. In 1816 it was almost covered with water, and was scarcely visible. I am informed by an intelligent shipmaster on the lakes, "that when he visited Detroit in 1797, the waters were at their height. He went to the south the following year, and did not return to that place until 1802, when he found the waters considerably lower. Having understood that there was a rise and fall every seven years, he determined to ascertain how great it was; for which purpose he caused marks to be made on a solid wharf that had been built more than twenty years before, and was perfectly firm and immoveable; and he found that the water declined on an average about an inch a year for nine years. What the fall was for five years during his absence he did not know, but it may be fairly stated at three times as much yearly; that is, fifteen inches, if compared with subsequent occurrences of a similar character. The lake began to rise again in 1811, in the spring of which it rose six inches, but during the summer it fell two inches. In 1812 it rose fourteen inches, and subsided three inches, leaving a nett gain of fifteen inches in two years. The surrender of Detroit to the British, in October 1812, compelled him to leave the country; but in October 1813 he returned with the fleet, and the water was then at its greatest altitude, having in that year gained twelve inches—in all twenty-seven inches. In 1814 and 1815 it was stationary. In 1816 and 1817 it fell at least eighteen inches. And he further supposes, from appearances at Michillimackinack, that the whole town of that island was formerly under water, and that one of the ancient outlets of the lakes was by Chicago, which he states at only thirteen feet above the present level of the lake; and he says that every spring you may pass up the Chicago River and carry in the shoalest place five feet water into the Illinois, and from thence into the Mississippi."

Mackenzie, in his account of his Voyages through the Continent to the Frozen and Pacific Oceans, in 1789 and 1793, says, that " along the surrounding branches of Lake Superior there are evident marks of the decrease of its waters by the lines observable along them. The space, however, between the highest and the lowest is not so great as in the smaller lakes, as it does not amount to more than six feet; the former, or highest lines, are very faint."

4. The lakes are subject to extraordinary swells and risings. On the 18th of October 1764, Colonel Bradstreet, who had been on an expedition against the Western Indians, broke up his camp at Sandusky to proceed on his return to Albany by Lake Erie. In the evening, as he was going to land the troops, a sudden swell of the lake, without any visible cause, destroyed several of his boats, but no lives were lost. This extraordinary event was, however, looked upon as the precursor of a storm, and accordingly one soon occurred, which lasted several days. Mackenzie, before quoted, states that a very curious phenomenon was observed some years ago at the Grand Portage in Lake Superior, for which no obvious cause could be assigned. " The water withdrew with great precipitation, leaving the ground dry that had never before been visible; the fall being equal to four perpendicular feet, and rushing back with great velocity above the common mark. It continued thus falling and rising for several hours, gradually decreasing until it stopped at his usual height."

The following occurrence, equally extraordinary, took place on the British side of Lake Erie on or about the 30th May 1823, which is thus described. " A little after sunset Lake Erie was observed to take a sudden and extraordinary rise, the weather being fine and clear, and the lake calm and smooth. It was principally noticed at the mouths of Otter and Kettle Creeks, which are twenty miles apart. At Otter Creek it came in, without the least previous intimation, in a swell of *nine feet perpendicular height*, as was afterwards ascertained, rushed violently up the channel, drove a schooner of thirty-five tons burden from her moorings, threw her upon high ground, and rolled over the ordinary beach into the woods, completely inundating all the adjacent flats. This was followed by two others of equal height, which caused the Creek to retrograde a mile and a half, and to overflow its banks, where water was never before seen, by seven or eight feet. The noise occasioned by its rushing with such rapidity along the winding channel was truly astonishing. It was witnessed by a number of persons.

"At Kettle Creek several men were drawing a fish net in the lake, when suddenly they saw the water coming upon them in the manner above-mentioned; and, letting go their net, they ran for their lives. The swell overtook them before they could reach the high bank, and swept them forward with great force; but, being expert swimmers, they escaped unhurt. The man who was in the skiff pulling in the sea line was drove with it a considerable distance over the flat, and grounded upon a small eminence until the water subsided. There were three successive swells, as at Otter Creek, and the effects up the creek were the same, with this difference, the water only rose seven feet. In both cases, the lake, after the three swells had spent their force, gradually subsided, and in about twenty minutes was at its usual height and tranquillity. It was observed at other places along the shore, but the high steep banks did not admit of the same observation. In all, however, there was a general correspondence as to the height of the rise

"Conjecture will doubtless be awake as to the cause of this most remarkable phenomenon; but it must only be conjectured, for it was unattended with any circumstance that could remotely hint at a probable cause. But such was the fact, and it must furnish its own comment."

Some have supposed that the occasional rise of Lake Erie is owing to the strong south winds in Lake Michigan; but this hypothesis cannot account satisfactorily for this appearance. Volney supposes that Lake Ontario is the crater of a volcano. Mackenzie says, that many of the islands of Lake Superior display a conformation of lava, intermixed with round stones of the size of a pigeon's egg. The western country abounds with what are called burning springs, consisting of volumes of hydrogen gas, issuing from spiracula in the earth, and it is underlaid with sulphur, coal, bitumen, and other inflammable substances. In boring for salt at Rocky Hill, in Ohio, about a mile and a half from Lake Erie, after proceeding to the depth of one hundred and ninety-seven feet, the auger fell, and salt water spouted out for several hours. After the exhaustion of this water great volumes of inflammable air issued through the aperture for a long time, and formed a cloud; and by ignition by the fire in the shops of the workmen, consumed and destroyed every thing in the vicinity.

Whether the country round the Great Lakes is volcanic or not, is not material to the present inquiry. We know that the bowels of the earth are stored with inflammable materials, and that there exist strong indications of subterranean communications at enormous distances. Indeed everything in earthquakes seems to indicate the action of elastic fluids seeking an outlet to spread themselves in the atmosphere. At the period of the last and the preceding destruction of Lisbon, according to Humboldt, the sea was violently agitated as far as America. For instance, at the Island of Barbadoes, more than twelve hundred leagues from Portugal, and on Lake Ontario, strong agitations of the water were observed in October 1755. The first destruction of Lisbon took place on the first day of November 1755, and the last on the 31st day of March 1764, the very year in which the sudden swelling of Lake Erie overwhelmed some of Colonel Bradstreet's vessels.

Bakewell, in his Geology, states that "during the earthquake at Lisbon, in 1775, almost all the springs and lakes in Great Britain, and in every part of Europe, were violently agitated, many of them throwing up mud and sand, and emitting a fetid odour. The morning of the earthquake the hot springs at Toplitz, in Bohemia, suddenly ceased to flow for a minute, and then burst forth with prodigious violence, throwing up turbid water, the temperature of which was higher than before. The hot-wells at Bristol were coloured red, and rendered unfit for use for some months afterwards. Even the distant waters of Lake Ontario, in North America, were violently agitated at the time."—"The connection which earthquakes (continues Bakewell) have with distant volcanos, and their frequency at particular periods, are truly remarkable. The tremendous earthquakes in 1812 in the Carraccas were followed by an eruption in the Island of St Vincents, from a volcano that had not been burning since 1718, and violent oscillations of the ground were felt, both in the islands and on the coast of America."

The late swell of Lake Erie has been followed by shocks of earthquakes, as well at a distance as in the vicinity. Have we not, therefore, reason to believe, that the extraordinary agitations which sometimes occur in the lakes are connected with earthquakes, and produced by the same causes?

Art. XVII.—*On the Pyrophosphate of Soda, one of a new class of Salts produced by the Action of Heat on the Phosphates.* By Mr Thomas Clark, Lecturer on Chemistry and Mechanics in the Glasgow Mechanics' Institution. Communicated by the Author.

The phosphate of silver is, according to Doctors Thomson and Berzelius, an insoluble yellow salt, which is produced when watery solutions of phosphate of soda and of nitrate of silver are mixed. These eminent chemists, it is well known, differ much as to the constitution of the phosphates in general; but in the instance of the yellow phosphate of silver, they have each given analyses, which substantially agree. It occurred to me, therefore, that by ascertaining the proportions of the salts necessary for mutual decomposition, and of the precipitate produced, and by adding a few collateral experiments, it would be possible to decide the matter at controversy, by starting from a point, at which both parties were agreed.

Having in this view commenced a set of experiments, I soon came to an unexpected appearance, and found myself engaged in a new train of research, the result of which I conceive of sufficient importance to be laid before chemists without delay.

In mixing solutions of nitrate of silver and of phosphate of soda, I was not a little surprised at obtaining a white, instead of a yellow precipitate; notwithstanding that Doctors Thomson and Berzelius speak with decision of the precipitate being yellow, and that in my former experience, I had always found it yellow. A question immediately arose, Why the precipitate was white instead of yellow?

As I had taken considerable pains, by repeated crystallizations, to render the phosphate of soda pure, it was natural to conjecture, that this salt, in its ordinary state, contains some impurity to occasion the yellowness of the precipitate. To try the accuracy of this conjecture, I dropped a solution of commercial phosphate of soda into one of nitrate of silver. The precipitate was yellow. But when, in order to contrast this effect with that produced by pure phosphate of soda, I dropped a solution of purified crystals into nitrate of silver, I was surprised to get a precipitate, which was likewise yellow. These effects were not altered by the reverse operation of dropping the nitrate of silver into solutions of the ordinary, and the purified phosphates.

Such were the experiments, which first pointed out to me the circumstance, upon which depended the production of a white precipitate. In order to avoid any uncertainty in my experiments as to the quantity of dry phosphate of soda, I had used a phosphate dried at a red heat, instead of crystals. It was a solution of this phosphate dried at a red heat, which had produced a white precipitate; whereas it was a solution of the crystals, which had produced a yellow precipitate. To be quite sure that the alteration was produced by heat, I divided a fine large crystal of purified phosphate of soda into two parts. One of these, I dissolved in water: the other I dried, heated red hot, and then dissolved in water. Dropped into a solution of nitrate of silver, the solution of the undried part of the crystal gave a yellow precipitate; whereas that of the dried part gave a white precipitate. The crystal which I used had been purified, indeed; but perfect purity is not at all necessary for the success of the experiment. The commercial phosphate of soda answers quite well; so that this very curious, and till now unobserved effect of heat may be verified by any body within reach of an apothecary's shop.

It was now evident that if the yellowness of the precipitate was owing to an impurity, that impurity must be one which heat expels. I was accordingly about to submit the phosphate of soda to a red heat, and to pass the vapours which might come from it through a solution of nitrate of silver; when I observed a new circumstance, which proved that the change was more fundamental than could be accounted for by the presence of any slight impurity.

When to a solution of the undried phosphate of soda, you add nitrate of silver till no farther precipitate appears, you get a mother liquor which is acidulous in its action on vegetable colours; but if you use in the same manner a solution of the dried phosphate of soda which yields a white precipitate, you get a mother liquor, which in its action on vegetable colours, is neutral. The reason why the yellow precipitate leaves an acid mother liquor, is that the phosphate of silver contains more oxide (two-sevenths more according to Dr Thomson; one-half more according to Dr Berzelius, but at all events more oxide) than the phosphate of soda. This excessive proportion of oxide, separating from solutions that are neutral, must leave them acid. But the white precipitate, as it leaves a neutral solution, must either contain a less proportion of oxide of silver, or be precipitated from a salt which contains a greater proportion of soda. In either case, the salt, which produces the white precipitate with nitrate of silver, cannot be the same, as the phosphate of soda, which produces the yellow precipitate, with nitrate of silver. I suspected, therefore, that a red heat had produced some constitutional change on the phosphate of soda.

In search of more decisive evidence of the production of such a change, I dried and heated red about a pound weight of crystallized phosphate of soda, bought at an apothecary's. The heat which I employed in this experiment did not fuse the salt; but, in after experiments, the heat was commonly urged to the temperature of fusion. The salt which had been dried and heated red was dissolved in water, concentrated, and set aside for crystallization. I thus obtained a plentiful crop of crystals, obviously different in their form from the common phosphate of soda. I refrain, however, from all description of their form, as that has been in disinterested kindness undertaken by Mr Haidinger; a gentleman who has established a peculiar claim to the gratitude of scientific men in this country, by his devotion to crystallography, at a time when that science is ripe for the efforts of genius, and is destined, by its successful efforts, to rise high in dignity among the sciences. The new crystals, being dissolved again in water, afforded a white precipitate with nitrate of silver. They were much less soluble in water than the common phosphate; they contained not more than two-thirds the water of crystallization in the same weight of crystals; they did not, like the common phosphate, become dim on the surface by loss of water after many days, exposure to the air; like the common phosphate they were alkaline in their action on vegetable colours, and in their taste; but unlike it they did not feel cooling to the tongue. The mother liquor, from which these crystals were separated, was concentrated and crystallized; and the operation was repeated, till the whole liquor was converted into crystals. Among these, none of the common crystals of phosphate of soda could be detected; and the last crop contained only a small quantity of foreign soda salts, just as if the crystallization had been made without previous exposure to red heat.

It was quite obvious then, that by simply drying the common phosphate of soda and heating it to redness, an entirely new salt had been produced. This new salt I shall, in the sequel of this paper, call *Pyrophosphate of soda*, a provisional name which it will probably be well to retain, till all doubts are removed respecting the constitution of this salt.

The question which now remained was: Did the phosphate of soda lose, or did it acquire any component in becoming the pyrophosphate of soda?

An observation to which I have not yet adverted, directed me, in the prosecution of this inquiry.

I soon found that phosphate of soda might undergo a considerable heat, without being converted into the pyrophosphate. The temperature of the sand-bath at which I operated cannot have been less than that of melting lead or boiling mercury ; and yet phosphate of soda dried on this bath always gave with nitrate of silver a yellow precipitate. I proposed, therefore, to ascertain first, the weight of water expelled by the sand-bath heat, and then, the alteration in weight produced by a red heat.

As likely to afford the most uniform results, I made choice of well-formed, unbroken, pure crystals of phosphate of soda. This salt after being dried in a strong sand-bath heat, uniformly underwent a loss in weight by the farther action of a red heat. The following is the result of three experiments, the quantity of crystals being supposed 1.

	Experiment			
	I.	II.	III.*	Mean.
Water, expelled by sand-bath	.6168	.6170	.6164	.6167
Loss, by red heat	.0250	.0247	.0247	.0248
Dry pyrophosphate of soda	.3582	.3583	.3589	.3585

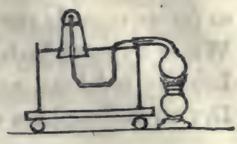
In these experiments, the salt after exposure to the sand-bath heat gave with nitrate of silver a yellow precipitate ; but after exposure to the red heat it gave a white precipitate. These experiments, then, establish that the phosphate of soda, in becoming pyrophosphate, loses weight. What is the matter lost?

To determine this important point, I dried a quantity of phosphate of soda, giving it the highest heat of the sand-bath. The phosphate thus dried still tested yellow, with nitrate of silver. I put 23.45 grains of this dried salt into a small retort of green glass. This retort was formed of a tube about a finger-length, about the thickness of a quill, and having a bulb at one end about the size of a hazel nut, and a bend a little above this bulb, the other end of the tube being open. To this small retort, there was adapted a

tube of this shape, narrow enough to go within the tube of the retort. The junction was made air-tight by oil cement. A small jar filled with mercury was inverted in a mercurial trough, and .1 inch of air

* The experiment marked No. III. is the mean of two experiments, the greatest and the least of the set. The water expelled by the sand-bath was in one, where efflorescence was begun on the surface, .6123, and in the other, whose surface was yet moist, .6204.

was let up to the top. The open end of the tube joined to the little retort was introduced into this jar so as to reach near the top, and to terminate in the .1 inch of air. The whole air including this .1 inch was not more than half an inch. Heat was ap-



plied by means of a spirit-lamp, and it was intense enough to melt the green glass. I earnestly watched for a gaseous product; but at the end of the experiment there was no increase, save only .1 inch = .03 grain, if it were common air, a quantity so inconsiderable, that I conceived it to be of accidental origin*, and inquired after it no farther. But there was another product, which, considering the change that the salt was undergoing, was hardly to be expected. In the narrow tube there gathered small drops of a liquid, which, when examined after the experiment, was found to be nothing else than WATER, tasting a little burned indeed, but not affecting vegetable colours. The salt which before being heated in the retort gave a yellow precipitate with nitrate of silver, now gave a white precipitate; and a portion of it, being subjected to a strong red heat in a platinum crucible, did not undergo the slightest diminution in weight.

The 23.45 grains of phosphate of soda dried on the sand-bath lost 1.46 grains by the process in the retort. Now we have before seen that 1. of crystallized phosphate of soda loses .6167 of water by the sand bath, and leaves .3833. But 23.45 : .3833 : : 1.46 : .0245. Hence the result of the experiment may be stated:

Dry pyrophosphate of soda,	-	21.99	.3588
Water, expelled by a red heat,	-	1.46	.0245
		23.45	.3833

* The small retort and its contents being weighed, the tube was adapted to it and cemented in the evening, and the experiment described in the text tried next morning. As the salt in the small retort was in a porous state, I think it not improbable that, like other porous substances, it may, in this interval, have absorbed air to the extent of .1 inch. This absorption would not affect the weights taken in the experiment, as the weighings were both made before the substances had more than time to cool, after removal from the sand-bath, and from the fire.

This result agrees sufficiently well with the mean result of the former experiments on the crystallized phosphate of soda, so far as regards the action of red heat.

Water by sand-bath heat, - -	.6167
Loss by red heat, now ascertained to be water, -	.0248
Dry pyrophosphate of soda, -	.3585
	1.0000

But though it is thus proved that .0248 of water is not separated from the common crystals of phosphate of soda, without the application of a red heat; yet the question remained: Did not the power to retain this portion of water belong also to the crystals of pyrophosphate of soda?

To determine this point, I subjected very fine, pure, and hard crystals of pyrophosphate of soda to the same treatment the common phosphate had undergone: that is, I exposed it to the same sand-bath heat, and then to a red heat; noting the loss by each operation.

	Experiment I.	Experiment II.	Mean.
Water expelled by sand-bath heat, -	.4061	.4065	.4063
Water expelled by red heat, -	.0011	.0007	.0009
Dry pyrophosphate of soda, - -	.5928	.5928	.5928

Now .0009 of water on .5528 of pyrophosphate of soda is not so much as .0006 on .3585. But .3585 retained .0248 of water under the same treatment, when it was the ordinary crystals of phosphate of soda, instead of those of pyrophosphate, that were subjected to the heat of redness, after undergoing that of the sand bath. Thus it seems established, that phosphate of soda so long as it may be dissolved in water without change of properties, retains .0248, or rather perhaps (.0248—.0006) = .0242 of its weight of water, which, in the state of pyrophosphate, it does not retain.

Before we can reflect with advantage on the probable function of this last portion of water, which is separated by a red heat, it will be necessary to consider the quantity of water in crystals of phosphate and pyrophosphate of soda, with reference to the doctrine of combining proportions. I have already hinted at the differences between Doctors Thomson and Berzelius respecting the combining proportions of the phosphates.

I do not enter into any statement of the grounds of my own opinion; because I anticipate an occasion when I shall discuss the subject at full length. At present, therefore, I shall content myself with simply expressing my conviction, that, with respect to the constitution of the phosphates, the weight of evidence lies decisively on the side of Dr Berzelius.

According to his tables, a combining proportion of dry phosphate of soda is 16.741, this quantity containing 7. parts of oxygen; namely 5. in the phosphoric acid and 2. in the soda; and this dry phosphate of soda corresponds, as the attentive reader must have observed, with what I have called, in this paper, dry pyrophosphate of soda.

I shall first consider the water of crystallized pyrophosphate of soda; because its proportion in this salt is least liable to doubt; and then I shall consider the water of the crystallized phosphate of soda.

Crystals of Pyrophosphate of Soda.

In the preceding part of this paper, there has been given two experiments on the water of hard well-formed crystals of this salt, where the water lost was .4072. I made only one other experiment on crystals, which were much softer, but which were pounded, and dried in blotting paper. The water was .4059.

Dried pyrophosphate of soda -	16.741	16.741
Water - -	11.521	11.438

The water in the former of these contains 10.24 oxygen; and in the latter 10.17. It is probable, therefore, that this salt contains 10 proportions of water.

Crystals of Phosphate of Soda.

The water in crystals of this salt has likewise been already stated. But phosphate of soda retains much water, mechanically, among its crystals; and this mechanical water is a source of difficulty; because you cannot pound and dry them, without risk of losing water by efflorescence. I took an approximate method. I put some crystals in the corner of a silk handkerchief and pounded them with a wooden mallet, drying them as they were broken with the handkerchief.

About a fourth part of the crystals however escaped pounding. I ascertained the water in one experiment where the salt had been thus treated, and where, it is evident, some mechanical water was likely to remain; and I made two experiments where the salt had been pounded and dried in blotting paper, and where of course there was risk of efflorescence. The following are the results:

	Crystals.	Pounded in a Handkerchief.	Dried in Blotting Paper.
Pyrophosphate of soda	16.741	16.741	16.741
Water expelled by red heat	1.158	1.188	1.112
Water expelled by sand bath-heat	28.786	27.305	26.803

The oxygen in the water expelled by a red heat is

1.03 1.05 .99 Mean 1.024

This ought evidently to be 1.

The water expelled by the sand bath contains of oxygen

25.59 24.27 23.83.

But as the first quantity includes mechanical water, as likewise probably the second, though in a much less degree; and as the water in the third was more likely to be in deficiency than in excess; we may safely conclude that the true quantity lies between the second and third. In this view, twenty-four must be the proportion of oxygen. Thus, exclusive of mechanical water, one proportion of crystallized phosphate of soda contains twenty-five proportions of water; of which twenty-four are separable by a sand bath heat, and the remaining one by a red heat; and, in losing this last one proportion of water, phosphate of soda becomes pyrophosphate of soda.

In what light are we to view this last proportion of water? Is it in combination with the salt, like the other twenty-four proportions of water of crystallization? Is it in combination with the soda, forming, with one half of it, a hydrate? Or, Is it in combination with the acid? Though one proportion of water is separated, let us recollect that this does not necessarily imply that one proportion of water existed: it may be, that the salt contained merely the elements of this water; namely, one proportion of oxygen and one proportion of hydrogen; and that the water is, not merely separated, but produced, by the action of heat; as we know nitrate of ammonia to be resolved by heat into nitrous oxide and water, neither of which it contained. Lastly, then, does the common phosphate of soda contain one proportion of oxygen, and one proportion of hydrogen, more than what is commonly supposed, in combination with the salt, with its alkali, or with its acid?

These are questions, which a more extended course of experiments than we yet possess must answer.

If we were to consider nothing else than the difference in the action of heat on crystals of the phosphate and the pyrophosphate of soda, the probability would be very strong indeed, that the last proportion of water, which is expulsible from the phosphate only by a red heat, is not water of crystallization in combination with the salt, but rather water, or the elements of water, in combination with the acid or base. But I made some experiments on another salt, which weigh very much against this probability.

The researches of Dr Berzelius and of Professor Mitscherlich have well established that the arseniates are similar to the phosphates, in their constitution, in their properties, and even their form. I was induced therefore to try whether a change could be produced by heat on the arseniate of soda, similar to that remarkable one, which the phosphate of soda had undergone. The appearances I found the same; but the effects were different. For, the arseniate of soda submitted to a sand-bath heat lost all its water, except one proportion, which it lost when urged by a red heat, just as the phosphate of soda had done; but then the watery solution of the arseniate which had been heated red hot, and even to fusion, did not produce different precipitates with other salts; and, being set aside for crystallization, it gave the old crystals back again, which had the property of retaining as obstinately as before the last proportion of water. Now all this looks very like, as if the phosphate and the arseniate of soda possessed the common property, of retaining one proportion of water, expulsible only by a red heat; and as if the heat, which expels this water from them both, produces on the phosphate of soda an additional change, which it does not produce on the arseniate of soda. In this view, the expulsion of the last proportion of water by heat would be, not the cause of the conversion of phosphate of soda into pyrophosphate, but merely a concomitant, and, it may be, an independent effect of heat.

Are we, then, to conceive that a red heat has produced a decisive change on the constitution and properties of phosphate of soda, without causing the addition or the separation of any constituent whatever? This, I think, to be at least conceivable; and I will explain how. Any compound, it is generally admitted, containing one proportion of sulphur and one proportion of sodium, united with oxygen in any proportion less than sufficient to form the sulphate of soda, is convertible by heat into sulphate of soda, and sulphuret of sodium. Thus, sulphite of soda, being heated red, forms sulphate of soda out of three-fourths of the sulphur, three-fourths of the sodium, and the whole of the oxygen, and also sulphuret of sodium out of the remaining fourth of sulphur, and the remaining fourth of sodium. These two compounds sulphate of soda, and sulphuret of sodium would probably be separable by crystallization from a watery solution of the heated product. But it is conceivable at least, that the sulphate of soda, and the sulphuret of sodium might remain in combination, forming a sort of compound salt. In this case, (water being out of the question) a red heat, without altering the weight of the sulphite, would produce a salt, whose solution would exhibit new properties, and afford crystals of a new form. Is it not admissible at least, that a red heat may produce some analogous change on the phosphate of soda?

I repeat, however, that the constitution of the pyrophosphate of soda must be decided by a more extended examination (particularly of the effects of heat on salts) than has yet been undertaken. Obliged by my avocations to relinquish experimental research for a few months to come, I can only hope that the interesting and extensive subject, which I am happy enough in introducing to the notice of chemists, will be taken up speedily, and prosecuted zealously, by others. In an age of unexampled enterprise in chemical investigation, it is impossible but that changes, analogous to the one which is the subject of this paper, will be discovered from time to time. But it is better to seek for such discoveries, than to wait for them;

as we know that the ore of gold would be trodden over by men, and remain unfound, if it were unsought.

August 15*th*, 1827.

ART. XVIII.—*On the Arseniate of Soda.* By Mr THOMAS CLARK, Lecturer on Chemistry and Mechanics in the Glasgow Mechanics' Institution. Communicated by the Author.

IN making the experiments on arseniate of soda, alluded to in the preceding paper, I made an observation, which, though I now find it is not original, is likely to be new to the chemists of this country, as it was new to myself.

Professor Mitscherlich describes the arseniate of soda, as of the same crystalline form with phosphate of soda. But in preparing the arseniate of soda, I found it very rare to get crystals of this form, the crystals which most commonly occurred being distinctly different. On submitting these crystals for crystallographic examination to Mr Haidinger, I was informed by that gentleman that they had been previously discovered by Professor Marx of Brunswick, and examined chemically by Dr L. Gmelin of Tubingen. They differ, chemically from the other arseniate only in their water of crystallization; and the last proportion of it cannot be expelled without red heat, just as with the other arseniate, and with the phosphate of soda.

To ascertain the water of crystallization, and especially to distinguish what was mechanical water, I made one experiment on crystals, two others on crystals pounded and dried in the corner of a handkerchief, and lastly two on pounded crystals, dried in blotting paper. I put down the result as if the dry arseniate of soda had turned out 22.226 in each case; this being Dr Berzelius's combining proportion for this salt, and containing 7 proportions of oxygen; namely 5 in the acid and 2 in the base.

	Crystals.	Dried in a Handkerchief.	Dried in Blotting Paper.
Water, expelled by sand-bath	17.460	16.386	15.732
Water expelled by red heat -	1.156	1.179	1.162
Dry arseniate of soda - -	22.226	22.226	22.226
	40.842	39.791	39.120

The oxygen in the water expelled by a red heat is 1.03, 1.05, 1.03. This is as nearly 1. as can be expected in such experiments. The oxygen in the water expelled by the sand-bath is as follows:

From crystals, - - - - -	15.47
From crystals pounded and wiped in a handkerchief,	14.56
From pounded crystals, dried in blotting-paper,	13.98

In the last experiment, there is little chance of deficiency of water, because the salt endures a long exposure to the air without experiencing loss of water. I conclude, therefore, that, exclusive of mechanical water, this arseniate loses 14 proportions by a sand-bath heat, and 1 proportion by a red heat.

Dr Gmelin gives two experiments; in one of which the total water turns out 15.17 proportions and in the other 15.65. He conceives that the salt contains 16 proportions; but, from his experiments and my own, I think it much more probable that 15 is the true quantity.

There seems, indeed, to be among chemists, a most unwarrantable habit of carelessness in deducing the water of crystallization. The following is rather a droll example, taken from Professor Mitscherlich's valuable *Essay on the Phosphates and Arseniates*. He has under examination the other arseniate of soda.

"6.789 grammes of arseniate of soda being ignited gave 3. of residue. Consequently 100 parts of arseniate of soda combine with 126.3 parts of water. 100 parts of arseniate of soda contain 35.18 parts of soda, according to the atomic weights of Berzelius; and these contain 9.00 parts of oxygen. 126.3 parts of water contain 112.3 parts of oxygen.

"But 9.00 : 112.3 : : 1 : 12.5

"THEREFORE, *the oxygen in the soda is to that of the water as* 1 *is to* 12. CONSEQUENTLY *the crystallized salt consists of, &c.*"

This may do in Chemistry, where we are apt to pique ourselves upon accuracy; but how would it do in Astronomy to read "By observation, it was half past 12. *Therefore*, it was precisely 12. *Consequently*, &c.?"

I select this instance from Professor Mitscherlich's essay, merely because it bears upon the subject of this notice; for, unfortunately the habit to which I refer is by no means peculiar to the eminent Professor. But the reader will probably agree with me in considering his experiment of more value than his inference; and that the arseniate of soda, contains, like the phosphate, 25 and not 24 proportions of water.

Dr Thomson has published two examinations of the arseniate of soda; one in the fifteenth volume of the *Annals of Philosophy*, and another in his *First Principles*. The water in the one examination differs from the water in the other by not less than 14 parts in the 100 of crystals. The reason is that he used in one case the arseniate with 25 proportions of water; and in the other, the arseniate with 15 proportions of water.

The arseniate which is of the same crystalline form with phosphate of soda, and which contains 25 proportions of water becomes speedily dim from loss of water, while the other does not. I propose that the one with the 25 proportions of water be called the *Efflorescing arseniate of soda*, and that the other be called simply the *Arseniate of soda*.

The proportions of water in the pyrophosphate, the phosphate and the arseniates of soda, which we have been considering are 10, 15, 25. It is not unworthy of observation that these proportions contain, twice, thrice, and five times, the oxygen in the acid of the salts.

August 15th, 1827.

Art. XIX.—*On a New Phosphate of Soda.* By Mr Thomas Clark, Lecturer on Chemistry and Mechanics in the Glasgow Mechanics' Institution. Communicated by the Author.

Professor Mitscherlich having found that the crystalline arseniates and phosphates, when they contained the same water of crystallization, were identical in their forms, I was curious to try whether a phosphate of soda could be produced, corresponding, in its form and water of crystallization, with the arseniate of soda, mentioned in the last paper, as containing 15 proportions of water. Aware of the effect of a warm temperature on solutions of the sulphate and carbonate of soda, in producing crystals containing less water of crystallization, I exposed a concentrated solution of phosphate of soda, to evaporation in a calico-printer's stove which was kept hot night and day, commonly at a temperature of about 90° Fahr. Crystals have been deposited since the preceding papers were written ; and I have the happiness to find that they are just the kind I was seeking for ; similiform with the arseniate of soda, and containing the same proportion of combined water ! In the following experiment, the water was separated from crystals, which had been pounded and dried in a handkerchief.

Water expelled by sand-bath	-	-	16.303
Water expelled by red heat	-	-	1.186
Dry pyrophosphate of soda	-	-	16.741

Compare the water in this phosphate with that in the similiform arseniate, as stated in the preceding paper ; this salt having undergone the same treatment.

Water expelled by sand-bath	-	-	16.386
Water expelled by red heat	-	-	1.179
Dry arseniate of soda	-	-	22.226

I need hardly remind the reader that, in Dr Berzelius's tables, 16.741 of pyrophosphate of soda is equivalent to 22.226 arseniate of soda ; each of these numbers representing one combining proportion. Comparing the above experiments together, there can be no doubt of the identity of the proportion of water of crystallization.

A solution of the new phosphate in water has the same properties as those of the common phosphate, crystals of which it yields by the usual treatment. The new phosphate does not lose its water by exposure at ordinary temperatures ; but it is difficult to remove completely from its surface, the mother liquor which almost immediately forms a thin covering of efflorescing phosphate to the salt, and speedily, by losing its water, gives to the new phosphate the appearance of an efflorescing salt.

Professor Mitscherlich may look to the discovery of the new phosphate of soda, not without triumph. The arseniate of soda, which does not effloresce, seems originally to have been published by Professor Marx, as a proof that the arseniate of soda is not similiform with the rhomboidal phosphate of soda; but it was merely an instance of a new arseniate of soda; and he did not obtain the rhomboidal one, only because he did not use the proper means. But there were now two arseniates of soda, only one of which corresponded in its water and in its form with the phosphate. It remained to obtain a second phosphate, corresponding in its form and its water, with the second arseniate; and this has been got, the very first time it was properly sought for. Perhaps also, the discovery may afford to Professor Mitscherlich some consolation against the terrible sneers of certain chemical gentlemen of London, who have written upon a subject, on which they were above experimenting. The dazzling brilliancy of his discovery was not to be beheld, or comprehended, by their eyes; and, accordingly, they put forth their breath—but happily it was a breath, destined to extinguish no light—save perhaps a candle.

Having now obtained an arseniate and a phosphate of soda, whereof each contained twenty-five proportions of water, and each lost a portion of this water on exposure to the air, and, also, an arseniate and a phosphate of soda, whereof each contained fifteen proportions of water, and lost none by exposure to the air; I became interested in ascertaining whether the former salts were changed by exposure into the latter. I therefore subjected to experiment some crystals of efflorescing arseniate and efflorescing phosphate of soda, which had been pounded, and left, now for four weeks, spread out on a paper in a large room, whose temperature would vary from 52° to 62° Fahr. The following are the results of one experiment on each effloresced salt:—

	Effloresced	
	Arseniate.	Phosphate.
Water expelled by sand-bath,	15.682	15.781
Water expelled by red heat,	1.225	1.212
Dry salt left, - - -	22.226	16.741

The water here is obviously identical with that which I formerly obtained from the arseniate of soda, freed from mechanical water by being pounded and dried in blotting-paper: namely,

Water expelled by sand-bath,	- -	15.732
Water expelled by red heat,	- - -	1.162
Dry salt left,	- - - -	22.226

The water, by computation, should be 15.74 and 1.13.

August 17*th*, 1827.

ART. XX.—*On the Crystalline Forms of Pyrophosphate of Soda and the Arseniate of Soda, described in the preceding Papers.* By WILLIAM HAIDINGER, Esq. F. R. S. E., &c. Communicated by the Author.

THE examination of the regular forms of the following salts I undertook at the request of Mr Clark, who put into my hands the interesting substances to which the descriptions refer.

1. *Pyrophosphate of Soda.*

Fundamental form, a scalene four-sided pyramid. $P = \left\{\begin{matrix} 76^\circ\ 6' \\ 56^\circ\ 2' \end{matrix}\right\}$, 130° 47′, 137° 0′. Fig. 8, Plate III. Inclination of the axis in the plane of the long diagonal = 21° 48′. Plane angles of the base 50° 8′, and 129° 52′.

$$a : b : c : d = 2.5 : 2.35 : 1.1 : 1.$$

Combinations usually like Fig. 7, whose crystallographic sign is $P - \infty\ (a).\ \frac{P}{2}(P).\ \bar{P}r\ (d).- \frac{\mathring{P}r}{2}\ (e).- \frac{P}{2}\ (e).$ $\mathring{P}r + \infty\ (b)$. Fig. 9 is the projection of it upon a plane parallel to the plane of inclination. Inclination of

a on *b*	= 111° 48′	*a* on *c*	= 103° 24′
a on *e* (adjacent)	= 118° 22′	*b* on *P*	= 121° 43′
b on *e*	= 129° 50′	*b* on *c*	= 107° 30′
a on *P*	= 119° 36′	*b* on *d* (over *P*)	= 101° 51′
a on *d*	= 123° 33′		

Observations.—The crystals have a perfect conchoidal fracture, and are quite permanent when exposed to the air; they do not effloresce like the common phosphate. I have often seen the latter substance, but never examined its crystallographic properties, this having been already done by Professor Mitscherlich; but I cannot at present turn to his description of it, in order to contrast the forms of the two salts.

2. *Arseniate of Soda.*

Fundamental form, a scalene four-sided pyramid. $P = \left\{\begin{matrix} 99^\circ\ 22' \\ 92^\circ\ 16' \end{matrix}\right\}$, 113° 27′, 119° 56′. Fig. 8. Inclination of the axis in the plane of the long diagonal = 7° 0′. Plane angles of the base 78° 18′, and 101° 42′.

$$a : b : c : d = 8.2 : 7.54 : 6.14 : 1.$$

Combinations usually like Fig. 10, whose crystallographic sign is $P - \infty\ (\underline{a})$. $\frac{P}{2}\ (P)$. $\bar{P}r\ (d). - \frac{\mathring{P}r}{2}\ (e). - \frac{P}{2}\ (c)$. $P + \infty\ (f)$; $(\mathring{P}r + \infty)^3\ (g)$. $\mathring{P}r + \infty\ (b)$. $\bar{P}r + \infty\ (h.)$ Fig. 11 is a projection of it upon a plane, parallel to *h*. Inclination of

a on *b*	= 97° 0′	*a* on *c*	= 116° 42′
a on *e* (adj.)	= 128° 27′	*g* on *g* (over *b*)	= 117° 16′
e on *b*	= 134° 33′	*f* on *f* (over *b*)	= 78° 46′
a on *P*	= 123° 22′	*a* on *f*	= 94° 26′

Observations.—There is a distinct cleavage parallel to the face *b*; otherwise the fracture is conchoidal. This salt was first described by Professor Marx of Brunswick, in a pamphlet "*On the Relations between the Chemical Mixture and the Crystalline Form*,"* and urged against Professor Mitscherlich as an instance of want of similar forms in two salts, consisting of similar sompounds of isomorphous bodies. Professor Leopold Gmelin has since shown,† that the arseniate of soda crystallizes with two different proportions of water, and produces, therefore, two essentially distinct species, one of them being efflorescent, which is that described by Mitscherlich, while the other is permanent, which was obtained by Marx. The

* *Ueber das Verhältniss der Mischung sur Form.* 1824.

† *Poggendorf's Annalen.* 1825-6.

latter crystallizes from more concentrated solutions at higher temperatures than the former. The descriptions published of the salt discovered by Marx are not so perfect as to render superfluous either the drawing given here Fig. 10, or the measures of the angles, though the latter be given only as approximations. Mr Clark has succeeded in discovering an analogous case to Marx's salt among the phosphates of soda; for the salt which he obtained by exposing a concentrated solution of phosphate of soda to evaporation in a calico-printer's stove, agrees in regard to form exactly with that arseniate of soda, the crystals being likewise similar to Fig. 10. Though regularly formed, and of considerable size, their surface was not bright enough to admit of a very exact measurement, which perhaps might have shown some slight deviation in the angles of the two substances.

Art. XXI.—*On the Topography, Animals, and Reptiles of some districts in India.* By P. Breton, Esq.

In the second volume of the *Transactions of the Medical and Physical Society of Calcutta* there is a valuable paper by Mr Breton on the medical topography of the districts of Ramghur, Chota Nagpore, Sirgoojah, and Sumbhulpore, and a description of the animals and reptiles met with in these districts. These provinces, the theatre of Mr Breton's travels for a series of years, are from three to four hundred miles from the sea, and the surface is variegated with forests, deep jungle, vallies, and plains. The plains in some parts are extensive. Those of Chota Nagpore and Sirgoojah (lat. 23° 6′ 11″ N.) extend in some parts many miles, and are for the most part cultivated. The chains of mountains run east and west. Some are continuous for many miles, others interrupted, and the highest does not probably rise above 2000 feet from the base, or 6000 feet above the level of the sea. These provinces are intersected by considerable rivers, the chief of which are the Maha Nuddee, the Ebe, Koel, Sunk, Baira, Hutsoo, and Dummoodah, the numerous tributaries to which afford the natives the means of irrigation for several months after the termination of the rains. Villages are interspersed over the face of the country, not only in the plains, but at the base and on the tops of the mountains, the soil of which last is considered to be the most fertile. The soil of Ramghur, in the declivities, is principally loam; in the high grounds loam, clay, and gravel, with mica. That of Chota Nagpore is in many parts a peculiar kind of red earth, extremely fertile. The soil of Sirgoojah is similar to that of Ramghur, but, in addition to the different kinds of pulse and cotton raised in the other provinces, possesses one peculiarity in producing in its vallies vast quantities of Tikhoor, *(Curcuma angustifólia,)* from the roots of which the natives prepare a farinaceous powder, not distinguishable from the West India arrow-root. Mr Breton in 1821 sent a specimen of this farinaceous powder to Dr Wallich of Calcutta, who found the resemblance so complete, that he requested to be furnished with a large supply for the purpose of sending it to Europe, which was accordingly transmitted in 1822. In Sirgoojah is a remarkable hot spring, the temperature of which, when examined by Mr Breton in 1819, was 186° Fahr. The valley of Sumbhulphore is of an alluvial nature, and produces crops of rice, wheat, and the sugar-cane. The soil is peculiarly adapted to the growth of the poppy, and wild indigo abounds on the banks of the Maha Nuddee. The bed of this river furnishes the finest diamonds in the world, and a class of diamond finders, or Jharas, annually search its channel from the termination to the commencement of the rains.

The range of Fahrenheit's thermometer in the plains of Ramghur, Chota Nagpore, and Sirgoojah, is from 72° to 88° in the twenty-four hours during the rainy season; from 78° to 98° in the hot season; and from 66° to 32° in the cold season. The cold season commences about the end of October, and terminates about the middle of March, when the hot season commences and lasts till the middle of June. The rains then set in and usually continue till the middle of October. But every year there is a little variation in the commencement and termination of these seasons.

The mountains are wholly covered with forests and underwood, and the jungles that extend from them contain a great variety of the trees common to the woods of Hindostan. The Saul tree *(Shorea robusta)* seems to predominate, and between

Singhbhoom and Sumbhulpore there is a forest of these trees extending uninterruptedly for thirty or forty miles. Mr Breton mentions a number of other trees known to the residents, but states that in these almost impenetrable forests are many trees and plants unknown to Europeans.

Of the wild animals which inhabit the mountains and wooded parts of these provinces, the *Gaour* or gigantic ox is one of the most important. Though occasionally seen by residents in a wild state, the habits and structure of this animal are scarcely known. A notice in the 9th volume of the *Memoires du Mus. d'Hist. Nat.* extracted from an English account of an Indian hunting match, and occasional allusions in the Journals of English travellers, form the scanty history of this magnificent animal. Major Charles Hamilton Smith, an excellent zoologist, and author of the supplementary account of the order *Ruminantia* in Griffith's translation of the *Règne Animal*, places the Gaour in his Bisontine group under the name of *Bos Gaurus*, and details the characters as given in these incidental notices. The chief of these characters, and which distinguishes the Gaour from all other animals of the tribe, is said to be an elevated spinous ridge, extending in the form of an arch from the end of the cervical vertebræ to half way down the dorsal vertebræ. The existence of this spinous projection, though doubted by Major Smith, is particularly noticed in the account of Mr Breton, who personally examined a specimen. From the measurements of the animal recorded in the French memoirs, however, and copied by the Major, being identically the same as those now printed in Mr Breton's paper, and from the specimen examined by that gentleman being seen so far back as 1816, it is not improbable that the measurements and the character of the spinous ridge rest on this single observation, communicated through some other channel to Europe. Though no doubt, therefore, is to be entertained of the fact, when detailed by an observer so capable, still it would be desirable that the nature of this anomalous structure were examined by the anatomists of Europe, and for this purpose, that specimens should be sent to our national museums. In the meantime, as all our knowledge of the animal seems to be derived from Mr Breton's observations, we give his description in his own words.

"A male Gaour killed on Myn Paut in Surgoojah on the 29th January 1816, was measured in my presence by Captain J. N. Jackson, and its dimensions were :—

	Feet.	Inches.
Height from the hoof to the withers, . .	5	$11\frac{3}{4}$
Length between the withers and the lower part of the chest, ...	3	$6\frac{3}{4}$
Girth, ...	7	7
Length from the tip of the nose to the extremity of the tail, ...	11	$11\frac{3}{4}$

"The form of the head and horns approaches very nearly to that of an English bull, and short tufts of dirty white curled hair cover the upper part of the forehead. The colour of the hairs of the skin on the body is dark brown; but owing to the fineness and density of the coat, it assumes in the sun's rays a jet black colour, which gives to the animal, from its being sleek and generally in high condition, a very handsome appearance. The legs, from the knee and hock to the hoofs, are covered with dirty white coloured hair, much coarser than that of the body. Its legs are large and well proportioned, combining apparently strength and elasticity. The animal is very muscular, and has great width of chest and quarters; and its legs being short in proportion to the magnitude of its body, there is an appearance of immense strength. But what characterizes this animal from others of the bovine species, is a thick and elevated spinous ridge, which extends in the form of an arch from the end of the cervical vertebræ, to half way down the dorsal vertebræ, the elevation over the shoulders being near seven inches above the line of the spine, where this ridge gradually terminates. At a distance, this ridge has somewhat the appearance of the hump on bullocks; but instead of flesh it is formed of the spinous processes.

"The Gaour is gregarious, and in defence of its young is considered one of the fiercest animals that inhabit the jungles. I once saw in the valley of Myn Paut a herd of Gaours with their young. I counted upwards of fifty; but as the herd was in motion, I might have erred in my calculation. On Myn

Paut the haunts of the Gaour seem to be in the deepest jungles in the vallies, probably from the verdure being there more abundant than in the plains. I have, however, seen a few grazing singly on the plains, as if strayed from herds; and in this situation they appear very timid, for they would not allow any thing to approach them within musket shot, but scampered off into the jungles the moment they descried people in pursuit of them. The natives attach to this animal great fierceness; for when they are wounded and brought to bay, they will attack any thing that approaches them.

"The Gaour, if it could be domesticated, would, from its size, structure, and activity, form the finest draught cattle in India. They are, however, so wild and ferocious, that it is very difficult to catch them or their young; and when the latter are accidentally caught, they cannot, from some unaccountable cause, be reared. The natives declared that every one of the calves that had been taken died a few months after being separated from their dams. In the latter end of 1822 a Gaour calf, more than quarter grown, was caught at Jushpore, bordering on Surgoojah, and it was suckled by a tame buffalo for about a month, when it was sent with the buffalo by the Rajah to Lieutenant Syers at Hazareebagh. I saw the calf on its arrival, and am confident it was the Gaour. It was as tame as if it had not been born of wild parents. For a few days after its arrival at Hazareebagh, it appeared to be well and healthy; it afterwards began to loathe its food, gradually drooped, and died of looseness of the bowels.

"Notwithstanding these failures, there is ground for believing that the Gaour might be reared and domesticated if proper means were resorted to; and with reference to the probable utility of these animals as draught and carriage cattle, and in yielding abundance of milk, over those of the bovine tribe in Hindostan, it would probably repay any one who could spare time and a little expense in the pursuit, to try the experiment of bringing into use probably the noblest species of the bos tribe, evidently designed by nature for something more than as mere beasts of the chase.

"Although Myn Paut seems to be the principal abode of the Gaour, a few are to be met with in the other districts in the south-west frontier. They have to my knowledge been killed in Ramghur, Palamow, and Chota Nagpore, and they are said to exist also in Sumbhulpore. The natives regard them with much greater indifference than they do the wild buffalo, since the former are by no means so injurious to their corn-fields as the latter are." P. 247—251.

Besides the Gaour, the Urna or wild buffalo, the Samur, a species of elk, two kinds of Neel-gao; the spotted deer, the antelope, the hog-deer, the kotaree, a deer with four horns, the red deer, and the Mirgee, or mouse deer as it is called, are found in these districts. This last is about the size of a fox, without horns, of a greyish colour, but with its four legs from the knee to the hoof black.

The ravenous animals are the tiger, panther, leopard, ounce, the black leopard, hyæna, bears, wolves, jackals, and foxes. There is also an animal in these provinces called by the natives *Qyo*, conjectured, Mr Breton says, to be a kind of wild dog. It is of a reddish brown colour, size larger than that of a jackal, and has more the appearance of a dog than that of any other animal, although it has a bushy tail similar to that of a jackal. The other animals met with are common to Hindostan, such as different species of monkeys, wild hogs, hares, porcupines, the polecat, weasel, and racoon. The pangolin is now and then seen.

The poisonous serpents observed by Mr Breton were the several varieties of the Cobra de capello; the Amaiter, the Katuka rekula poda of Russel; and the Sankunee *(Boa fasciata.)* The Boa constrictor is occasionally met with. The other noxious reptiles in these provinces are the scorpion, the centipede, and the tarantula; but they possess no active poison, for they are incapable of destroying small animals, such as kids or fowls. In general, Mr Breton says, the irritation is not greater than that excited by the sting of a wasp.

Several kinds of bees, varying in size and colour, and producing honey of different qualities, are found. They usually construct their combs on thick branches of large trees, and when disturbed are very formidable. A detachment of the Ramghur corps in Sumbhulpore, only avoided the annoyance of a swarm by flight from the spot; and several valuable pointers and greyhounds belonging to the commanding-officer, and tied to a tree, were, on the retreat of the dog-keeper, stung to death. From the cocoon of the *Bombyx paphia* cloths called Soosee and Mushru are manufactured. The lac insects abound in the jungles, and the lac produced is one of the principal articles of traffic among the natives.

Lead and antimony are reported to exist in different parts of Ramghur, and iron is found in every part of the district. A few miles east of Hazareebagh are beds of very fine mica, from which large transparent laminæ are procured. Sumbhulpore has from time immemorial been distinguished for the production of the finest diamonds. They are found in the bed of the Mahanuddee, and at the mouths of its tributary streams.

ART. XXII—*On a peculiar Defect in the Eye, and a mode of correcting it.** By G. B. AIRY, Esq. A.M. and Lucasian Professor of Mathematics in the University of Cambridge. With observations by the EDITOR.

Two or three years since I discovered that in reading I did not usually employ my left eye, and that in looking carefully at any near object, it was totally useless; in fact, the image formed in that eye was not perceived except my attention was particularly directed to it. Supposing this to be entirely owing to habit, and that it might be corrected by using the left eye as much as possible, I endeavoured to read with the right eye closed or shaded, but found that I could not distinguish a letter, at least in small print, at whatever distance from my eye the characters were placed. No farther remark suggested itself at that time, but a considerable time afterwards I observed that the image formed by a bright point (as a distant lamp or a star) in my left eye was not circular, as it is in the eye which has no other defect than that of being near sighted, but elliptical, the major axis making an angle of about 35° with the vertical, and its higher extremity being inclined to the right. Upon putting on concave spectacles, by the assistance of

* From the *Transactions of the Cambridge Philosophical Society*, vol. ii. part ii. p. 267—273. Read Feb. 21, 1825.

which I saw distant objects distinctly with my right eye, I found that to my left eye a distant lucid point had the appearance of a well-defined line, corresponding exactly in direction and nearly in length to the major axis of the ellipse abovementioned. I found also that if I drew upon paper two black lines crossing each other at right angles, and placed the paper in a proper position, and at a certain distance from the eye, one line was seen perfectly distinct, while the other was barely visible. Upon bringing the paper nearer to the eye, the line which was distinct now disappeared, and the other was seen very well-defined. All these appearances indicated that the refraction of the eye was greater in the plane nearly vertical than in that at right angles to it, and that consequently it would not be possible to see distinctly by the assistance of lenses with spherical surfaces. I found, indeed, that by turning a concave lens obliquely, or by looking directly through a part near the edge, I could see objects without confusion; but in both cases the distortion produced in their figure was such that I could not hope to make any use of the left eye without some more effectual assistance.

My object was now to form a lens which should refract more powerfully the rays in one certain plane, than those in the plane at right angles to it; and the first idea was to employ one whose surfaces should be cylindrical and concave, the axis of the cylinders crossing each other at right angles, and their radii being different. To show that this construction would effect my purpose, it is only necessary to imagine the lens divided into two lenses by a plane perpendicular to its axis. Then it is easily seen that the refraction of one will not be perceptibly altered by that of the other, and that the whole refraction will be the combination of the two separate refractions. The rays in one plane will be made to diverge entirely by the refraction of one lens, and those in the other plane by that of the other lens. If then r and r' be the radii of the surfaces, and n the refractive index and parallel rays be incident, the rays in one plane after refraction will diverge from a point whose distance is $\frac{r}{n-1}$, and there is another plane from a point whose distance is $\frac{r'}{n-1}$. This construction was then sufficient; but for the facility of grinding, and for the diminution of the curvatures, it appeared preferable to make one surface cylindrical, the other spherical, both concave. Let r be the radius of the cylindrical surface, R that of the spherical, then the refraction in the plane passing through the axis of the cylindrical surface being entirely effected by the spherical surface, parallel rays in this plane after refraction will diverge from the distance $\frac{R}{n-1}$: while the refraction in the plane perpendicular to the axis being caused by both surfaces, parallel rays in this plane will, in their emergence, diverge from the distance

$$\frac{1}{\overline{n-1}\left(\frac{1}{R}+\frac{1}{r}\right)}.$$

To discover the necessary data I made a very fine hole with the point of a needle in a blackened card, which I caused to slide on a graduated scale; then strongly illuminating a sheet of paper, and holding the card between it and the eye, I had a lucid point, upon which I could make observations with great ease and exactness. Then resting the end of the scale upon the cheek-bone, and sliding the card on the scale, I found that the point at the distance of six inches appeared a very well-defined line inclined to the vertical about 35°, and subtending an angle of 2° by estimation. At the distance of $3\frac{1}{2}$ inches it appeared a very well-defined line at right angles to the former, and of the same apparent length. It was necessary, therefore, to make a lens, which, when parallel rays were incident, should cause those in one plane to diverge from the distance $3\frac{1}{2}$ inches, and those in another plane from the distance six inches. Making the expressions above equal to these numbers, and supposing $n = 1.53$, we find $R = 3.18$, $r = 4.45$. To prevent, if possible, the eye from becoming more short-sighted, I fixed upon the values $R = 3\frac{1}{3}$, $r = 4\frac{1}{2}$.

After some ineffectual applications to the different workmen, I at last procured a lens to these dimensions from an artist named Fuller of Ipswich. It satisfied my wishes in every respect. I can now read the smallest print at a considerable distance with the left eye, as well as with the right. I found that vision is most distinct when the cylindrical surface is turned from the eye. It alters the apparent figure of objects by refracting differently the rays in different planes. I judged it proper to have the frame of my spectacles made so as to bring the glass pretty close to the eye. With these precautions, I find that the eye which I once feared would become quite useless can be used in almost every respect as well as the other.

Since I procured this lens, I have been informed that a foreign artist has made spectacle-glasses with cylindrical surfaces of different radii for general use. What his object can be I am quite unable to imagine. Certainly no one whose eye is not defective can see with them distinctly. With my right eye, which, (by the method of examination above described,) I find to have no other defect than short-sightedness, I am unable to read any thing in the lens made for my left eye. After many inquiries, I have not been able to discover that this construction has been used to correct any defect in the eye, or even that a defect similar to that which I have described has ever been noticed.

OBSERVATIONS BY THE EDITOR.

We consider the preceding paper as a very interesting and important one. The fact, we believe, has been before observed, that some eyes have a different refractive focus in a vertical and in a horizontal plane, but we cannot at present refer Mr Airy to the work which contains it. This, however, does not affect the originality and value of his observations, of his successful exertions to discover the nature of the defect, and to construct a glass for correcting it. Mr Airy does not seem to have ascertained in what part of the eye this curious defect exists,—whether in the cornea or in the crystalline lens. By examining the image of a taper reflected from the outer surface of the cornea, he will readily discover whether its form is spherical or cylindrical. If it is spherical, there can be little doubt that the crystalline is in fault, and it will remain to be determined whether the differences of refraction in different planes arise from the lens having one or both of its surfaces cylindrical, or what is more probable, from a want of symmetry in the variation of its density,—an effect which is very common at that period of life when the eye begins to feel the approach of age.

Mr Airy has misconceived the information which he has received, "that a foreign artist has made spectacle-glasses with cylindrical surfaces of different radii for general use." This information is quite correct, and we had one of these lenses executed for us many years ago by a Scotch artist, which is figured and described in the article OPTICS in the *Edinburgh Encyclopædia*, vol. xv. p. 509. The cylindrical surfaces, however, are placed with their axes, or homologous lines, *transverse* to each other, so that the whole lens acts like a spherical lens. Mr Airy, consequently, is quite correct in his conclusion, that these lenses were not intended for correcting any such defect as that which he has observed, and so well described.

ART. XXIII.—*On Davyne, a New Mineral Species.* By WILLIAM HAIDINGER, Esq. F. R. S. E. &c. Communicated by the Author.

THE *Prodromo della Mineralogia Vesuviana*, by Messrs Monticelli and Covelli, has been so frequently quoted of late, and accounts and abstracts of it given in systematic works and in journals, that a notice of it might have been ere now expected also in the present *Journal of Science*. A great many species were described in that work, some of them probably new, but with so little regard to the present state of mineralogical information in the rest of the world, have they been brought forward, that mineralogists will have to adopt them only with the utmost caution, if they wish to avoid giving double descriptions of the same substances.

Christianite, for instance, one of the species proposed as new, was described under the name of Albite long previous to the publication of the *Prodromo*, and much better determined by Professor Gustavus Rose, who published his masterly account of it in Gilbert's *Annals* for February 1823. It is much to be regretted that names so honourable and respected as those of his Royal Highness Prince Christian of Denmark, and Professor Cleaveland of Boston, should have been attached to a species which had a name before, that of Albite, a name adopted by Professor Rose from the imperfectly characterized specimens, to which it had been given by the Swedish mineralogists and chemists, whatever objections there might have been against the name itself, in order to avoid that unnecessary increase of synonyms which now a days so generally prevails.

Systematic denominations should refer to systems, and express the degree of resemblance among the objects denominated. The only attempt at such a nomenclature was made by Professor Mohs, whose system is the only one in existence framed upon the pure principles of natural history. Trivial names are single words attached to each species, without expressing their degree of resemblance. No rule can be given for their formation except that they should not be compound, and that they may refer to anything connected with the species. They should consist, as Linnaeus has it, "*vocabulo unico, libere, undequaque desumto.*" Mineralogists ought to look to the interest of their science, and avoid applying new names to increase, without the utmost necessity, what is already too much. A new species requires a new systematic denomination; but since a short name to designate it is sometimes called for, when the species is viewed from another than a systematic point of view, also a trivial name is necessary. To give a name to an acknowledged variety of another species, as amethyst, prase, flint, and others, from the older mineralogy, and many more that have been proposed in our own days, is to betray a perfect indifference in regard to the determination of the species, in as much as what only a species has a right to is bestowed upon a variety. But it is still more reprehensible from mere caprice to object to whole classes of trivial names, such for instance as are taken from persons, or from localities, or from colours, and supplant others for them, which are often not better than those which had been current before. The authors of the *Prodromo* would probably not have deprived Professor Rose of the authority of fixing a name on the species, which he first solidly established, had they been acquainted with his memoir; and we can now do nothing but wish that the compliment to Prince Christian had been paid by a mineralogist better versed in the literature of his science.

Humboldtilite, Davyne, Cavolinite, Biotine have been described as new species; I select Davyne for the subject of the present communication, as I have lately had an opportunity of examining several of its properties in specimens of Mr Allan's cabinet. The following description is drawn up from them, to which are added the varieties observed by Messrs Monticelli and Covelli in a much more comprehensive series of specimens.

Form rhombohedral. Crystals similar Fig. 5. Combination. $R - \infty$ *(P)*. P *(r)*. $R + \infty$ *(s)*. $P + \infty$*(M)*. The faces *r* sufficiently enlarged produce an isosceles six-sided pyramid, with terminal edges of 154° 46′, and lateral edges of 51° 47′, nearly, as deduced from the admeasurement of the latter. The fundamental form, from which this pyramid derives, is a rhombohedron of 112° 16′, whose axis is $= \sqrt{1.59}$.

Cleavage highly perfect, parallel to the faces *M*, or $P + \infty$, cross fracture conchoidal.

High degrees of lustre upon the faces of cleavage, which by the numerous parallel fissures to them often assume a pearly aspect. The surface of the faces *r* is often a little rough, though perfectly even. Colour white. Transparency considerable.

Brittle. Hardness = 5.0...5.5, a little above apatite. Specific gravity nearly 2.4.

In the specimens which I examined, the Davyne was associated with brown dodecahedral garnet. They had been sent to Mr Allan by Lord Compton. Beside the variety represented in the figure, Davyne is described by Messrs Monticelli and Covelli as occurring in the combinations of the six-sided prism *M*, consisting of *P*, and with *r* and *s* separately, of different brownish tints, and various degrees of translucency. They state the specific gravity at 2.25. I am confident that the one of 2.4 given above approaches nearer truth, though I could not arrive at a result entirely to be depended on, from having too small a quantity of the material.

In contrasting the properties of Davyne with those of nepheline, the specific gravity of the latter is quoted as high as

3.27, whereas in fact it is much lower, and comprehended within the limits assigned to the species by Professor Mohs, namely, 2.5...2.6. The result of a late experiment, which I tried with very pure crystals, is 2.592. The numbers 3.2741 are given in the first edition of Haüy's *Traité*, and by most subsequent authors; but they cannot refer to nepheline.

The authors of the *Prodromo* obtained the following result by chemical analysis of this species.

Silica, - -	42.91
Alumina, -	33.28
Lime, - -	12.02
Iron, - -	1.25
Water, - -	7.43
	96.89

Hence they infer that Davyne consists of one atom of bisilicate of lime, five atoms of silicate of alumina, and two of water, giving the formula $CS^2 + 5\ AS + 2\ Aq.$ It forms a jelly with nitric acid, froths before the blowpipe, and altogether shows the phenomena corresponding to its contents.

The preceding statements, as far as they refer to the account given by Messrs Monticelli and Covelli, were taken from the translation contained in Silliman's *Journal* for October 1826, as I have not had the advantage of comparing the original.

All the characters of Davyne, and the general aspect of the substance itself, concur in assigning to it a place among the numerous family of the zeolites, that is, in the genus kouphone-spar of the system of Professor Mohs. As a systematic denomination, that of the *Davyan kouphone-spar* seems very appropriate; and it retains the allusion to the illustrious individual, in whose honour the name of *Davyne* was proposed.

There is a peculiar charm attached to every novelty, particularly if the new object, like a species in mineralogy, bears so large a proportion to the whole contents of a natural kingdom. Next to this is the interest of contributing towards the more firm establishment of a fact but lately discovered, and from this point of view I believe the preceding account will not be considered quite superfluous.

Art. XXIV.—*Notice regarding the Structure and Mode of Generation of the Virgularia mirabilis and Pennatula phosphorea.* By Robert E. Grant, M. D. F. R. S. E. F. L. S. Professor of Zoology in the University of London. Communicated by the Author.

Several specimens of the *Virgularia mirabilis*, Lam. and *Pennatula phosphorea*, lately taken in the Frith of Forth, and brought to me alive in sea-water, afforded me a favourable opportunity of observing some of the living phenomena of these singular animals. Notwithstanding the excellent observations of Bohadsch, Ellis, Pallas, and Muller, on the structure and habits of Pennatulæ, there is still much uncertainty respecting the nature of these anomalous zoophytes, and the most contradictory statements are met with in authors respecting their locomotive powers. As they exhibit no point of attachment by which they can adhere, like almost every other zoophyte, to solid substances at the bottom of the sea, no doubt is entertained among naturalists that they float freely to and fro in the deep, and Lamarck has instituted a new order of zoophytes (*Polypi natantes*), for the reception of seven genera which appear to exist in this unconnected state. Many naturalists, however, have even maintained that they swim through the ocean by their own spontaneous movements, effected either by the waving up and down of the lateral expansions of the animal, which was supposed by Pallas (*El. Zooph.* p. 369,) and by Ellis (*Phil. Trans.* liii. 421,) or by the synchronous pulsations of the tentacula of all the polypi; and Cuvier (*An. Comp.* iv. 147.) supposes that the polypi are enabled to keep time, in rowing the mass through the deep, by their being all actuated by one volition. Cuvier expresses the same opinion in his *Règne Animal*, tom. iv. p. 83. A more singular and beautiful spectacle could scarcely be conceived, than that of a deep purple *Pennatula phosphorea*, with all its delicate transparent polypi expanded and emitting their usual brilliant phosphorescent light, sailing through the still and dark abyss by the regular and synchronous pulsations of the minute fringed arms of the whole polypi. But some authors, as Lamarck, (*An. sans Vert.* ii. 418,) and Schweigger, (*Unter. uber Coral.*) reasoning from what is known regarding other compound animals, have denied the existence of this great locomotive power in a zoophyte placed so low in the scale, as contrary to every analogy, and not necessary to the existence or wants of the animal.

The *Virgularia mirabilis*, (*Pennatula mirabilis*, Mull.) is one of the most beautiful and rare zoophytes found on this coast. The specimens measured from six to ten inches in length, and were dredged up in deep water on the north side of Inch Keith. They perfectly correspond in form and external appearance with the elegant coloured figure given by Muller, (*Zool. Dan.* Tab. xi.) Their *axis* is calcareous, solid, white, brittle, flexible, cylindrical, of equal thickness throughout, and exhibits no mark of attachment at either end. When broken, it exhibits a radiated surface, like the broken spine of an *echinus*. The axis appears to have little connection with the fleshy part, and to consist of concentric layers deposited by the soft parts surrounding it. When a portion of the axis is broken off from either extremity, the animal retracts at that part, so as continually to expose a fresh naked portion of the axis: hence we can take out the axis entirely from its soft sheath, and we always find the lower pinnæ of the animal drawn up closely together, as if by the frequent breaking of the base. These very delicate and brittle animals seem to be confined to a small circumscribed part of the coast which has a considerable depth and a muddy bottom, and the fishermen accustomed to dredge at that place believe, from the cleanness of the Virgulariæ when brought to the surface, that they stand erect at the bottom with one end of the axis fixed in the mud or clay. Muller's specimens were likewise found on a part of the Norwegian coast with a muddy bottom. The *polypi*, much resembling those of the common *Lobularia digitata*, are long, cylindrical, transparent, marked with longitudinal white lines, and have eight *tentacula* which present long slender transparent filaments or *ciliæ* on each of the lateral surfaces when fully expanded. The polypi are easily perceived extending through the lateral expansions or *pinnæ*, to near the solid axis, where we observe two transverse rows of small round white *ova* placed under each pinna, and contained within the fleshy substance. These ova appear to pass along the pinnæ, to be discharged through the polypi, as in the Lobularia, Gorgonia, Caryophyllea, Alcyonia, &c. but they are certainly not generated by the polypi themselves, as we might be led to believe by some authors, as Pallas, (*El. Zooph.* 362.) who state as a character of these animals that their polypi are oviparous. The ova in almost every known zoophyte are formed by the common connecting substance of the animal, and not by the polypi, which appear to be only the mouths or organs of digestion. In *Plumulariæ*, *Sertulariæ*, *Campanulariæ*, horny *Cellariæ*, *Antennulariæ*, the ova are formed in vesicles which originate from the centre of the stem. In *Flustræ*, calcareous *Cellariæ*, and some others, the ova are formed in the cells, but exterior to the bodies of the polypi, which disappear before the ova arrive at maturity. In the Lobulariæ, Gorgoniæ, Spongiæ, Clionæ, &c. the ova are formed and matured in the common fleshy substance of the body before they advance to be discharged through the polypi, or the fecal orifices. The formation of the ova by the general connecting mass appeared more obvious in the *Pennatula phosphorea*, where I found innumerable round yellow ova about the size of poppy-seeds placed, not precisely in the situation described by Bohadsch (see *Phil. Tr.* liii. 423.) but at the back part of the pinnæ, and many of them advancing forward in the substance of the pinnæ to pass out through the bodies of the polypi. Both Bohadsch and Pallas have placed the ova in the pinnated part of the stem where I could not detect any, the whole of that part being filled with a very soft semi-muscular substance destined to move the axis, the stem, and the pinnæ.

The axis of the *Pennatula phosphorea*, Linn. (*P. rubra*, Pall.) like that of the Virgularia, dissolves with effervescence in nitric acid. It is so slender and flexible at its extremities, that it is found coiled up at both ends in the contracted state of the animal, and becomes straight in its expanded condition. The polypi resemble those of the Virgularia. They have eight tentacula, with long conical lateral ciliæ. From the dark opaque purple matter, and numerous calcareous spicula covering their sheaths, the polypi cannot so easily be perceived extending along the pinnæ. On the back part of the pinnated portion of the stem of this animal we observe innumerable *spicula* collected into small groups, and disposed on each side of a mesial longitudinal groove. When viewed through a lens, these slender shining spicula much resemble the groups of setæ forming the feet of a *nereis* or *aphrodita*, and they all point backwards from the naked part of the stem. On watching the polypi of both these zoophytes when fully expanded in pure sea water, their arms and ciliæ were observed remaining like those of the Lobularia perfectly motionless, excepting when some floating particles or animalcules impinged against them, which caused them to contract their ciliæ or their tentacula, and sometimes to withdraw themselves languidly into their sheaths or cells. The only motions of the polypi were those of advancing and retreating to their cells, which they did slowly, and with the same irregularity observed in every other zoophyte, no two polypi and no two pinnæ exhibiting any constant uniformity in their motions. The long *ciliæ* of these animals are not vibratory organs, as in many smaller polypi, but are supplementary tentacula which feel, distinguish, and seize their prey when it strikes against them. By looking through the heads of the extended polypi with a lens, I could perceive a constant vibratory motion most obvious in the Virgulariæ, within the mouth, apparently produced by minute moving ciliæ placed round the entrance of that passage, and minute particles were occasionally seen propelled from the mouth. The whole fleshy substance of both animals became slowly contracted or distended by agitating or renewing their water, and these motions were as languid as the dilating and contracting of an *actinia*, to which Dr Fleming very justly compares the Pennatulæ (*Phil. of Zool.* ii. 613.) The *Virgulariæ* did not exhibit the slightest power of changing their positions, or of retiring from each other when placed in contact with each other perpendicularly in a vessel of sea-water, nor could they turn themselves by distending their pinnæ when they were placed on their faces horizontally at the bottom of the water. The *pennatulæ* showed no power of raising their bodies or swimming in the water, even when pinched and irritated; but in distending their whole fleshy substance, by absorbing water like an *actinia* or *lobularia*, they exhibited that slow peristaltic or vermicular motion, accurately described by Bohadsch, which passes very gradually over their stem and pinnæ, and causes the pinnæ to assume various positions. The result of this successive distension of the parts when the animal lay horizontally on its back, was an almost imperceptible creeping motion in the direction of the naked part of the stem. This direction was probably given by the bundles of spines placed along the back, and the motion may be quicker when the animal lies on a rough surface, and in its natural element. The motions of the pennatulæ in bending their body, or contracting and extending their pinnæ in different directions, were performed with the same languor as in other fleshy zoophytes, and were not in the least calculated to make them swim to and fro in the sea. Mr Ellis states that they are often found floating near the surface (*Phil. Trans.* liii. 420), but this does not show that they reach that situation by their own efforts, and not by tides, currents, or storms; and there is nothing in Bohadsch's account of the slow motions of the pinnæ which should make Mr Ellis believe that these parts move like the fins of a fish, and serve the same purpose as these organs in making the *pennatulæ* swim. The fishermen, almost daily accustomed to see these animals, inform me that they have never seen them swimming, but always procure them by their dredges or hook-lines from the bottom, where they shine with so great brilliancy as to enable them to perceive the fishes swimming into their nets. On shaking the *Pennatulæ* in the dark, I observed a few only of the polypi emit a brilliant but momentary bluish white light, and the *Virgulariæ* when shaken, emitted no luminous appearance. From all that I could observe of these animals in the living state, I think it quite improbable that *Pennatulæ* possess the power of swimming to and fro by their own efforts, but that they most likely lie at the bottom, and move in a languid manner, like *Spatangi*, *Asteriæ*, or *Actiniæ*, and that their structure and mode of generation do not differ essentially from those of many other zoophytes.

Art. XXV.—*Notice respecting Professor Barlow's New Achromatic Telescopes with Fluid Object-Glasses.*

As we have on various occasions directed the attention of our readers to the great importance of the aplanatic fluid object-glasses of our countryman Dr Blair, we are sure that they will partake in our gratification when they learn that two gentlemen, highly qualified both by their knowledge and their ingenuity, have been for some time directing the whole energy of their minds to this most interesting branch of practical science.

Mr Blair, the only son of Dr Blair, has for more than two years been busily engaged in constructing fluid object-glasses on the principles discovered by his distinguished father. We had an opportunity of looking through one of them, and though it was only at a terrestrial object, yet it was easy to see its vast superiority to all ordinary achromatic instruments. Professor Barlow of Woolwich, to whom other branches of science owe great obligations, has likewise been occupied with the same subject, both theoretically and practically. He has had completed two telescopes, one of $3\frac{1}{4}$ inches aperture, and another of 6 inches aperture. With the former he can separate all the double stars of that class which Sir William Herschel has pointed out as tests of a good $3\frac{1}{2}$ inch achromatic; and with the other he can of course separate many closer double stars, but as it is only newly finished he has not yet had any favourable nights for observation.

The principle of construction of this telescope is different from that of Dr Blair's, and possesses some important advantages, as it increases the focal power of the instrument without increasing the length of the tube; or, by keeping the focal length the same, he can shorten the telescope very considerably, viz. by one-third at least of the usual length.

Professor Barlow will, we presume, submit these instruments to the Board of Longitude, whose especial duty it either is, or ought to be, to patronize with a liberal and active zeal every improvement on the telescope. If other nations have already been allowed to outstrip ours in this branch of rival manufacture, the time has now come for retrieving our character, and replacing us in the position from which we have been driven.

Professor Barlow informs us that he has been very greatly indebted for his success to the liberal scientific views and practical ingenuity of Messrs W. and T. Gilbert, mathematical instrument makers to the Honourable East India Company, and we have no doubt, from our own knowledge of their ingenuity and enterprise, that these able artists will now take a more prominent place in their profession than they have hitherto done. They are now occupied in constructing for the Commissioners of the Scottish Light-houses one of the polyzonal or built up lenses, invented by Dr Brewster. This lens is to be made of flint glass, and is to have a diameter of no less than three feet. One of the zones has been for some time finished, and we expect that it will be completed in such a manner as to advance the reputation of the artists, and do honour to the arts of Great Britain.

Art. XXVI.—*On the Permanency of Achromatic Telescopes constructed with Fluid Object-Glasses.* By Archibald Blair, Esq. In a letter to Dr Brewster.

Dear Sir,

As I have been for some time occupied with the construction of aplanatic telescopes on the principle discovered by my father, in which the aberrations are destroyed by means of a fluid which disperses the variously coloured rays of the spectrum in the same proportion as crown glass, with a view to the establishment of a regular manufacture of these instruments, it will not be thought improper to give an account of the experience which has been already had of the permanency and general practical utility of instruments constructed on this principle, as it has been believed that there are certain practical objections which have hitherto prevented them from being brought into general use.

In the first place, it has been very generally doubted whether any method had been discovered of enclosing the fluid so perfectly as to prevent the risk of its escape at a future period; and it has likewise been supposed that the fluid itself might be liable to some change which might impair the performance of the telescope.

Amply sufficient experience has been had, however, to show that telescopes may be constructed on this principle so as to be liable to neither of these objections. A telescope of this kind is now in my possession, in the object-glass of which the fluid has been enclosed for upwards of thirty years, without suffering any diminution of quantity, and its performance continues decidedly superior to that of any common achromatic telescope of the same focal length. In this instrument, however, a slight change did take place in the fluid within a few years after it was constructed, owing to a minute quantity of one of the substances contained in it being deposited in a crystalline form. By this the refractive and dispersive powers of the fluid necessarily underwent a slight alteration, and the correction of the aberrations is certainly not so perfect as at first; the degree of imperfection, however, is barely appreciable, and the correction of the colour is still considerably more perfect than is possible in the common achromatic telescope.

In order to obviate entirely this last mentioned defect, experiments were made for the purpose of discovering a substance capable of supplying the place of the one disposed to crystallize, and free from that defect. In this complete success has been attained, and object-glasses have remained with this fluid enclosed in them for twenty-one years without suffering any alteration, and which continued to perform as well as at first. This fluid, which is the one now adopted, produces a perfect correction of the chromatic aberration, dispersing the variously coloured rays of the spectrum in exactly the same proportion as crown glass. Its refractive power is somewhat greater than that of the former, which rendered a different set of curves necessary for the correction of the spherical aberration; and as the services of a glass-grinder could not at that time be commanded, these last mentioned object-glasses were not altogether perfect in this respect, on which account they were taken to pieces for the purpose of being rendered complete, one, however, being reserved for the purpose of proving the durability of the construction.

The method employed for enclosing the fluid has proved so effectual, that not a single instance has occurred of its escape from a finished object-glass; and there were ten or twelve small ones of about two inches aperture, which remained filled with the first mentioned fluid for upwards of twenty-six years without its suffering any diminution. These were afterwards taken down for the purpose of being filled with the improved fluid, at the time when I was receiving instructions from my father in the method of putting this invention into practice.

When object-glasses of this kind are of considerable diameter, it is difficult to prevent the intrusion of a small quantity of the cement, used for the enclosing, into the space containing the fluid. This takes place, however, only to a very small extent, presenting the appearance of a few minute globules only adhering to the edges of the object-glass, which, if objected to, may be kept out of sight by slightly reducing the aperture. In some cases a small bubble of air is present; this, however, does not arise from any escape of the fluid, but is present from the first, and when so present, the intrusion of the cement does not take place. When the object-glasses do not much exceed two inches in aperture, they may generally be made without either bubble of air or intrusion of cement.

On the whole, if there be any difference in regard to permanency, it would seem to be rather in favour of an object-glass composed of two lenses with an enclosed fluid, as it will be impervious to the dust which gets between the lenses of common achromatics. *

The superiority of these instruments, when accurately constructed, over common achromatic telescopes, is greater than might be at first expected, even from a perfect removal of the colour. It is to be kept in mind, however, that the colours of a secondary spectrum, produced by a combination of crown and flint-glass, are more injurious to the performance of a tele-

* When the object-glasses with fluids are properly constructed, so as to correct the spherical aberration, three lenses are required, and the fluid is only between two of them, so that in that case they will be liable to the intrusion of dust between two of the glasses in the same way as common achromatics.

scope, *in proportion to their entire breadth*, than those of the primary spectrum produced by the refraction of a single medium, on account of the more uniform density of the former. A great part of the breadth of the primary spectrum is composed of rays which are weak and inefficient, and incapable of doing much injury to the distinctness. The secondary spectrum, on the contrary, consists of the whole primary spectrum blended into two narrow but dense fringes, which do not fail to produce their full bad effect upon the performance of the telescope, as is very manifest when the aperture is at all considerable. Upon these considerations probably, Mr Herschel very judiciously recommends, that in the construction of achromatic telescopes a union should be formed, not of the extreme red and violet, but rather of two of the intermediate colours, such as the orange and green, which may be best done by somewhat over-correcting (as it is termed) the primary colour, by which means the blue and red will be united, and the violet thrown out altogether, forming the least refracted ray. By this means a greater concentration will be obtained of the more effective rays of the spectrum at the expence of the diffusion of those which are of less importance. I have heard my father mention that he believed a very fine telescope belonging to the late Mr Aubert owed its excellence to its being constructed by accident in this way, as it exhibited a diffuse violet fringe round the object on pushing in the eye-piece, instead of the usual wine-coloured one.

I have constructed several telescopes on my father's principle of twenty inches focal length, and two and three-quarter inches aperture, in which the removal of both aberrations is complete, so that the edges of the brightest object continue of a perfectly pure white when the eye-glass is brought within or without the focus, showing that the colour is corrected not only for the lenses of the telescope, but for the humours of the eye itself, thus rendering vision through the telescope more perfect than the most perfect naked vision. This may perhaps be thought extravagant, nevertheless it is strictly true, as the chromatic aberration in the eye is far from being a small quantity, and may easily be rendered visible.

These instruments, notwithstanding their shortness, bear with the most perfect distinctness a power of two hundred times, and are most effective in reading a printed paper during bright sunshine with a power of three hundred times. Not having any convenience for observing, I have not yet been able to make trial of their performance in separating double stars. I am inclined to believe, however, that the terrestrial objects which I am in the habit of using are even more rigid tests of the performance of the telescope than the fixed stars. The object which I think best for proving both the figures of the lenses and the accurate removal of the aberrations, is a minute image of the sun reflected from a small convex surface, such as a thermometer bulb blown of black enamel; this, when viewed at a proper distance, has exactly the appearance of a fixed star, excepting that it has the advantage of being capable of being made much brighter. This object, when of sufficient brightness, is by much the most delicate test of the correction of the colour that can be used; and as the telescopes I have constructed show such an object extremely small and perfectly round, I know from experience that they may safely be relied on for separating the most difficult double stars. The apertures of these instruments might have been made still considerably larger than they are, had I not been prevented by the want of glass of a sufficient thickness. As it is possible, however, that a minute quantity of the spherical aberration which remains in those parts of the lens which are about half way between the circumference and the axis, and which it is impossible altogether to get rid of, may in extreme cases become sensible, it will on that account not be advisable to push the increase of aperture to an immoderate extent. In the largest apertures which have been tried, however, I have not been able to discover any traces of the green and purple which constitute the secondary spectrum.

I am at present engaged in the construction of a telescope five and three-eight inches in aperture, and five feet in focal length; but as I have not yet the advantage of employing a machine for the purpose of giving to the lenses the very accurate figure which an instrument of that size demands, very great success is perhaps not to be expected. I should wish likewise to make the aperture for that focal length to exceed six inches, but have been prevented from doing so by the want of glass of a sufficient thickness.

After what has been said, it will perhaps be asked how it happens that the manufacture of such valuable instruments has not been prosecuted hitherto. A full answer to this question it is perhaps not in my power to give; but this much I am able to state from certain experience, that it has not arisen from any defect in the instruments themselves. I know that many years and much painful perseverance were employed in bringing the invention to perfection, for to perfection I trust it will soon be known that it was brought; and although it may be thought surprising that exertion should cease just at the time when all the difficulties had been surmounted, yet I am persuaded that it is far from impossible. The ardour of discovery will then be gone, and may even pass into a degree of depression if the previous anxiety and interest have been great. Besides that the kind of exertion requisite for establishing a manufacture is very different from that required for prosecuting an interesting object of science, and the capacity for both may not co-exist in the same individual; I may likewise be allowed to add that my father's attention was diverted from that object by being subsequently engaged in rendering services not less important to the country. He had previously made experiments by which he discovered the method of preserving lime juice at sea for any length of time, and being afterwards appointed first commissioner of the Board for the care of Sick and Hurt seamen, he succeeded, by his urgent representations, in prevailing upon the Admiralty to order a regular supply of lime juice thus preserved for the use of his Majesty's ships, the consequence of which has been the complete fulfilment of his prediction at the time, viz. the entire expulsion of that destructive disease, the sea scurvy, from the British navy.* Dr Blair has, however, never lost sight of the object of forming a manufacture of these instruments, and was sometime ago at the pains to instruct me by actual practice in every particular connected with their manufacture. And in order to remove all hesitation in regard to their permanency, I may add that my father has

* To learn the extent of the benefit thus conferred it is only necessary to read the account of Lord Anson's *Voyage round Cape Horn*.

always recommended me to guarantee the maintenance of the instruments in a state of good performance for a certain time, such as twenty or thirty years, or indeed almost any limited term, which recommendation I shall certainly follow, if sufficient encouragement can be obtained for the establishment of the manufacture.

I am, Dear Sir, respectfully,

Your most obedient servant,

A. Blair.

Edinburgh, 16, Broughton Place,
3d September 1827.

Art. XXVII.—*Mineralogical Notices*, communicated by Dr Charles Hartman of Blankenburg, of the Duke of Brunswick's Mining Service, M. W. S. &c. &c.

1. Glaucolite, a new mineral species. This substance was first described by Mr Sokoloff in the *Russian Journal of Mines.** It is found massive, presenting traces of cleavage. The fracture is splintery and uneven; lustre vitreous; colour lavender-blue, passing into green. It is translucent on the edges. Hardness = 5.0...6.0. Specific gravity = 2.721 Bergemann; = 2.9 John.

According to *Dr Bergemann*, † it consists of

54.58 Silica,	4.57 Potash,
29.77 Alumina,	11.08 Lime.

Its mineralogical formula is $NS^3 + 3CS^3 + AS$.

Before the blowpipe it melts difficultly on the edges, but is soluble in borax and salt of phosphorus. It loses it colour.

It occurs in compact felspar and granular limestone, with talc, near Lake Baikal, in Siberia.

2. *Bismuthic Blende*, a new mineral species described by Professor Breithaupt of Freiberg ‡.—Tessular. Simple forms. $\frac{O}{2}$; $\frac{C1}{2}$; $-\frac{C1}{2}$.

* *Poggendorff's Annalen der Physik u. Chemie*, 1827, Number ii. p. 267.

† *Von Leonhard's Handbuch der Oryktognosie*, 2d Edit. p. 741.

‡ *Poggendorff's Annalen, &c.* 1827, Number ii. p. 275.

Character of combination, semi-tessular, with inclined faces. Combinations, 1. $\frac{C1}{2}.-\frac{C1}{2}$. 2. $\frac{C1}{2}.-\frac{C1}{2}.\ \frac{O}{2}$ Plate III. Fig. 12.

Cleavage, dodecahedron, imperfect. Fracture conchoidal, uneven. Lustre adamantine, resinous. Colour, clove-brown and reddish-brown, inclining to blackish-brown and wax-yellow. Streak yellowish-grey, sometimes inclining to smoke-grey. Opaque, semi-transparent.

Brittle. Hardness = 4.5...5.0. Spec. grav. = 5.912...6.006.

Compound varieties.—Twin-crystals: axis of revolution perpendicular, face of composition parallel to a face of the octahedron. Globular and stalactitic, sometimes with fibrous composition. Crystals and imitative shapes very fine.

The chemical composition is unknown.

It is found in veins at Schneeberg in Saxony, in the mine *Kalbe*, with quartz, bismuthic ochre, and native bismuth.

3. *Ilmenite.*—Under this name Professor Kupffer of Kasan describes * a mineral found at Ilmensee, in Siberia, as a new species. Professor Gustavus Rose of Berlin, † and Mr Levy ‡ have since shown that it is nothing else but titanitic iron, a variety of the axotomous iron ore of Mohs.

4. *Oligoclase.*—Under this name Professor Breithaupt ‖ describes a new species of the felspar family. Its forms are tetartoprismatic, like those of Albite, from which it differs in specific gravity, which is = 2.64...2.66. In the second Number of *Poggendorff's Annals* for 1827, Professor Breithaupt says that the soda spodumene from Stockholm belongs to the oligoclase.

Art. XXVIII.—*Notice respecting an Emigration of Butterflies.* § By P. Huber.

In the month of August last (1826) I had the honour to

* *Kastner's Archiv für die gesammte Naturalehre*, 1821. No. i.

† *Poggendorff's Annalen, &c.* 1827. No. ii. p. 286.

‡ *Phil. Magazine*, and *Ann. of Phil.* January 1821, p. 27.

‖ *Poggendorff's Annalen, &c.* 1826. No. x. p. 238.

§ Translated from the *Mémoires de La Societé de Physique et d'Histoire Naturelle de Geneve,* Tom. iii. part ii. p. 247.

communicate to the Physical and Natural History Society of Geneva the following fact, which I believe to be entirely new in the history of butterflies. Not having been an eye-witness, I shall be obliged to enter into all the details necessary to give confidence to my lecture, and I hope I shall be excused, if, in obedience to the wishes of the committee, and in order to give greater notoriety to the phenomena, I omit in this novel relation none of the circumstances necessary to establish the truth of the facts.

This singular observation was made by all the members of a respectable family of Neuchatel in Switzerland, residing during the summer in the district of Grandson, (Canton of Vaud) in the country called *La Outre.*

On the 8th or 10th of the month of June last, Mrs Meuron Wolf saw with surprise passing by the window of her dining-room, which is on the ground-floor of her house, and facing the east, a crowd of flying objects, to which she then paid no attention; but the phenomena continued so long as to excite her curiosity, and mistrusting her own short-sightedness, she called to her son James to go and see what was passing by the terrace.

Mr James de Meuron immediately called his parents to behold a singular and astonishing thing. It was an immense flight of butterflies, who crossed the garden with the utmost rapidity.

They immediately left the table to see this curiosity. It was certainly worth the trouble, and without being naturalists, they could not but admire this beautiful sight.

These butterflies were all of one species, and amongst the most beautiful of our country. They caught several with a net, with the same ease that they fish for herrings. They then recognized them to be the daily butterfly of the thistle, called in French *La belle dame.* These butterflies flew very swiftly, and they all went in the same direction, crossing the garden diagonally, and exactly from south to north. The presence of men did not frighten them; they neither diverged to the right nor the left, and flew as near the one as the other.

The whole of the Neuchatel family, with the true tact of naturalists, divided, that they might better observe the phenomena.

Those who were younger and more active followed the butterflies for a long time in the direction to which they were going, the others went to the other side from whence the columns were coming; but although they accompanied them a very long time, they did not succeed in beholding *either the beginning or the end* of this inoffensive army.

The passage lasted upwards of two hours, without any interruption, from the moment when they were first observed, and it is probable that they had begun some time before they caught the eye of Mrs de Meuron.

The column was from ten to fifteen feet broad; these butterflies did not alight upon the flowers; their flight was low, rapid, and equal.

Such are the facts which have been unanimously transmitted to me by the members of the enlightened and interesting family who were witnesses of the curious phenomenon.

All that has been capable of observation in this remarkable fact has been examined as if by real naturalists, and with that sort of interest which overlooks no characteristic circumstances in a new question, by those young persons, occupied with collections, and well versed in the natural history of insects.

The fact then is undoubted.

But it appears to me most singular, that it relates to a species of butterfly, whose caterpillars do not live in societies (at least not in our country) and are themselves isolated from the time they quit the egg.

I should have been less surprised if I had heard of the emigrations of the butterflies *Petite-tortue*, *Paon de jour*, or *Morio*, whose caterpillars live in common and in very numerous families upon the nettle and the willow. All the caterpillars who live in societies seem to keep together by the common ties of utility; each one goes out to explore, and leaves behind them the silk which helps to conduct their companions upon the branch where they have found food; but when once they are provided with wings these insects seem no longer to recognize each other, as if the state of the chrysalis, that sleep of the instinct, during which the developement of the organs is so active, as if I say that state of transition had made them forget the memory of mutual relations.

Concerning the butterflies, *belles dames*, isolated from their birth, what singular cause could induce their uniting in such numerous phalanxes, and determine them to quit their country for a northern climate, mountainous and severe? From what region do they come, and in what place will they stop?

A fact so striking ought to have made some sensation in other parts: These same butterflies, indeed, were seen in Piedmont by Professor Bonelli of the academy of Turin, before they appeared in Switzerland. According to his account, given in a letter addressed to Mr Moricand, 13th January 1827, the appearance of the thistle butterflies took place in the end of March 1826, in the neighbourhood of Turin. These butterflies, though they stopped some time in places through which they passed, went in a mass in a direction from south to north. The air was filled with them, especially where there were flowers, and at night all the plants were covered with them: The 29th of May was the day in which they were most abundant. A considerable number were seen during several days following. Their numbers then sensibly diminished, but a good many remained till the month of June.

The fact was common in all the country, especially at Coni, Racconni, Susa, &c.

A passage similar to this had taken place at the end of the last century. The Count of Locke has given a description of it in the *Memoirs of the Academy of Turin*. There is little doubt that a part of this column, a strong division, had steered towards Switzerland, where it had most probably divided itself in order to occupy our different valleys.

I have reason to suspect that one of these parties had taken the route along the valley of the Lake of Geneva, and had reached that of the Rhone, having heard from the young entomologists that the number of butterflies, *belles dames*, seen this year in the environs of Lausanne as far as Bex, and even to the mountains which end that valley, was infinitely greater than usual. This beautiful butterfly without being rare, is nevertheless not common in our country; but this year, and before I knew of their great emigration, I had myself observed with astonishment the inconceivable numbers of these insects in the districts of Grandson and Yverdun, and what made it more singular, it was not the time when they used generally to appear, which was at the end of summer and autumn; they were also larger and more beautiful than they commonly are, from the brilliancy and fine preservation of their colours. I found a great number at the foot of the mountains, and upon the Jura, where their brilliant appearance contributed not a little to the embellishment of nature.

These butterflies dispersed among the flowers did not appear to have amongst them any other connection but the sexual one.

These caterpillars were from that time well known. They not only found their food upon the thistles and artichokes, but the *viperine* and the leaves of the *passeroses* were attacked.

Here then is a new fact simply stated. One of the most beautiful species of our butterflies comes to us from the south; it flies in a close column, expands through our country, and spreads probably as far as Germany; but are these emigrations frequent, are they annual? The letter of the learned Italian naturalist says, that they had already seen this phenomenon a few years before in Piedmont.

We ought not to infer, from their irruption towards the north, that they emigrate again to our climate in autumn, or that their natural multiplication is not great enough to give an equal increase. These migrations, then, do not resemble those of birds of passage; nevertheless, in our complete ignorance of all the causes and motives which determine them, it is proper to gather the facts which relate to them, and carefully to study all the circumstances. The naturalists of the countries who read our memoirs are invited to communicate their analogous observations. It will be very interesting to know how far the multiplication and existence of this species extended into the south, to know exactly where they came from, in the first place, in what place they are most common, why they quitted it, &c. &c.

The answer to these questions will form one of the most curious chapters in the history of insects.

ART. XXIX.—*On the Permeability of Transparent Screens of extreme tenuity by radiant Heat.* * By WILLIAM RITCHIE, A. M.

THE permeability of transparent screens by invisible radiant heat flowing from a body of an elevated temperature was first established by Professor Prevost of Geneva, and confirmed by the elaborate experiments of M. Delaroche. As the results, however, have been doubted by several philosophers, Mr Ritchie considered that it would be desirable to place the fact beyond the reach of controversy by new experiments.

EXP. 1. A large glass globe having been blown so thin as to be nearly iridescent, a small portion of it was fixed opposite a circular hole about an inch in diameter, in a piece of tin plate. A delicate air thermometer was then placed opposite the disc of glass on one side of the plate, and a heated iron ball opposite to the bulb on the other. The disc of glass was kept uniformly *below* the temperature of the surrounding air by a current of cold air playing constantly against it. The following results were then observed :—

1. When the ball was at a low temperature, the thermometer indicated no sensible effect.

2. When the temperature of the ball was high, but not visible in the dark, the effect on the thermometer was very considerable, even when the ball was placed at a greater distance than formerly.

" Here," says Mr Ritchie, " we have two sources of heat, which, on account of the change of distance, would produce equal effects on the naked bulb of the thermometer ; but by the intervention of a cold screen the effect of the former is almost annihilated, whereas the effect of the other is still very considerable. This difference cannot possibly result from the difference of temperature in the screen, which is kept as nearly as possible at the same temperature by the influence of the current of cold air. We are therefore unavoidably led to the following conclusion,—*that the progress of the heat was in the*

* This is a full abstract of Mr Ritchie's paper read before the Royal Society on the 8th March 1826.

first experiment arrested by the screen; whereas in the other, a portion of it freely radiated through the screen, and found its way directly to the bulb of the thermometer!"

Exp. 2. Two air thermometers, with the thinnest possible bulbs were taken, and the interior hemisphere of one of them was coated with a fine opaque film of pounded charcoal. The bulbs of the thermometers were then placed at the same distance from a heated ball at the temperature of about 200°, and the space through which the fluid descended in each was divided into the same number of equal parts. The heated ball, just visible in the dark, was placed at a greater distance from the two thermometers, and the liquid sunk further in the one with the *coated* bulb than in the other.

Hence it follows, "that when the temperature of the ball was *low*, the whole current of radiant heat was arrested by the external hemispheres of the balls, but when it was *high* a portion of the radiant heat freely permeated the *transparent* bulb, which portion was arrested by the opaque *coating* in the other, and raised the temperature of the included air.

Exp. 3. A number of very fine threads of glass or wire were stretched parallel and at right angles to each other across a frame of moderate size. A broad camel-hair pencil dipped in the white of an egg was brushed over the whole, so as to cover the small square with a delicate transparent liquid film. The screen was then placed between the differential thermometer described in this Number, and the heated body, when the following effects were produced.

1. The temperature of the ball being low, and the screen kept at almost the same temperature by constantly applying the white of an egg mixed with cold water to the upper side of the frame, no sensible effect on the thermometer was perceived.

2. The ball being just visible in the dark, was placed at a greater distance, and a striking effect produced.

Hence *radiant heat freely permeates a very thin transparent liquid screen.* Mr Ritchie also found *that a liquid screen is more permeable by radiant heat than a solid one.*

Exp. 4. When the screen was placed at different distances from the heated ball, a very little difference was observed in the descent of the fluid. In one experiment the effect was 18° with the screen close to the instrument, and yet this fluid rose only *one degree* when the screen was removed five inches towards the heated ball.

Hence in the preceding experiment the effect was not produced by heat radiating from the posterior surface of the screen, but by heat actually radiating *through* the screen, in the same manner as light radiates through water, or other transparent fluids.

Art. XXX.—*On a new form of the Differential Thermometer, with some of its applications.* * By William Ritchie, A. M. Rector of Tain Academy.

On account of the difficulty of placing the bulb of the thermometer exactly in the focus of a metallic reflector, when the source of heat is removed to different distances, Mr Ritchie has proposed the following instrument for experiments on radiant heat.

It consists of two cylindrical chambers of very thin brass or tin plate from *two* to *six* or *eight* inches in diameter, and from a quarter of an inch to an inch thick. These chambers, like those of the photometer, described in this *Journal*, Number iv. p. 340, are connected by a thermometer tube bent in the form of the letter U, having small bulbs blown near its upper extremities. The tube contains a coloured fluid, such as sulphuric acid tinged with carmine, alcohol, &c. The outer faces of the cylindrical chambers are coated with lamp black, in order to absorb the radiant heat, which is quickly conducted to the interior of the chamber, and expands the included air. The scale may be divided into any number of equal parts, as the results are only to be compared with each other.

Mr Ritchie next proceeds to determine by this instrument the law of decrease of radiant heat with the distance.

Exp. 1. A cylindrical vessel of tin plate filled with hot water, and having its diameter the same as that of the cham-

* This is a full abstract of Mr Ritchie's paper read before the Royal Society, December 21, 1826.

bers of the thermometer, was placed at different distances from it. The *results deviated very considerably from the law of the squares of the distances.*

Exp. 2. The same experiment was repeated with a canister of a smaller diameter. *The results now approached more nearly* to the squares of the distances.

Exp. 3. Iron balls about two inches in diameter were now substituted in place of the canister. *The results were now within the limits of error, as the squares of the distances of the centres of the balls from the end of the instrument.*

Exp. 4. Two heated balls were placed on one side of the instrument, and one on the other, (the whole being of the same temperature,) and the instrument was moved till the fluid remained at zero. *The distances of the centres of the balls were then as* 1 to the square root of 2.

The deviation from this law in the case of the large canister was ascribed by Mr Leslie either wholly or in part to *imperfect reflection;* but as the same anomaly takes place without *reflection,* Mr Ritchie concludes that this cause cannot be the true one.

Art. XXXI.—*Notice respecting Professor Hansteen's New Chart of the Isodynamic Lines for the whole magnetic intensity.* With a Chart, Plate IV. Communicated by Professor Hansteen of Christiania.

We have much pleasure in laying before our readers a corrected chart (Plate IV.) of Professor Hansteen's Isodynamical lines for the whole magnetic intensity, which he has been so kind as to communicate to us. It contains the recent observations made by Captain King at Rio Janeiro and Maldonado Bay, near the River Plate.

The dotted line of the dip in 1780 will be seen cutting the equator in 90° west longitude, and passing through Bahia towards the equator in 40° east long. The same line for 1823 will be seen to the south of Bahia, cutting the former in 10° west longitude, and passing to the south of Ascension and St Thomas.

The uppermost curve on the left hand, where the intensity is 1.7 returns into itself in an oval form, and surrounds the whole of Hudson's Bay, touching nearly the 70th degree of north latitude. The maximum intensity appears to be 1.8, and occurs in the centre of the above oval near the bottom of Hudson's Bay, *at a distance of more than 35° from the North Pole of the earth.* This point is consequently altogether different from that point where the dip is = 90°, a result which perfectly agrees with Professor Hansteen's theory of two magnetic axes. In his *Researches* respecting the magnetism of the earth, p. 373, he has already hinted that the inclination of the magnetic axes must be greater than is there assumed, a fact which the chart of intensity plainly shows, and by previously assuming this angle at 35° he found that there was such a very near agreement between the calculated and observed variations, dips, and intensities, that he has no doubt that the theory will perfectly harmonize with the observations.

In every meridian there is a minimum of intensity near the equator; but these minimums are of different values in different meridians. The greatest of these minimums occurs in about 112° west longitude from Ferro, and about 7° north latitude, and amounts to 1.51. The least minimum occurs in 50° east longitude, and about 14° south latitude, and amounts to 0.8. A line joining all these points of least intensity would be called the line of the minima. This curve, it must be observed, is very different from the line of the dip. It would be of great interest to the theory to determine, by accurate experiments, the ratio between the greatest and least minimum, and the situation of the two points where they occur. The eccentricity of the magnetical axes might thus be exactly determined.

As the chart does not contain the northern parts of Europe, we may mention that the curve line of

1.6 passes north through Greenland.

1.5 passes south of Iceland, and turns round the north of Lapland.

1.4 passes through Edinburgh, through Norway, Sweden, Finland, and south of Archangel.

1.3 passes through Madrid, Austria, Poland, &c.

Art. XXXII.—*On Berthierite, a New Mineral Species.* By William Haidinger, Esq. F.R.S.E., &c. Communicated by the Author.

The species to which the present communication refers is one of the numerous results of Professor Berthier's indefatigable exertions to increase our knowledge of mineral productions. No scientific account of it having yet reached this city, I must content myself with giving here what can be extracted from *Le Globe* newspaper of the 30th June 1827, relative to a meeting of the Institute, held on the 25th of the same month. In that meeting M. Berthier gave an account of the new species, and did me the honour of proposing for it the name of Haidingerite, not aware of the same name having been previously applied by Dr Turner * to the diatomous gypsum-haloide, a species which I had described some time ago, and which Dr Turner had analyzed,† and found to be an arseniate of lime combined with less water than in the pharmacolite. In order to avoid the double employment of one name, I take the liberty of proposing a new name for the new substance. From my coming thus forward, I trust M. Berthier will perceive my desire of having my name linked with the literary history of the species in question; while the mineralogical public will no doubt approve of my proposing the name of Berthierite, which happens to be unoccupied, and which is peculiarly appropriate to the species in question; much more so than most of our mineralogical names, as the species was not only discovered and analyzed by M. Berthier himself, but, by the particular process which he devised, rendered useful to the arts.

The Berthierite is an ore of antimony in the economical acceptance of the word; as it consists of four atoms of sulphuret of antimony, and of three atoms of protosulphuret of iron, the antimony being combined with twice as much sulphur as the iron. It occurs at Chazelles, in Auvergne, in a vein which promises to be very productive. It had been worked for

* *Edin. Journ. of Science*, April 1827. † *Id.* October 1825.

some time, but was again abandoned on account of the bad quality of the antimony extracted. M. Berthier has imagined the following process, by which the metal obtained becomes perfectly pure. The mineral, without previous roasting, is to be melted with about one-third, or a little less, of its weight of metallic iron, to which is added a small quantity of sulphate of soda mixed with charcoal.

In regard to its external appearance, Berthierite much resembles some of the other species of the genus antimony-glance, as the common grey antimony, and the Jamesonite, and also the zinkenite. It occurs in elongated imbedded prisms, with a single pretty distinct longitudinal cleavage. Its colour is a dark steel-grey, inclining to pinchbeck-brown, with a metallic lustre. These properties are not sufficient to characterize the mineral. A future number of this Journal will contain an exact account of all of them.

Art. XXXIII.—ZOOLOGICAL COLLECTIONS.

1. *On the Change in the Plumage of some Hen Pheasants.* By. W. Yarrell, Esq. F. L. S.

The last shooting season having been unusually productive of hen pheasants, which have assumed more or less the plumage and appearance of the male, much discussion has in consequence arisen on the cause of this change; and the author, having had many opportunities of examining the facts, as respecting both the pheasant and the domestic fowl, was induced to notice the internal peculiarities which invariably accompany this transformation. According to an opinion of John Hunter and Dr Butter, this change only takes place at an advanced age; but Mr Yarrell considers the facts in his possession as at variance with this idea, and that the appearances in question may occur at any period of life, and may even be produced artificially.

In all the instances examined by him the sexual organs were found diseased, and to a greater or less extent in proportion with the change of plumage. The ovarium was shrunk, purple, and hard. The oviduct diseased, and the canal obliterated at the upper part, immediately preceding its infundibuliform enlargement at the bottom of the ovarium. Having opened a hen pheasant in her natural plumage for the sake of comparison, he found a similar diseased state of the organs to exist, thus proving that the disease must exist some time before the corresponding change of feather takes place. He observes, that it is no uncommon thing to find among numerous broods of pheasants reared by hand, some females, which, at the age of only four months, produce the brightest plumage of the male; and in two instances of birds shot in a wild state the nest-feathers had not been shed, proving them to have been birds of the year.

A partridge, having a white bar across the breast, and the first three primaries in each wing white, being opened, exhibited the same sort of organic disease; and from circumstances adduced, it appears that this was also a bird of the year.

But all variations in plumage are not traceable to this cause. In most of the excepted instances, however, the individuals are dwarf birds; and the author attributes their variety of plumage to defective secretion, the effect of weakness.

When the sexual organs are artificially obliterated in the common fowl, as soon as the operation is performed in the male bird, he ceases to crow, the comb and gills do not attain their full size, the spurs remain short and blunt, and the feathers of the neck assume an appearance intermediate between the hackled character of the cock and the ordinary web of the hen. When the oviduct of the female is obliterated, the ova cease to enlarge; she makes an imperfect attempt to crow; the comb increases in size, and short and blunt spurs make their appearance. The plumage alters in colour and in form, approaching to that of the cock, the bones of the lower part of the back never acquiring the enlargement requisite for giving a proper breadth to the pelvis. In short, the two sexes approximate so nearly in character by this process, that it frequently becomes difficult to determine the sex.

Hen pheasants assume the plumage of the male at best but imperfectly, and it is probable that they do not live many years after the change.

It appears to be a general law, that where the sexes of animals are indicated by external characters, these undergo a change, and assume a neutral appearance, whenever original malformation, subsequent disease, or artificial obliteration has deprived the sexual organs of their true influence. —*Annals of Philosophy*, July 1827, p. 67.

2. *Observations on the Scarus of the Ancients.** By BARON CUVIER.

This fish, which was so celebrated among the naturalists and epicures of ancient Rome, still exists upon the shores of Greece, and has always preserved the same name. M. Cuvier, who has observed that in a great number of instances the names given to animals are preserved with singular fidelity, conjectures that the *scaros* of the modern Greeks is the same as the ancient *scarus*. He has collected particulars from these parts, and has had one of the fish sent to him, which he has presented to the academy, and which appeared to possess all the characters which are mentioned by the ancient naturalists. Aristotle particularly remarks that the Scarus was fond of vegetables, and the form of its teeth; he adds also, but as a mere report, that it ruminated. The stomach of the Scarus could never admit of rumination; but the habit which it had of keeping *le bol alimentaire*

* The memoir, of which this is a brief abstract, was read to the Academy of Sciences on the 25th June 1827.—See *Le Globe*, 28th June.

a long time in its mouth has easily led to this mistake. As to the rest, every thing in the *scaros* of the modern Greeks agrees with the picture of the Scarus of which so many of the ancient naturalists have spoken; the same colour, same shape, the same delicate flesh, which made it so much in request among the epicures of Rome; the same excellent flavour of its intestines, and the same address with which it avoids the snares laid for it. In short, the popular opinion respecting the succours which these fish lend to others of their species to help them out of the nets prevails yet among the Greeks.

3. *Notices regarding the Camelopard.*

As a live camelopard has been sent to London and another to Paris, the history and habits of these animals have excited some interest. At a meeting of the Academy of Sciences on the 2d July last, M. Geoffroy Saint-Hilaire observed that naturalists were wrong in supposing that there was only one species of the camelopard. The animal now in Paris differs from the Cape of Good Hope species by several essential anatomical characters, and he proposes to distinguish it by the name of the *Giraffe of Sennaar*, the country from which it comes. Some natives of Egypt having come to see the one in Paris in the costume of the country, the animal gave evident proofs of joy, and loaded them with caresses. This fact is explained by the circumstance that the Giraffe has an ardent affection for its Arabian keeper, and that it naturally is delighted with the sight of the turban and the costume of its keeper.

Some authors have proved the mildness and docility of the camelopard, while others represent it as incapable of being tamed. This difference is ascribed by M. Saint-Hilaire to difference of education. Four or five years ago a male Giraffe, extremely savage, was brought to Constantinople. The keeper of the present Giraffe had also the charge of this one, and he ascribes its savageness entirely to the manner in which it was treated.

At the same sitting M. Mongez read a memoir on the testimony of ancient authors respecting the Giraffe. Moses is the first author who speaks of it. As Aristotle does not mention it, M. Mongez supposes that it was unknown to the Greeks, and that it did not then exist in Egypt, otherwise Aristotle, who travelled there, must have known about it. In the year 708 of Rome, Julius Cæsar brought one to Europe, and the Roman Emperors afterwards exhibited them at Rome, either for the games in the circus, or in their triumphs over the African princes. Albertus Magnus, in his *Treatise de Animalibus*, is the first modern author who speaks of the Giraffe. In 1486 one of the Medici family possessed one at Florence, where it lived for a considerable time.

In its native country the Giraffe browses on the twigs of trees, preferring plants of the Mimosa genus; but it appears that it can without inconvenience subsist on other vegetable food. The one kept at Florence fed on the fruits of the country, and chiefly on apples, which it begged from the inhabitants of the first storeys of the houses. The one now in Paris, from its having been accustomed in early life to the food prepared by the Arabs for their camels, is fed on mixed grains bruised, such as maize, barley, &c. and it is furnished with milk for drink morning and evening. It however willingly accepts fruits and the branches of the acacia which are presented to it. It seizes the leaves with its long rugous and narrow tongue by rolling it about them, and seems annoyed when it is obliged to take any thing from the ground, which it seems to do with difficulty. To accomplish this it stretches first one, then the other of its long fore-legs asunder, and it is not till after repeated attempts that it is able to seize the objects with its lips and tongue.

The pace of the Giraffe is an amble, though when pursued it flies with extreme rapidity, but the small size of its lungs prevents it from supporting a lengthened chase. The Giraffe defends itself against the lion, its principal enemy, with its fore feet, with which it strikes with such force as often to repulse him. The specimen in the museum is about two years and a half old.

M. Geoffroy-Saint-Hilaire on the 8th of August presented two heads of the Giraffe to the Academy in illustration of its organization. One of these, the head of a young animal, showed that the horns are not, as believed, simple excrescences of the frontal bone, but a superadded process, which it is possible to separate at a certain age. This structure, common to the stag, seems to justify the classification adopted by M. Geoffroy, especially as it has also been remarked, that in the horns of the adult Giraffe are tuberosities analogous to the antlers of the stag.

The name *Camelo-pardalis* (camel-leopard) was given by the Romans to this animal, from a fancied combination of the characters of the camel and leopard; but its ancient denomination was *Zurapha*, from which the name Giraffe has been adopted.

4. *On the Poison of the Rattlesnake.*

The curious fact regarding the poison of the Rattlesnake, alluded to in our last number, as related by Mr Audubon, was, it has been pointed out to us, originally published in a volume of Letters by J. Hector St John, an American farmer, and copied into *Dodsley's Annual Register* for 1782. We now give it as there detailed.

"One of this species (the rattlesnake) was the cause some years ago of a most deplorable accident, which I shall relate to you as I had it from the widow and mother of the victims. A Dutch farmer of the Minisink went to mowing with his negroes in his boots, a precaution used to prevent being stung: Inadvertently he trod on a snake, which immediately flew at his legs, and as it drew back in order to renew its blow, one of his negroes cut it in two with his scythe. They prosecuted their work and returned home. At night the farmer pulled off his boots and went to bed, and was soon after attacked with a strange sickness at his stomach; he swelled, and, before a physician could be sent for, died. The sudden death of this man did not cause much inquiry. The neighbourhood wondered as is usual in such cases, and without any further examination the corpse was buried. A few days after the son put on his father's boots, and went to the meadow. At night he pulled them off, went to bed, and was attacked with the same symptoms, about the same time, and died in the morning. A little before he expired the doctor came, but was not able to assign what could be the cause of so singular a disorder. However, rather than appear wholly at a loss before the country people, he pronounced both father and son to have been bewitched. Some weeks after the widow sold all the moveables for the benefit of the younger children, and the farm was leased. One of the neighbours who bought the boots presently put them on, and was attacked in the same manner as the other two had been; but this man's wife being alarmed by what had happened in the former family, dispatched one of her negroes for an eminent physician, who fortunately having heard something of the dreadful affair, guessed at the cause, applied oil, &c. and recovered the man. The boots which had been so fatal were then carefully examined, and he found that the two fangs of the snake had been left in the leather, after being wrenched out of their sockets by the strength with which the snake had drawn back its head. The bladders which contained the poison, and several of the small nerves, were still fresh and adhered to the boots. The unfortunate father and son had been poisoned by pulling off these boots, in which action they imperceptibly scratched their legs with the points of the fangs, through the hollow of which some of this astonishing poison was conveyed."—*Dodsley's Annual Register* 1782, *Nat. Hist.* p. 100.

5. *Observations on Toads found alive at great depths in the ground.* By M. Geoffroy Saint-Hilaire.

Dr Quenin, physician and mayor of Orgon, exhibited to M. Geoffroy Saint-Hilaire a toad which had been taken alive from a well that had been covered up for 150 years. This well was excavated in the rock to a depth of fifty-two feet. In announcing this fact to the Academy of Sciences on the 18th of June last, M. Geoffroy Saint-Hilaire entered into a discussion upon the curious phenomena of the preservation of animals enclosed in places where they remain without motion, or nourishment, or respiration. He states, that in a memoir presented lately to the Academy, an ineffectual attempt was made to prove, from learned researches, that all the facts stated by authors upon this subject are forged. M. Geoffroy, in considering the existence of these facts as at least very probable from the concurrence of so many witnesses in their favour, is of opinion that it gives a very inaccurate idea of this phenomena to assimilate the state of those beings whose lives are preserved in torpidity to the animals benumbed during winter. According to him, if the phenomena can be demonstrated in an incontrovertible manner, we must conclude *that there exists, for organization under certain combinations, a state of neutrality intermediate between that of life and death,* a state into which certain animals are plunged in consequence of the stoppage of respiration, when it would take place under determinate circumstances. This is observed in a certain degree in the crustaceous animals; vital action is probably suspended in them in such a manner that the excitation of certain agents is required to awaken them and put them into motion. Most certainly the toad found in the well near Orgon was not alive; but all at once, when brought into the air, it became re-animated, being somewhat similar to the state of the fœtus when it comes from the membrane.

Art. XXXIV.—HISTORY OF MECHANICAL INVENTIONS, AND PROCESSES IN THE USEFUL ARTS.

1. *Account of a Sea Couch for preventing Sea-sickness.* By Mr S. Pratt, New Bond Street.

The object of this ingenious invention is to construct an elastic or swinging seat, couch, or bed, for preventing the uneasy motions of a ship or a carriage. To effect this, the frame of the seat or couch is suspended on jimbals or joints, turning at right angles to each other, and an elasticity is produced both in the seat or cushion, and in the swinging-frame, by the use of spiral metal springs. These springs are made by twisting steel or iron wire into the form of an hour-glass, that is, like two cones united at their apices. The lower points of these springs are to be sewn to the canvas or webbing, and their upper parts secured in their proper situations and erect positions by pack-thread or small cords, tied or braced from one to the other, crossing like a net. On the tops of these springs the usual covering of canvas is laid, and then a thin layer of horse hair or wool, upon which the outer covering is fitted.

Mr Newton, the editor of the *London Journal of Arts and Sciences*, and a competent judge, has actually used this invention in a voyage across the channel, and in a journey in a jolting diligence to Paris, and found it to answer its purpose completely. He judiciously proposes that a number of the seats should be let out for hire at Dover, Brighton, Holyhead, and Liverpool, Glasgow, and London.—*Journal of the Arts*, May 1827, p. 117.

2. *Notice of Mr Perkins's Steam Engine.*

We are informed by Mr Newton that he has repeatedly seen this engine in action since his last notice of it. (See this *Journal*, No. xii. p. 338,) and that it gives great satisfaction to those who have visited it. The following testimonial has been given respecting it, for some private purpose, by several respectable engineers, whose names he does not publish. " We, the undersigned, having made ourselves practically acquainted with Perkins's high pressure safety steam engine, do not hesitate to state that he has established the following new and important facts in the construction of his engine. 1*st*, Absolute safety. 2*d*, Greater economy in fuel than in any other engine hitherto invented. 3*d*, The removal of all the reaction of the steam and atmospheric air on the eduction side of the piston, without the necessity of an air-pump. 4*th*, A new and simple flexible metallic piston, requiring no oil or lubrication whatever. 5*th*, A reduction of three-fourths of their weight and bulk, by very much simplifying certain complicated parts of steam engines, and substituting a very simple eduction valve for the one commonly used both for eduction and induction, by which means a reduction is made in the size of the engine; a saving of power is effected, and a diminution of friction; less wear and tear occurs, and less destructibility of materials; and lastly, the joints, by Mr Perkins's peculiar mode of connecting, are more easily made secure and tight, even with the steam at the pressure of 1000lbs. to the square inch, than the joints of the low pressure condensing engines."—Newton's *Journal of the Arts*, May 1827, p. 162.

In the same Journal for July 1827 we find the following certificates:—

"We, the undersigned, certify, that there are two low pressure steam engines employed night and day in discharging the water which flows into St Catherine's dock from the land springs, &c., and that one of them is a *sixteen*, and the other a *ten* horse engine. We also certify that Mr Perkins has recently put up a small high pressure steam engine, the diameter of whose piston is eight inches, and its stroke twenty inches, and yet we have seen this engine pump the same quantity of water from the docks which has been heretofore pumped by the other two.

"James Lamon.
"Pearson Woodward.
"Thomas Browne."

"I, the undersigned, certify that I have put up Mr Perkins's high pressure safety engine, and that what is stated by the above engineers is true, and that it was done with only 42lbs. of coal per hour. Having been engaged twenty-two years in making and putting up engines, principally in Cornwall, it is not likely that I could be deceived as to the power and efficacy of this engine, and I conscientiously believe that two-thirds of the coals used in this country might be saved by the use of this engine.

"Henry Hornblower."

"I, the undersigned, carefully weighed the coals, and placed them under Mr Perkins's generator, and 42lbs. weight of coals only were used per hour. I also certify that what is stated by the above engineer respecting the work done is true. "W. Herne."

Mr Perkins is of opinion that the two low pressure engines could not have been worked up to their full power, though they used the full quantity of coal, $3\frac{1}{4}$ bushels per hour. But admitting that they worked only at two-thirds of the power, there would be a saving of three-fourths of the coal consumed in low pressure engines, by the employment of Mr Perkins's new principle.

3. *Account of a new Register Rain-Gage.* By B. Bevan, Esq. Civil Engineer.

The *collecting* vessel of this rain-gage has the form of an inverted cone, with a base twelve inches in diameter. From the lower end of this vessel passes a tube three-fourths of an inch in diameter, to the *receiving* cylinder, six inches in diameter, and thirty-six inches deep. In the receiving cylinder there is a copper float about nine and a half inches in diameter, and two inches high, having a socket on the middle of the upper side to support a light rod of deal about five feet long, near the upper part of which is fixed a small frame with friction rollers to support a black lead pencil. The pencil is kept upon the roller by a small weight, and is also pressed forwards by another small weight against a sheet of paper, which is fastened upon a brass cylinder two feet long, and five inches in diameter. The brass cylinder is connected by a line and pully wheel, with a time-piece, so as to revolve uniformly at any pace that may be required. The whole of the apparatus, excepting the first-mentioned conical vessel, is placed under cover. The deal rod which carries the pencil is about four inches wide, and one-fourth of an inch thick, and passes between two vertical guides to insure the parallel position of the pencil.

The moment the rain begins to fall into the collector it is conveyed by the tube into the receiving cylinder, and begins to raise the float, and with it the dial rod with its pencil, which makes an oblique line on the paper compounded of the vertical motion of the pencil, and the horizontal motion of the surface of the brass cylinders, and indicates the quantity of rain fallen by the total height of the oblique line, and the rate of falling by the angle of obliquity, and the time of the beginning and end of each shower by the distances along the line.

The only care necessary is to wind up the time-piece from time to time, and to take off the paper from the cylinder and replace it with a fresh sheet, marking the time on the paper when it is put on.—*Annals of Philosophy*, July 1827, p. 74.

4. *New Process for making Steel.* By CHARLES MACKINTOSH, Esq. Glasgow.

There are few individuals of the present age who have done so much for the advancement of the useful arts, and for the promotion of the manufactures of his country, as the eminent individual whose new process we are about to describe. In the patent by which he has secured the privilege of this invention he claims, as the principle of his process, the impregnation of iron at a high temperature with carbon in a gaseous form. The gas which he employs as the most economical and convenient for this purpose is that evolved from coal under distillation. The iron is inclosed in a crucible, or melting pot, of the usual materials, and placed in the furnace, and when it is raised to a very high degree of temperature, a jet, or current of the gas, is thrown into the crucible through a suitable aperture and tube provided for this purpose. In the cover of the crucible there is made another aperture to permit the escape of that part of the gas which is not absorbed by the iron.

5. *Method of improving Soap.* By Mr WILLIAM POPE, Lombard Street.

This process, for which a patent has been obtained, is as follows:—A hundred weight of good soap is sliced into thin pieces, and mixed with seven pounds of marl of the purest kind, two ounces of potash, and a sufficient quantity of water to reduce the whole into a fluid state. The soap being thoroughly dissolved, the materials are stirred together, and when of the consistency of cream they are boiled, and then poured out into suitable moulds for making it into cakes. This process greatly improves the soap, by destroying the effects of the caustic alkali upon the skin, and it also renders it soft and smooth.—Newton's *Journal of the Arts*, May 1827, p. 140.

Art. XXXV.—ANALYSIS OF SCIENTIFIC BOOKS AND MEMOIRS.

Memoir on the Geology of Central France, including the volcanic formations of Auvergne, the Velay, and the Vivarais. By G. Poulett Scrope, Esq. F. R. S., F. G. S. In one Volume 4to, with a Volume of Plates. Lond. 1827.

The subject of volcanos, whether active or extinct, must always be considered as one of the most important in geology. The products of their eruptions are derived from those inner regions of the globe which would otherwise be inaccessible to observation; and the primary phenomena which they exhibit, as well as the extraordinary effects by which these phenomena are attended, give us the only information which we possess respecting those tremendous agents which are imprisoned within the adamantine walls of our planet. It seems scarcely possible to conceive that the study of volcanos could have been set at nought by any person bearing the name of a geologist. Some of the half-taught votaries of the Wernerian School indeed affected to consider them as mere superficial convulsions, which had no effect on the main crust of the globe, and which disclosed none of the secrets of its interior arrangements. Such opinions had no other object but to undervalue the influence of a central heat as one of the leading agents in the induration and elevation of the earth's crust, but though they passed current in that level of intellect for which they were adapted, they at last roused the indignation of the philosophical geologist, and have at last sunk never more to rise, under the the powerful weapons of argument and observation.

One of the first persons who assailed and overthrew these dogmas of the Wernerian theory, was our distinguished countryman Professor Playfair. In a dissertation on volcanos which he read to the Royal Society of Edinburgh, and which was intended to form a part of the second edition of his *Illustrations of the Huttonian Theory*, he arranged all the facts which characterized the most remarkable eruptions, he traced over the globe the effects of the earthquakes which accompanied them, and he proved by calculations, founded on these facts, that the agent from which they arose must in some cases have been seated at a depth beneath the earth's surface at least $\frac{1}{3}$ or $\frac{1}{4}$ of its radius. These opinions, though the memoir which contained them was never published, were speedily propagated, and several of our young geologists, who had not been tainted with preconceived opinions, devoted themselves to the study of the volcanic phenomena.

One of the most distinguished of these was Mr Scrope, the author of the present work, who explored with his own eyes the volcanos of Italy and Sicily, and whose work on that subject we have already fully analyzed in a preceding number. Not satisfied, however, with the study of active volcanos, he resolved to examine those which had been long extinct, and whose products, modified by accidental causes, and by the action of diurnal operations, might be in some degree assimilated to formations of doubtful origin. With this view he examined the district of Auvergne, covered with extinct craters, the products of which are in contact not only with primitive rocks, but with the tertiary and fresh water strata, or those which have been most recently formed. In June 1821 he established himself at Clermont, and from this central point he made excursions through the vicinity, transferring his head-quarters to the Baths of Mont D'Or, Le Puy, and Aubenas.

The result of this examination is given in two books, the first of which treats of the geology of the interior of France, and the second of the volcanic formations.

After treating in the first chapter of the first book of the primitive and secondary formations, Mr Scrope discusses at considerable length, and with great ability, the curious subject of the fresh water formations of Central France. These are found to occupy three different districts on the primitive plateau, and appear to have been deposited in as many distinct and independent basins, viz. that of the Limagne, the Cantal, and the Haute Loire. These three formations he attributes to the same era, both from the similarity of their composition, and of the fossils which they contain. "That of the Cantal alone," says he, "appears deficient in gypsum, but this may be owing to the very small portion of it which lies open to observation. All are remarkable for containing highly siliceous beds. The formation of the Haute Loire distinguishes itself from the others in the circumstance that the limits of the lake basins in which its strata were deposited remain obvious, so much so, that if the narrow gorges of La Voute and Chamalières were filled up, the lakes would be immediately restored nearly to what may be supposed their original level; while the deposits of the upper end of the Limagne and also of the Cantal are found at a height which overlooks an extensive and low horizon, in which no traces of a former barrier can be perceived capable of containing a body of water accumulated at that level, and we have consequently been forced to suppose these strata to have sustained a considerable degree of elevation since their deposition. The formation of the Limagne is remarkable for the alternation of strata of compact pure marl, which would seem to have concreted from a pulpy mass in the manner of the chalk strata, or the lower beds of shell marl in the Bakie Loch, described by Mr Lyell, (*Geol. Trans.* vol. ii. No. 8. p. 76.) with the beds containing the indusia tubulata, which bear marks of a tedious and gradual formation, analogous to that of stalagmites, and by their gravelly nature, and the characters of the fossils they inclose, appear to have formed the banks of a marsh or river, generally dry, though occasionally overflowed, rather than the bottom of a permanent lake."

As the last fresh water of Auvergne, Mr Scrope classes the remarkable deposit from which tripoli is extracted at Menat between Riom and Montaign. It occupies the bottom of a circular basin about a mile in diameter, encircled by lofty primitive rocks, and emptying itself into the

Sioule by a narrow gully twelve feet deep and ten wide, perforated in the mica schist. Before this passage had been effected, the basin must have been a lake, the sediments of which consist of a black desiccated bituminous clay disposed in thin flakes. Iron pyrites is extremely abundant in this clay, and in many points the pyrites seems to have undergone a spontaneous combustion, and the clay of the strata round been in consequence converted into tripoli, of which the parts most exposed to the heat are of a bright red, the others varying between pink, yellow, and white. These baked beds occasionally alternate eight or ten times with those that are untouched. The tripoli, which is very light, separates with facility into the finest folia; but it is so brittle that it must be taken out with great care by the hand. It is then dried in the sun, and needs no farther preparation for the market. Besides the casts of fish, Mr Scrope observed casts of numerous leaves between the laminæ, which were perfect and beautiful. They resembled those of the willow, the elder, and the sycamore. The fish were very imperfect, but bore some resemblance to the carp and the eel.

Previous to giving an account of the volcanic formations of central France, Mr Scrope has favoured us with some interesting notices of the labours of those geologists who have written on the volcanic remains of that district. When MM. Guettard and Malesherbes passed through Montelimart in 1751 on their return from Italy, where they had visited Vesuvius, they observed the street pavement formed of short articulations of basaltic columns fixed vertically in the ground, and learning that they were from the rock of Rochemaure, and were found also in the Vivarais, they visited that province, and made known its volcanic character. (See *Mém. Acad. Por.* 1752.) The views of these naturalists obtained at first little credit, but M. Desmarest afterwards removed every doubt by his *Memoirs on the Origin of Basalt*, which appeared in those of the academy for 1771. In 1778, Faujas de St Fond published his work entitled "*Des Volcans eteints du Vivarais et Velay*;" but he unluckily found a crater in every chasm and decomposed lavas in beds of marl and sandstone. It was now, however, universally admitted that *numerous volcanos had broken out in the interior of France, at different and very remote periods*, and had covered with the products of their eruptions the provinces of Auvergne, Velay, and Vivarais. M. Dolomieu glanced at this district in 1797, and in 1802 M. de Montlosier published his work *sur la Theorie des Volcans d'Auvergne*, and exhibited the various relations and characters of those volcanic remains. M. de Buch, M. Lacoste, Baron Ramond, and Dr Daubeny, have more recently employed their talents on the same subject.

Mr Scrope next proceeds to give a general account of the two classes of volcanic formation in Auvergne, and afterwards a detailed description of the *four* regions into which he divides the volcanic district, viz. 1. Mont Dome of the Limagne of Auvergne. 2. The Mont Dor. 3. Cantal, and 4. The Departments of the Haute Loire and Ardeche. In his account of the first of these regions we meet with the following interesting observations on the nature and origin of trachyte.

"There is every reason to conclude the trachytes of the Mont Dor and Cantal, as well as the phonolite of the Megen, to have been propelled from a volcanic orifice in a state of liquefaction, and to have followed the inclination of the ground they occupied, flowing in a manner differing only from that of basaltic lavas in proportion to their different consistence and very inferior fluidity, and the accidental circumstances which may have occurred to modify their dispositions.

"It is evident that, under similar circumstances of the surrounding levels and of propulsive force, the tendency of a mass of lava to quit the neighbourhood of the orifice from which it is emitted, will be in exact proportion to its fluidity; and when the fluidity is at its *maximum,* it will accumulate immediately around the orifice: one layer of the half-congealed and inert substance spreading over that which preceded it, till the whole assumes the form of a dome or bell-shaped hillock, perforated in the centre by the chimney or vent through which fresh matter may continue to be expelled, but which will at the end remain closed by that last sent up. Now the variety of trachyte which composes the Puy de Dome and the neighbouring Domitic Puys, consisting almost wholly of felspar, and therefore possessing the lowest possible specific gravity, and at the same time a very rude and coarse grain and highly porous structure, is precisely that species of lava which we should expect *à priori* to have possessed the *minimum* of fluidity when protruded into the air; and we therefore understand perfectly why, instead of flowing in thin and continuous sheets or streams to a distance from its vent, like the basaltic lavas produced about the same time and from the same fissure, it has accumulated in dome and bell-shaped hillocks on the point where it was emitted. That this *was* the mode of production of these masses of trachyte, that they were thrown up on the spots they now occupy is proved by their rising in every instance either from the middle or the side of a regular crater and cone of scoriæ.

"If it could be imagined possible for the volcano of the Mont Dor to have sent forth a vast current of trachyte in this direction, of which these hills have been supposed the remaining segments, in spite of the fact that the great elevation of the granite ridge upon which they rest above the surrounding country, renders it the last of all directions which such a current could have taken, and in spite of the improbability that a rocky bed, of which the Puy de Dome, a mass rising 1600 feet above its base, is *merely* a *detached remnant,* should have left no traces of its existence in the interval between that mountain and the Mont Dor, a distance of 788 miles; yet a still stronger objection to this hypothesis remains behind, viz. the improbability that the position of *each* of these remains should severally coincide exactly with that of the vent of a separate recent eruption; that the *only* points on which the remnants of this supposed bed are to be found, should be *precisely those* on which, from the disturbance occasioned by the volcanic explosions, there would be good reason to suppose it might have been destroyed and carried off.

"The theory of Von Buch evidently approaches more nearly to this explanation than that of Daubuisson and Ramond. Von Buch supposes the Domite to have been "granite liquefied by volcanic heat." I also conceive it to have been, like all lavas, a mass of granite, or some congenerous crystalline rock, which, while confined beneath the surface of the globe at an intense temperature, was suddenly allowed to expand by the bursting of the overlying rocks, and was consequently liquefied, or so far softened by the immediate generation of highly elastic fluids, both gases and aqueous vapour, through every part of its texture, as to be protruded, by the tumefaction incident to this process, through the clefts of the overlying crust.

"The part of Von Buch's theory with which I agree the least, is his supposing these hills to be hollow, and blown up like a bladder. I imagine, on the contrary, the aëriform and highly elastic fluids the expansion of which elevated the lava, to have remained chiefly where they were generated, viz. in a state of uniform and intimate dissemination throughout the texture and between the solid crystalline particles of the porous and elastic mass; and not by any means to have united into one great bubble or volume beneath an overlying cake of the lava, as is implied in Von Buch's theory, a theory which Humboldt has adopted and applied I think with rashness, to all trachyte formations."

In the same region occurs the *Puy de Pariou,* which, from its aspect and that of its lava, is supposed by Mr Scrope to be the result of one of the last eruptions which convulsed the country. The following description of it is peculiarly instructive.

"It is one of the most considerable and regular cones of the chain. A segment of a former crater half encircles it on the north, and here the whole process of this and similar formations is manifest. (See Mr Scrope's *Considerations on Volcanos,* p. 67.) * * * The new crater of Pariou, formed upon the brink of the older one, has the figure of an inverted cone. It is clothed to the bottom with grass, and it is a somewhat singular spectacle to see a herd of cattle quietly grazing above the orifice whence such furious explosions once broke forth. Its depth is 300 and its circumference 3000 feet. The inclination of the sides of the cone and of the crater are both about 35°. The acute ridge resulting from their junction is so little blunted by time that in some parts it scarcely affords space to stand on. Its highest point is 738 feet above the southern base of the Puy.

"The first direction of the lava of Pariou is to the N. E. and the current appears to have set with fury against a long-backed granitic eminence opposing it on that side. Hence, led by a considerable slope towards the S. E. it coasted the base of this hill, and leaving to the right another protuberance of the primitive plateau on which now stand the church and hamlet of Orcines, advanced to a spot called La Barague. Here it met with a small knoll of granite capped with scoriæ and volcanic bombs. Impeded in its progress the lava accumulated on this point into a long and elevated ridge, which still bears the appearance of a huge mass, about to break over the seemingly insignificant obstacle. But an easier issue offered itself in two lateral valleys, having their origin in the part of the plateau occupied by the lava current, which, separating consequently into two limbs, rushed down the declivities presented on either side.

"The right hand branch first deluged and completely filled an area surrounded by granitic eminences, and probably the basin of a small lake; thence entered the valley of Villar, a steep and sinuous gorge, which it threaded exactly in the manner of a watery torrent, turning all the projecting rocks, dashing in cascades through the narrowest parts, and widening its current where the space permitted, till, on reaching the embouchure of the valley in the great plain of the Limagne, it stopped at a spot called Fontmore, where its termination constitutes a rock about fifty feet high, now quarried for building-stone. From the base of this rock gushes a plentiful spring, the waters of which still find their way from Villar, beneath the lava which usurped their ancient channel.

"The branch which separated to the left plunged down a steep bank into the valley of Gresinier, replacing the rivulet that flowed there with a black and shagged current of lava, entered the limits of the Limagne at the village of Durtol, and continuing the course marked out by the streamlet, turned to the north, occupied the bottom of the valley lying between the calcareous mountain Les Côtes and the curtain of granitic rocks, and finally stopped on the site of the village of Nohanent. Here, as at Fontmore, an abundance of the purest water springs from below the extremity of the lava current. The various rills which drain the valley of Durtol and its embranchments have recovered their pristine channel, and filtering through the scoriform masses which always form the lowest surface of a bed of lava, flow on unseen till the rock above terminates, and they issue in a full and brilliant spring. Above this point, consequently, is seen the anomaly of a valley without any visible stream; and the inhabitants of Durtol are condemned, in seasons of drought, to the strange necessity of seeking at Nohanent, a distance of two miles, the water which flows there beneath their own houses.

"In its appearance, the Cheir of Pariou is even more bristling and rugged than those already described. M. D'Aubuisson justly compares it to a river suddenly frozen over by the stoppage and union of immense fragments of drift-ice."

This interesting description is followed by an account of the Puys de Sarconi, a group of volcanic hills, whose structure throw much light on the mode and formation of the dome-shaped masses of trachyte which occur in so many volcanic districts. Our limits, however, will not allow us to transfer it to our pages.

In the departments of the Upper Loire and of Ardeche, there occur a very extensive system of volcanic rocks, of which Mont Mezen is the most elevated. These rocks seem to have proceeded from the S.E. side of Mont Mezen, from which two principal embranchments of clinkstone (*phonilite*) have been projected, one to the S. and the other to the N.N.W. The first exhibits itself in between twenty and thirty neighbouring rocky eminences of considerable magnitude; but the second, which is of a most remarkable character, constitutes a mountainous chain of numerous similar rocks covering a wide extent of country.

"The uniformly progressive declination," says Mr Scrope, "of this system of phonilitic summits from the Mezen to the bed of the river, where they terminate, the two last leaning against the foot of the primitive range of La Chaise Dieu on the *opposite* bank, *proves them, in my opinion, to be the remains of a single enormous lava current, prior in date* to the excavation *of the actual channel of the Loire,* and far the most considerable in bulk and extent of any I have had occasion to observe in the Phlegraen fields of France. *The space it appears to have covered is more than twenty-six miles in length, with an average breadth of six, containing, therefore, a superficies of* 156 *square miles.* Its thickness must originally have been prodigious, and may be judged of by the mountainous portions still remaining. Many of these rise to a height of 400 and 500 feet from their base; and none, I believe, show any marks of a division into separate beds, so that the whole colossal range must be supposed of a piece, the result of an individual eruption. It rests generally on granite, either immediately, or with the intervention of basalt, but appears also to have crossed a large angle of the calcareous fresh water formation which occurs in the neighbourhood of Le Puy."

Mr Scrope concludes the descriptive part of his work with an acccout of a chain of volcanos in the Velay and Vivarais, which he considers as the products of a later effect of volcanic activity. They cover uninterruptedly a broad zone of the primitive plateau from Paulhaguet and Alegre to Pradelle and Aubenas, and seem to be a prolongation of the chain of Puys of the Auvergne. Numerous cones still mark the point at which these eruptions took place; and they are so thickly sown along the axis of the granitic range that separates the Loire and Allier from Paulhaguet to Pradelle, that they generally touch each other at their bases and form an almost continuous chain. Between Pradelle and Aubenas they are of less frequent occurrence, and there are more to the south of the latter. A large and productive group, however, exists to the N. E. of Pradelle in the neighbourhood of Prezailles. Mr Scrope counted more than *one hundred and fifty* of these cones in the above tract. These cones are not so fresh and well-preserved as those of Auvergne. Not many have an entire or even a distinctly marked crater, and as the volcanic energy seems to have been exerted far more furiously, the lava currents have been united into one continuous and enormous current, where all are mingled and confounded. Mr Scrope is of opinion that the most recent eruption of the district was that which produced the double hill of Mont, S. E. of the Le Puy, and which formed a small platform of columnar basalt called Montredon, rising in the middle of the valley of the Borne, and resting on a shingle of primitive and volcanic boulders.

Some of the most remarkable and interesting of the recent volcanic remains in Old France, are those which occur on the deep declivity by which the preceding escarpement is connected with the southern valley of the Bas Vivarais and Languedoc. As seen from below, that front of the great platform appears as a precipitous curtain-like range, broken by recesses into short, deep, and massive formations, in which all the rude and stupendous scenery of a primitive mountain district is displayed in its full magnificence. There we have the grand scenery of the Apennines, with all the luxurious vegetation of the finest chesnut forests. It is, therefore, a striking contrast to observe the six perfect volcanic cones of Montpezat, Burzet, Thueyts, Jaujac, Souillols, and Ayzac, perched at distant intervals on the rocky ridges of these granitic embranchments. For an account of these volcanic cones we must refer the reader to Mr Scrope's work.

In summing up the principal facts in the history of this district, as disclosed by its present appearances, Mr Scrope refers them to four epochs.

1. The primary elevation of the high nucleus of central France above the ocean which deposited the secondary strata, by which a large protuberant mass of crystalline rock, with massive and laminar (granite, gneiss, and mica schist) was erupted in a solid state, and superficially exposed the incumbent secondary strata, apparently sliding away by a lateral movement on all sides towards the lower level.

2. After that occurred an era marked by the abundant deposition of calcareous strata from a series of fresh water lakes, occupying the irregular hollows of that elevated district, and probably overflowing from the highest to the lowest levels; while, at the same time, numerous eruptions of volcanic matter, both trachytes and basalts, were taking place at intervals from these principal habitual sources, as well as from some minor vents.

3. This state of things seems to have been at length disturbed by a second paroxysmal elevation of the same immense continental tract, comprehending both the primitive platform and the overlying fresh water formations. By this the barriers of the lake basins being burst, their contents were discharged upon the lower levels, in one or more sudden debacles, which produced extensive denudations throughout the valleys of the Allier and Loire by the force of the escaping water, and perhaps deposited the vast accumulation of diluvial matter observable along the course of these rivers in the departments of the Allier, Nievre, and Cher.

4. To this epoch succeeded a period of occasional volcanic eruptions, chiefly of separate openings on the longitudinal fracture line, accompanied by the continual deepening and widening of the vallies of the district by ordinary excavating forces; a period which the apparent extinction of the volcanic vents cannot be said to have terminated, since some of these bear all the appearance of very recent activity, and render it by no means incredible that their phenomena may again be renewed at no distant date.

From this brief and general abstract of Mr Scrope's work, the geological reader will perceive how much pleasure awaits him from a perusal of the work itself. To a general reader, even not versant in geological details, the admirable coloured engravings which accompany the work will convey much curious information, and they will, we are persuaded, induce many an ordinary traveller to visit the interesting district which they represent.

As our friend and coadjutor Dr Hibbert is now on his way to examine the geology of Auvergne, &c. we expect to be able to lay before our readers some account of those parts of the volcanic district which Mr Scrope did not examine, and some of which have, we believe, never been described. The whole valley of the Loire, for example, from Roanne southwards up to Le Puy, the Canton of D'Aubrac, and the southern part of the Cantal, will on this account attract his particular attention.

Art. XXXVI.—PROCEEDINGS OF SOCIETIES.

1. *Royal Society of Edinburgh.*

May 7.—The following gentlemen were elected Members:

Alexander Copland Hutchison, Esq. Surgeon to his Majesty's Dock-yard, Sheerness

George Swinton, Esq. Secretary to the Government, Calcutta.

Professor Wallace read a paper on the quadrature of the conic sections, and the calculation of logarithms.

There was read a paper by Dr Brewster on the theory and construction of polyzonal lenses, and their combination with mirrors, for the purposes of illumination in light-houses.

The following papers were communicated to the Society:—

1. Observations on the structure of the fruit in the order Cucurbitaceæ, by Francis Hamilton, M. D. F. R. S. London and Edinburgh.

2. Account of *Oxahverite, a new mineral* from Oxahver in Iceland, by Dr Brewster. Printed in Number xiii. p. 115.

3. Analysis of *Oxahverite*, by Dr Edward Turner. Printed in Number xiii. p. 118

The Society adjourned till November.

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

April 3.—The following Gentlemen were elected Members:

Ordinary.

Mr Charles Chalmers, Edinburgh.

Associates.

Alexander Nasmyth, Esq. Edinburgh.

Mr James Clark, mechanist, Edinburgh.

Mr J. A. Ventress exhibited and described a stereometer on a new construction, for measuring the specific gravity of powders, as well as solid bodies. See last Number, p. 143.

Mr Lizars read a notice on preventing forgery in bank notes, and exhibited specimens of notes executed by himself.

Dr Brewster communicated a notice respecting the theory of Barker's Mill, by Davies Gilbert, Esq. M. P. V. P. R. S. who undertook the investigation, in consequence of that society having offered a premium on the best set of experiments on that machine.

Sir Samuel Stirling Bart. exhibited and described the model of a cart, in which the driver assists the horse in steep ascents, by a piece of mechanism.

Mr COLIN MACLENAN exhibited and explained the model of a horse to be put in progressive motion by its rider.

There was exhibited a very ingenious revolving protracting table, for laying down surveys, and also a portable levelling rod, invented by Mr BUCHANAN, civil engineer.

April 17.—There was read a memoir of the life of M. Fraunhofer, an honorary member of the Society, by Dr BREWSTER. See last Number p. 1.

Mr CLAUD RUSSELL exhibited and described a hydrostatic lamp, which he had used for many years.

Mr MONTEATH of Closeburn, exhibited a model of a machine for polishing stone pavement erected at Closeburn.

The room was lighted by a gas lamp, suspended by the patent gas chain made by Messrs SWAN and NEILL; Mr SIMPSON the patentee, described the chain to the Society.

May 8.—A dissertation was read on the natural history of the herring, considered in connexion with its resort to the Scottish coast, by Mr JOHN MITCHELL Junior Leith, being one of the essays sent in competition for the honorary medal offered by the Society.

A method of making a cheap soda liquor without crystallizing, for the use of turkey-red dyers, by Mr CHARLES CAMERON, Glasgow, was also read.

There was likewise read an account of a proces for making screwed tools and screwed work, by Mr ALEXANDER NICOL, Monikie.

Distribution of Medals.

May 26.—At a general meeting held this day, the following medals were delivered by LORD NEWTON, viz.

1. The gold medal to Mr WHITELAW for his improved clock.
2. A gold medal to Professor WALLACE, for his eidograph.
3. A silver medal to Mr SHIELLS, for his triangle for directing the jets of fire engines.
4. A silver medal to Mr WILLIAM WARDEN, for his safety gas burner.
5. A silver medal to Mr JOHN MITCHELL Junior Leith, for his paper on the natural history of the herring.

3.—*Proceedings of the Royal Irish Academy.*

May 22, 1826.—ROBERT BROWN, Esq. F.R.S. &c. &c. unanimously elected an Honorary Member.

Read a Paper by the PRESIDENT, "Appendix to a former paper on the Quantity of the Precession of the Equinoxes, as determined by certain Stars that appear to have no proper Motion."

June 5.—The subjects for prize essays were chosen, and are as follow:—

1. A premium not exceeding Thirty Guineas to the author of the best essay in answer to the following queries, "What are the general indica-

tions of metals being in any given place, the lines of direction, extent, nd dipping of the veins, deduced from the appearance of the surface, and the occurrence of different metallic substances found combined or associated in veins or beds? What is the medium per centage of the value of the ores hitherto found in Ireland, and the average cost per ton of working and smelting them, with the expence of land and water carriage? It will be necessary that any particular terminology used by miners be added and explained, and that a section of a regularly-worked mine be subjoined."

2. A premium not exceeding Thirty Guineas to the author of the best essay "On the state of Architecture in Ireland previously to the reign of Henry the Second."

3. A premium of Eighty Pounds and the Cunningham Medal to the author of the best essay on the following subject:—"The Social and Political State of the People of Ireland from the commencement of the Christian era to the 12th century; their advancement or retrogression in Science, Literature, and the Arts; and the character of their Moral and Religious Opinions, as connected with their Civil and Ecclesiastical Institutions, so far as they can be gleaned from any *original* writings prior to the commencement of the 16th century, exclusive of those in the Irish and other Celtic languages, as such documents may, on a future occasion, be proposed by the academy as a subject of examination; every statement to be supported, not by references only, but by extracts in the form of notes or an appendix; and it is expected, that every accessible source of information shall be examined, under the above limitation. Besides the above-mentioned prize to the best essay, the academy will give additional premiums to essays on this subject, provided they possess positive merit."

Essays on the first and second subjects will be received, if sent post free to the Rev. J. H. Singer, D. D. Secretary, at any time previous to the 1st of May 1827; and on the third till the 1st of May 1828; each essay to be inscribed with some motto, and accompanied with a sealed billet, superscribed with the same motto, in which shall be written the author's name and address.

June 26.—Read a letter, communicated by the President, from Dr Brewster, expressing the desire of the Royal Society of Edinburgh to possess a set of simultaneous meteorological observations, during a series of years, on the 17th of July and the 15th of January, and accompanied with a schedule for their insertion; after which 100 copies of said letter and schedule were ordered to be printed for distribution among the members.

Oct. 30.—An address was presented to the President, and his answer received as follows:—

My Lord.—In congratulating your Lordship on your recent elevation, the members of the Royal Irish Academy do not merely perform it as a part of public duty, but obey the suggestions of private respect and friendship. In the connection which they have had with you as their President they have become too well acquainted with your worth not to rejoice to see it rewarded; while the zeal with which you have watched over the interests of science, and the success which has attended the application of your distinguished talents to the same object, justify the choice, which, at so critical a period, has raised you to your high station, and form an earnest of the energy with which the duties of that station will be fulfilled. In joining the public feeling which has sanctioned your elevation, we trust that an institution over which you have so long presided, and on which you have reflected the lustre of your talents, will still share your patronage; that, aware of the connection between the interests of true religion and the advancement of sound knowledge, you will still watch over and assist its progress; and that the approbation of your sovereign, which has placed you among the high dignitaries and guardians of the National Church, will not deprive the Royal Irish Academy of your protection as its President. S. KYLE.

MY LORDS AND GENTLEMEN.—It is difficult to express how greatly I appreciate the good opinion of the Royal Irish Academy. The motives which you have been pleased to state as having led you to distinguish me by this great mark of your approbation, will always be present to my mind.

The Academy, founded for the promotion of science and literature in Ireland, requires the joint exertions of its members; and since I have had the honour of presiding therein, I have uniformly been assisted by the most cordial support and co-operation.

Religion and knowledge cannot be separated; each requires the aid of the other. In the station to which his Majesty has been pleased to call me, the pursuits of science may, in my opinion, be continued without impropriety, and without interfering with more appropriate duties.

As a member of the Royal Irish Academy I shall always consider myself as called on to assist in promoting the objects for which it has been instituted. The office which I have held appears to me necessarily to require a residence in or near Dublin; and, however gratified I might be by being continued in this distinguished post, I feel it could not take place without injury to the interests and reputation of the academy, to serve which my humble efforts shall always be directed. JOHN CLOYNE.

Dec. 18.—"Remarks on the Irish Language, with a Review of its Grammar, Glossaries, Vocabularies, and Dictionaries, by Mr James Scurry," was unanimously voted for publication in the Transactions.

Jan. 8, 1827.—A letter from Mr Goulburn being read, stating his Majesty's wishes to have a copy made of the Book of Leacan by Mr Owen Connellan, it was ordered that the librarian be requested to afford him every facility of access to said book in the Academy House for that purpose.

Jan. 22.—The DUKE of BUCKINGHAM was unanimously elected an Honorary Member, and SIR WILLIAM BETHAM an Ordinary Member.

March 16.—The following Members were elected officers and council for the ensuing year.

PRESIDENTS.

The Right Rev. Lord Bishop of Cloyne, D. D., F. R. S. &c. &c.

VICE-PRESIDENTS.

Joseph Clarke, M. D.; Colonel E. Hill; The Provost; William Brooke, M. D.

OFFICERS.

Treasurer.—William Brooke, M. D.

Secretaries.—Rev. J. H. Singer, D.D., F. T. C. D.; Rev. Francis Sadleir, D. D., S. F. T. C. D.

Secretary of Foreign Correspondence.—Colonel E. Hill.

Librarian.—Rev. W. H. Drummond, D. D.

COMMITTEE OF SCIENCE.

His Grace the Archbishop of Dublin; Joseph Clarke, M D.; The Provost; Rev. F. Sadleir, D. D. &c.; Sir C. L. Gièsecke; Rev. R. MacDonnell, D. D., F. T. C. D.; Rev. Dionysius Lardner, LL. D.

COMMITTEE OF POLITE LITERATURE.

Rev. J. H. Singer, D. D. &c.; Andrew Carmichael, Esq.; Samuel Litton, M. D.; Rev. C. R. Elrington, D. D., F. T. C. D.; Rev. W. H. Drummond, D. D.; George Kiernan, Esq.; Rev. John Darley, F. T. C D.

COMMITTEE OF ANTIQUITIES.

Colonel E. Hill; William Brooke, M. D.; Isaac D'Olier, LL. D.; Rev. Henry H. Harte, F. T. C. D.; Thomas H. Orpen, M. D.; Hugh Ferguson, M. D.; Sir William Betham.

An essay "On a New Species of Apparatus designed for popular illustration of Lectures on Mechanical Subjects, by the Rev. D. Lardner, LL. D." was read. A large sectional model of a steam-engine was at the same time exhibited as a specimen of the proposed apparatus.

April 2.—Dr Lardner's essay "On a New Species of Apparatus," &c. was unanimously voted for publication in the Transactions.

An essay entitled "Theory of Systems of Rays, by William Rowan Hamilton, Esq. T. C. D." was afterwards laid before the Council, and referred for reading to its next sitting.

Art. XXXVII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Figure of the Earth, deduced from observations on both hemispheres.*—On the 2d March 1827, M. Duperrey read an account of his experiments with an invariable pendulum, during his voyage in the Coquille. The principal anomalies have been observed in the Isle of France, Mons, Guam, and Ascension. At the Isle of France M. Duperrey found, as Freycinet did, that the pendulum made 13 or 14 oscillations in a day less than it ought to have done, by supposing the flattening of the earth to be $\frac{1}{305}$, as the lunar theory makes it. At the Isle of Ascension we found, as Captain Sabine did, an acceleration of from five to six oscillations, even by

supposing the flattening of the earth to be $\frac{1}{288}$. In other stations the difference is almost nothing, and in some there is a retardation. All these differences cannot be ascribed to errors of observation. M. Duperrey agrees with Captain Sabine, in ascribing them to a want of homogeneity in the earth, considered in its mass, or to simple variations of density in the superficial strata. Both observers have remarked, that the acceleration takes place in volcanic countries, and the retardation on sandy and clayey districts. From M. Duperrey's observations, compared with those of M. Freycinet, it follows that the flattening of the earth for the southern hemisphere is $\frac{1}{291}$, and for the northern are $\frac{1}{288}$.—*Le Globe, Avril* 5, 1827.

2. *Observatory at Vienna.*—The Emperor of Austria, in imitation of the late Emperor of Russia, has purchased for the imperial observatory at Vienna, a telescope by Fraunhofer, similar to the one at Dorpat, and described in this Journal, No. iv. p. 306.

3. *Comet of June* 1827.—M. Gambard discovered on the 20th of June, and M. Pons of Florence on the 21st, a small comet situated in one of the feet of Cassiopeia. It is invisible to the naked eye, and was rapidly approaching to the Pole.

4. *Comet of August* 1827.—On the 3d August M. Pons of Florence discovered a small comet in the constellation of the Lynx. It was moving towards the north west.

5. *M. Bessel's Corrections on Bradley's Observations.*—In the corrections which M. Bessel has suggested for Bradley's observations, and which have been recently published by the Board of Longitude, there is a passage which seems to require some illustration. His remark on p. 259 of vol. ii. is printed as follows:—

1.o and 2.o (Orionis) 40. 2. 6. 12. 37. 38. 33. 0. 1.0.

Now, it would not be easy for a common reader to make out what this 1.0 at the end can mean; and the alteration of the arrangement which is suggested in note *(z,)* would, as it is printed, only increase the difficulty.

The passage in the printed observations is as follows:—

1.o	42. 2. 6. 10.	29. 31. 3.
2.	40. 14. 10. 0.	38. 21. 25.

No constellation is here assigned to the stars by Dr Bradley, and M. Bessel means to point out that both 1.o and 2.o belong to Orion, but that the correction of the numbers refers only to the zenith distance of 1.o. It was to distinguish the different parts of the correction that note *(z)* was added; but here the printer has substituted 10 and 20 for 1.o and 2.o, which destroys the meaning of the whole.

Oxford, *July* 14, 1827. S. P. R.

OPTICS.

6. *M. Cauchoix's New Achromatic Telescope*—M. Cauchoix, a very ingenious optician in Paris, has nearly completed an achromatic telescope, of which the object-glass is *twelve inches* and *three quarters of an inch in diameter*. Its focal length is about 19½ feet. The glass was manufactured by the late M. Guinand.

MAGNETISM.

7. *Professor Hansteen's Magnetic Tour through Siberia.*—We have just learned by a letter from this eminent philosopher, that he proposes to set out on a magnetic tour through Siberia, for the purpose of examining the intensity of the earth's magnetism in different parts of that vast country. As there can be little doubt that the Storthing (national assembly) will grant him the sum requisite for that purpose, he will set out in March 1828. This journey will be a most important one for science, and we may expect to have much light thrown by Professor Hansteen's observations on the curious subject of the magnetism of the earth.

8. *M. Kuppfer on a peculiarity in the Magnetic Equator in Siberia.*—In a memoir on the magnetism of the earth, presented to the Academy of Sciences on the 28th May last, M. Kuppfer announces, that in Siberia the *line of no variation* is surrounded to the right and left with points in which the variation is easterly, or in other words, that there is easterly variation on each side of the line of no variation, a fact which has never been observed any where else. Is it not possible that there may have been a duplication of the line of no variation between the points in which the easterly variation was observed? It is well known that in Siberia, in lat. 60, the line of no variation crosses that parallel *three* times in the Russian empire. This will be seen in Professor Hansteen's chart suited to 1787; and since that time it is possible that two of these branches may have approached so near to each other as to occasion the very remarkable anomaly mentioned by M. Kuppfer.

The singularly irregular form of the eastern line of no variation in passing from Petersburg to New Holland is a subject of prominent interest, and we should like to see it projected from the latest observations that can be got, and compared with the chart of Professor Hansteen. In Dr Young's chart, principally from Churchman, and suited to 1794, the eastern is made as regular as the western line of no variation.

HYDRODYNAMICS.

9. *Heat evolved during the Compression of Liquids.*—It was announced to the Academy of Sciences on the 14th May last, that M. Despretz had found that 1-75th of a degree (*centigrade* of course) of heat is disengaged, by subjecting water to a pressure of twenty atmospheres.

METEOROLOGY.

10. *Brilliant Auroræ Boreales in Scotland on the 27th and 28th August.*—

A fine aurora borealis was seen at Perth on the evening of Monday the 27th of August, and in Roxburghshire on the evening of Tuesday the 28th. On the 27th the coruscations were very rapid and transparent, and overspread nearly the whole northern hemisphere. Some of the flashes were almost vertical; and latterly they resembled, in clearness and motion, the undulations of a bright flame. At one time the meteors formed themselves into a narrow belt, crossing the heavens from east to west.

11. *Hourly Meteorological Observations at Christiania and Drontheim.*—At Christiania we have begun, from the 1st of January of the present year, a series of hourly observations of the thermometer and barometer, taken by night and by day at two of the guard-houses of the town. A similar series will be executed next year at Drontheim, exactly in the manner of the observations now carrying on at Leith Fort under the direction of the Royal Society of Edinburgh.—*Letter from Professor Hansteen to the Editor,* June 30, 1827.

12. *Meteorological Phenomena observed at Plymouth on Sunday, July* 29, 1827.—On the preceding evening the sea and the land were enveloped in a copious mist. There was a very light air from the south. This mist was succeeded towards morning by a fresh east wind, which blew with a force varying between two and three pounds avoirdupoise on a foot square The barometer during the day, between 9 A. M. and 9 P. M. fell a quarter of an inch. The dew point at 3 P. M. was 67 ° and the temperature of the air 75° by Fahrenheit's thermometer. About 5 P. M., notwithstanding the strong east wind which still prevailed on the surface, there appeared above nearly an opposite current, vast banks of clouds being observed to proceed from the west and south. These clouds were principally modifications of the cirrus cumulus and stratus, the cirro stratus prevailing. The curl cloud was discernible in the zenith on a fine blue sky; it seemed like cotton wool violently electrified. At 8 P. M. a long continuous line of cloud extended from the south-east to the north-west, from which proceeded several flashes of lightning, with distant thunder, both in the south-east extremity toward the sea and also toward the west; the distance, as estimated by counting the interval which elapsed between the flash and the sound, being about seven miles. The electrical flashes were now more frequent and brilliant, and distinct sparks were observed to dart apparently upward. There were likewise occasionally other luminous coruscations, not unlike those which are observed to occur when the electric spark is passed through an exhausted receiver. These appeared to dart for a short distance along the inferior edge of the cloud, about its middle portion. The lightning in the south-east now became more frequent and vivid, but the rumbling noise of the thunder was very indistinct. About 9 P. M. the clouds were more immediately over the town, and some rain fell in large drops. The wire of an electrical apparatus for investigating atmospheric electricity became violently electrified, and the shocks from it were similar to those of a powerful galvanic series. This apparatus evinced positive electricity.

The mass of cloud now appeared to move more rapidly toward the north-east, when the luminous flashes were almost incessant, and the light brilliant beyond description. The whole north-east horizon, during three hours, being constantly lighted up either by widely diffused flashes or by brilliant sparks and luminous coruscations, which were occasionally of a red colour; they appeared to strike in all directions, and one in particular was observed to ramify in various directions like radii from a common centre. There were during the evening several shooting stars, some of them of great brilliancy. These phenomena continued until midnight, when the clouds sank in the north east. The lightning was not followed by thunder after the clouds had passed the town, and it was, when heard, rather indistinct. The wind died away at 10 P. M. but sprang up again from the east at about 11, with a moderate breeze. The barometer again rose after midnight, and the next day it blew a gale of wind from the west, the force varying from 5 to 8lbs. on a square foot.

As the preceding very curious phenomena were observed by Mr SNOW HARRIS, an eminent and scientific meteorologist, our readers may depend upon their perfect accuracy.

ACOUSTICS.

13. *Sounds of Gas issuing under great pressures.*—It was observed by M. Clement that a species of suction took place at the orifice of a tube when a current of gas or steam escaped under considerable pressure. A metallic plate was thus suspended, as it were, at the orifice. M. Clement had noticed that the plate thus suspended emitted sounds extremely grave and disagreeable. M. Savart, on the other hand, observed that they were sometimes acute and very agreeable; and having strewed sand upon the surface of the plate, he discovered, from the manner in which it arranged itself, that the sounds are the results of a molecular vibration similar to that which would be produced by the friction of a bow on the edges of the plate, and not of a vibration of the air, analogous to that produced by the mouth-pieces of wind instruments. One of the consequences of this explanation is, that the sounds ought to vary with the size of the plate, which is actually found to be the case.

14. *M. Savart on a new fact in Acoustics.*—On the 30th July, M. Savart announced a new fact in acoustics to the Academy of Sciences, namely, that when the vibrating parts of a body are susceptible of displacing themselves in the body, preserving their respective positions, *they may either oscillate round their first position, or enter into a continued motion of revolution.* The first case takes place when the vibratory motion has been communicated by means of a single stroke of the bow; the second when several repeated strokes of the bow have been given at small intervals. The experiment may be made in two ways with a circular metallic plate, either by means of sand placed on the plate, which, according to the circumstances, takes one or other of the above movements, or by making the rays of the sun fall upon the plate, and observing the image which

they form on the ceiling. This image is not circular, but polygonal, on account of the undulating motion of the reflecting plate, and the angles of the polygon are seen oscillating round fixed positions, or turning in a continuous manner.—*Le Globe*, August 2, 1827.

15. *M. Savart on Normal Vibrations.*—An interesting memoir by M. Savart on this subject was read at the Academy of Sciences on the 13th August. It is well known that sounding bodies emit several sounds at once, and consequently that they are the seat of several modes of division that are superimposed. Among these co-existing modes of division, M. Savart shows that there is always one which is more strongly and distinctly marked than the rest. In order to show this, he throws lycopodium and sand, dry, but not too fine, upon the sounding body. The sand delineates the principal mode of division, and the fine dust the co-existing modes of division, in which the amplitudes, and the oscillations of the vibrating parts are the greatest possible. From the principal figure, M. Savart can predict the secondary acoustic figure, and *vice versa*. He regards the secondary motions as the cause of the *timbre* of different sonorous bodies, and he supposes that the nodal, helicoidal lines which he has observed on the faces of bodies vibrating longitudinally, are only the traces of a secondary mode of division, an opinion which, if confirmed, will throw light on one of the most obscure and curious points of acoustics.—*Le Globe*, August 23, 1827.

ELECTRICITY.

16. *M. Becquerel on the Electricity from the pressure of two bodies, and the cleavage of crystals.*—In a memoir on this subject, read at the Academy of Sciences on the 6th August, M. Becquerel shows, that, if we press two bodies against each other, and afterwards diminish the pressure, and again augment it, these bodies, in being freed from the pressure, never carry off with them any more than the quantity of electricity relative to the strongest pressure, so that the partial frictions which the particles experience during these pressures of unequal intensity produce no modification in the developement of electricity.

M. Becquerel also shows that a great number of substances produce, by rapid cleavage, the same electric phenomena as mica and sulphate of lime. He shows also, that when the separated laminæ are again brought together and slightly pressed, they produce the same effects as by cleavage. Here the pressure produces the same phenomena as the force of aggregation He then shows that in the topaz the species of electricity acquired by each plate, at the time of the cleavage, is not owing to the position of the plate in reference to the axis of the crystal, but to the nature of the vibration of is molecules.—*Le Globe*, 23d August 1827.

II. CHEMISTRY.

17. *Dr Christison on the Taste of Arsenic, and on its property of preserving the Bodies of Persons who have been poisoned with it.* (*From*

the Edinburgh Medical and Surgical Journal for April.)—It is singular that on so important a subject as the taste of arsenic, a point which has been alluded to on so many trials, and which admits apparently of such easy decision, any difference of opinion should prevail among men of science. In most elementary works on chemistry and legal medicine, the taste of arsenic is reported to be acrid, and yet it appears from the facts adduced by Dr Christison, that this poison may be deliberately tasted without exciting any sensation of acridity. After quoting several authorities to support this statement, Dr Christison gives the result of direct trials made by himself and several of his friends. "Dr Turner, lecturer on chemistry, tasted two grains, moving the powder over his tongue and palate for half a minute, and perceived no taste. Mr Haidinger, well known as a mineralogist, tried two grains in the same way, and perceived no taste. Dr Becker, an intelligent pupil of this university, also tried it in my presence, and perceived no taste. I have tried two grains often,—once for a whole minute, and towards the close I thought I perceived a faint sweetish taste, but never any thing else. Dr Duncan Junior tried nearly double the quantity for a minute and a-half, and like me thought he perceived a faint sweetish taste towards the end, but nothing more. With regard to the taste of the solution, Dr Turner perceived an obscure sensation of sweetness. Mr Haidinger thought he perceived a slight astringency; and to myself the taste was faintly sweet and acid: but none of us remarked any acridity."

From this evidence it appears certain, that arsenic, as applied to the tongue and palate, whether in substance or in solution, does not occasion an acrid taste. These observations, it will be remarked, do not decide what the taste would be, were the arsenic applied to the root of the tongue and fauces, as in the act of deglutition. That a substance, however, should excite an acrid taste when swallowed, and not produce that effect when deliberately applied to the tongue and palate, is very unlikely; and indeed Dr Christison has cited one instance of arsenic having been actually swallowed without any sense of acridity being perceived. It is probable, as Dr Christison suggests, that those who have complained of an acrid taste from arsenic, have confounded the primary impression with the inflammation produced by that poison after a certain interval. We are acquainted with no unequivocal instance of a person who complained of acridity, after swallowing arsenic, within that short space of time usually required for the distinct developement of taste. In the trial of Mary Blandy for the murder of her father, the physician reports Mr Blandy to have complained, that *soon after* taking a cup of gruel he felt an extraordinary grittiness in his mouth, attended with a very painful burning and pricking in his tongue, throat, stomach, and bowels. In another part of the examination the symptoms are said to have occurred *almost immediately* after taking the poisoned gruel; but the actual interval was probably not carefully observed, since sufficient time had elapsed for the developement of inflammatory action in the throat and stomach, before any burning pain was referred to the tongue.—(Howell's *State Trials*, vol. xviii.)

The second point which we shall notice in Dr Christison's valuable paper, relates to the property which arsenic possesses of preserving from decay the bodies of those poisoned with it. This subject, hitherto almost entirely neglected in this country, has been investigated by the medical jurists of Germany, who have supplied Dr Christison with most of the facts which he has mentioned. The antiseptic effects sometimes extend only to the stomach and intestines, that is, to the parts directly in contact with it; but in some instances the whole body is preserved. The stomach and intestines of persons killed with arsenic have been found entire and firm at the distance of five, six, and fourteen months, or even at two years, and two years and a-half after death; and in some of these instances the poison itself was detected. It appears from some cases of poisoning which have fallen under Dr Christison's own observation, that, owing to the preservative action of arsenic, morbid changes of the stomach may sometimes be clearly distinguished at an interval of two, three, or four weeks after death.

18. *MM. Delarive and Marcet on the specific heat of the Gases.*—These able young chemists have found that the specific heat of the gases submitted to the same pressure is like their dilatability, always the same. M. Gay Lussac had been led to another result, but this was owing to the apparatus he employed.

19. *Phosphate of Magnesia more soluble in cold than in hot water.—Philosophical Magazine and Annals* for July.—Mr Thomas Graham has observed that the phosphate of magnesia, like the hydrate of lime and sulphate of soda, is more soluble in cold than in hot water. A solution of this salt made with cold water was gradually heated by immersion in the water-bath. Before the bath had reached the temperature of 120° the solution became turbid, and it assumed more and more of a milky appearance as the heat increased, till the temperature settled at 212° F., when a cloudy precipitate slowly subsided, and the supernatant liquid became nearly transparent. The precipitate was found not to differ in its sensible properties from phosphate of magnesia deprived of its water of crystallization. According to the experiments of Mr Graham one grain of the anhydrous phosphate of magnesia requires for solution 744 grains of water at 45° F. and 1151 grains of boiling water.

20. *Liquid Phosphorus at* 40° *of Fahrenheit.*—We have been favoured with the following notice on this subject, by Mr T. Clark of Glasgow. Though not unknown, I believe it is not generally known that a solution of phosphorus in ether, essential oils, or the like, readily affords crystals by slow evaporation. I noticed these for the first time last winter. For the purpose of examination, I had put some of them into an evaporating dish with a little water over them. In the evening, during a hurried visit to my laboratory, I unwittingly filled this dish with boiling water, not observing the crystals I had left in it. The night was a very cold one, and there was no fire in my laboratory. Next morning I was surprised to see oil-like drops at the bot-

tom of the water. Taking them out I found them to be phosphorus, and, of course, recognized them to be the crystals I had examined the day before. A thermometer put into the water at the time stood at 40° Fahrenheit, which is 50° below the melting point of phosphorus. The oily drops remained liquid till I got them on my hand; but they became readily solid, and smoked as phosphorus commonly does. This liquidity of phosphorus, at a temperature so far below its melting point, is analogous to the instance of sulphur mentioned some time ago by Mr Faraday, to the instances of tin and bismuth, discovered long ago by the late Mr Crichton of Glasgow; to those of oil of vitriol and aquafortis mentioned in the *Philosophical Transactions* by Cavendish and Keir, and to the well-known instances of Glauber's salt, and of water; in all of which the liquidity is preserved to many degrees below the congealing points of the substances. The melting point, therefore, is not the lowest point at which a substance can exist in the liquid state, but the highest point at which it can exist in the solid state. I have tried once again in summer to obtain liquid phosphorus by the means above described; and I have succeeded; but the temperature was no lower than 58° Fah.

III. NATURAL HISTORY.

MINERALOGY.

21. *Argentiferous Native Gold in the Mines of Colombia.*—M. Boussingault has found that the native gold of all the localities which he visited is combined with silver in definite proportions, so that one atom of silver is combined with two, three, four, to eight atoms of gold; but the gold is always in a greater proportion than the silver.

In certain mines in Siberia, on the contrary, the number of atoms of silver is much greater than that of the atoms of gold. Notwithstanding this regularity in the combinations, M. Boussingault has never been able to perceive any trace of crystallization, and he thinks himself authorized to conclude, from the facts which he has collected, that these metalliferous beds are not of igneous origin, or if they were, that they must have been cooled with extreme slowness.—*Le Globe,* Mai 10, 1827.

22. *A New locality of Apophyllite.*—During his excursions as a student of geology, Professor Christison many years ago discovered a beautiful variety of this mineral in the Chapel Quarry, near Kirkaldy in Fife. It was at that time declared to be calcareous spar, and as such he preserved the specimen in his collection of minerals, but very liberally presented it to me, when I had made out its true nature. The crystals, of a grey colour, but considerably transparent, possess the form of low rectangular four-sided prisms, whose solid angles are each replaced by one plane, belonging to the acute isosceles four-sided pyramid of 104°2′ and 121°0′, the fundamental form of the species; and the lateral edges by two planes, inclined to each other at an angle of 143°8′, and yielding

an eight-sided prism. The face perpendicular to the axis possesses its usual bright pearly lustre. The sides of the prisms are often half an inch broad. The specimen itself occupied a drusy cavity in the limestone. I had lately the pleasure of examining the same quarry in company with Mr Allan and Mr Robert Allan; but all our exertions were unsuccessful to find any more of the same species, except a small specimen, which I picked up from the rubbish heap near the west end of the quarry. On examination it proved to be apophyllite, filling up, along with a reddish-white translucent variety of opal, the cavity of a shell, probably of Schlotheim's species Gryphites aculeatus, which, although this petrifaction is not sufficiently distinct in the specimen, yet occurs in other parts of the quarry, and also in several other quarries situated in the continuation of the same limestone, as at Innerteil near Kirkaldy. Evidently the variety in the cavity of the shell is the product of a slow process of the same kind as that by which the cavities of amygdaloidal rocks are filled with the various species of the genus kouphone spar, and with apophyllite as one of them; a process similar to that which produced the number and variety of crystals of calcareous spar and brown spar in the same quarry, traversing the limestone in veins, which often contain masses of bitumen, probably the residue of the organic matter of the enormous quantities of corals, encrinites, and shells, which are now found there petrified. The veins lined with crystals are more abundant near the top of the quarry, where the water from the surface had more easy access; and being charged with carbonic acid, could dissolve carbonate of lime from the massive rock; and on the superfluous acid being expelled, deposit it again in the shape of crystals. A short notice of the new locality of apophyllite was given in the *Caledonian Mercury* of Saturday, 8th September 1827. W. HAIDINGER.

GEOLOGY.

23. *New Cavern with Fossil bones.*—On the 20th August M. Marcel de Serres announced to the Academy of Sciences that he had discovered in the department of the Eastern Pyrenees new caverns with bones, which appear to him to give a solution of several of the questions which have arisen from the study of those singular localities.

ZOOLOGY.

24. *A new Species of Buceros*—Besides the common toucan, the *Buceros albirostris,* we have got a noble specimen and drawing of the finest of the genus, with an undulated four-furrowed casque, and a beautiful cinnamon-coloured bare crest, black body, and white tail, coming near *B. undulatus,* but differing in several points, especially in having a yellow ample gula. Its length from tip to tip is 2 feet 11 inches, and between the ends of the spread wings 4 feet 4 inches.—*Letter from India.*

BOTANY.

25. *Circulation of the Sap in the Chara vulgaris.*—M. Blainville notified to the Philomathic Society at their meeting on the 26th May, that he had

observed, along with Professor Amici, the manner in which the sap circulates in the *Chara*. The microscope magnified 1500 times, (superficial magnifying power we presume,) and exhibited a motion of two liquid currents, the one ascending, and the other descending, circulating in the same tube, without being separated by any partition which could insulate them. The reality of this phenomenon was placed beyond a doubt by the distinct passage of certain molecules of one of the currents, which being attracted by the one which moved in the opposite direction, were occasionally dragged along with it. The tube in which this double circulation took place had a very perceptible diameter.

26. *A new Plant which supplies limpid and wholesome water.*—A shrub has been discovered in our new Indian countries, from whose stem, when divided, there issues a copious vegetable spring of limpid and wholesome water. The natives know this well, and hence we rarely meet with an entire plant. It is a powerful climber, and is quite new and nondescript.—*Letter from India,* March 31st, 1827.

27. *Botanical acquisitions in our New Indian Territories.*—No fewer than about 1648 species of plants, mostly new, have been discovered in our new Indian territories. Among these are a chesnut and an oak, both noble and beautiful. No country was ever more gifted than those with natural capabilities. The forests abound in useful and diversified timber trees. In all directions run fine and navigable rivers. Animals of all sorts abound, and tigers and elephants swarm in the woods.—*Letter from India.*

Art. XXXVIII.—CELESTIAL PHENOMENA,

From October 1*st*, 1827, *to January* 1*st*, 1828. *Adapted to the Meridian of Greenwich, Apparent Time, excepting the Eclipses of Jupiter's Satellites, 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.

OCTOBER.

D.	H.	M.	S.		D.	H.	M.	S.	
3	4			☿ ☌ ϑ ♍	14	9	47	43	☽ ☌ 2 α ♋ ☽ 9′ S.
4				♅ Stationary.	14	22			☿ ☌ λ ♍
4	14	19		○ Full Moon.	15	13			☿ ☌ ♃ near Appulse.
4	21	50	36	☽ ☌ ι ♓ ☽ 44′ N.	17	16	15	50	☽ ☌ υ ♌ ☽ 32′ S.
6	22			♀ Sup. ☌ ☉	18	0	30		♅ in Quad. with ☉
7	0			☿ ☌ ♃	18	10	45		♃ ☌ ☉
8	22	53	56	☽ ☌ ε ♉ ☽ 6′ S.	20	3	47		● New Moon, Sun eclipsed invisible.
9	16			♂ ☌ σ ♌					
12	13	17		☾ Last Quarter.	20	11			☽ ☌ ♀
13	14	15		♄ ☌ ☉	21	23	59		☽ ☌ 2 α ♎ ☽ 19′ N.
14	8	43	52	☽ ☌ 1 α ♋ ☽ 15′ N.	22	13	18	3	☽ ☌ 1 β ♏ ☽ 75′ N.

D.	H.	M.	S.	
22	13	19	22	☽ ☌ 2 β ♏ ☽ 74′ N.
22	7			♂ ☌ β ♍
23	16	36		☉ enters ♏
23	17			♀ λ ♍
26	19	7	56	☽ ☌ β ♑ ☽ 40′ N.

NOVEMBER.

D.	H.	M.	S.	
1	5	27	51	☽ ☌ ε ♓ ☽ 45′ N.
1	14			☿ ☌ δ ♏
2				♄ Stationary.
3				Moon eclipsed, partly visible.
				Begins 3h. 29′ ½
				☽'s limb rises 4 44 ¾
				Middle, 5 7 ¾
				Ecliptic ☌ 5 13 ¾
				Ends 6 45 ¾
				Digits eclipsed on ☽ N. limb 10° 35′ 3/7
3	5	14		○ Full Moon.
4	7			♂ ☌ η ♍
5	6	58	43	☽ ☌ ε ♉ ☽ 7′ S.
5	13			♀ ☌ σ ♍
7	4			♀ ☌ α ♍
9	10			♀ ☌ κ ♎
10				☿ Greatest Elong.
10	17	2	48	☽ ☌ 1 α ♋ 14′ N.
10	18	7	36	☽ ☌ 2 α ♋ 9′ S.
11	8			☾ Last Quarter.
11	16			♀ ☌ λ ♎
14	0			☿ ☌ 1 β ♏
14	1			☿ ☌ 2 β ♏
16	5	19	14	☽ ☌ α ♍ ☽ 46′ N.
16	23			☽ ☌ ♃
18	15	19		● New Moon.
20				☿ Stationary.
22	13	2		☉ enters ♐
23	1	27	18	☽ ☌ β ♑ ☽ 37′ N.
24	9			☿ ☌ ♀
25	6	18		☽ First Quarter.
28	4			♀ ☌ θ Ophiuchi.
28	11	18	20	☽ ☌ ε ♓ ☽ 42′ N.
28	23			♀ ☌ B Ophiuchi.
30	1	45		☿ Inf. ☌ ☉

DECEMBER.

D.	H.	M.	S.	
2	13	54	10	☽ ☌ ε ♉ ☽ 6′ S.
2	18	39	4	Imm. I Sat. ♃
2	22	50		○ Full Moon.
3	4			♃ ☌ λ ♍
4	16			☿ ☌ ν ♏
6	20			☿ ☌ 2 β ♏
6	21			☿ ☌ 1 β ♏
8	0	6	9	☽ ☌ 1 α ♋ ☽ 22 N.
8	1	11	32	☽ ☌ 2 α ♋ ☽ 1′ S.
8	17	19	12	Imm. II. Sat. ♃
9				☿ Stationary.
10	8			♀ ☌ λ ♐
11	3	23		☾ Last Quarter.
12	13			☿ ☌ 1 β ♏
12	14			☿ ☌ 2 β ♏
13	15	21	23	☽ ☌ α ♍ 56′ N.
14	14	25	29	☽ ☌ λ ♍ 29′ S.
14	18			☽ ☌ ♃
15	3			♀ ☌ 1 ν ♐
15	6			☿ ☌ ν ♏
16	14			☽ ☌ ☿
18	2	5		● New Moon.
18	16	54	42	Imm. I Sat. ♃
19				☿ Greatest Elong.
20	10	18	21	☽ ☌ β ♑ ☽ 29′ N.
22	1	31		☉ enters ♑
24	17	49		☽ First Quarter.
25	19			♂ ☌ ε ♓
25	18	48	14	Imm. I. Sat. ♃
28	9			♀ ☌ ♅
29	16	56	24	Im. } III. Sat. ♃
29	19	9	29	Em. } III. Sat. ♃
29	19			☿ ☌ ξ Ophiuchi.
29	19	45	4	☽ ☌ ε ♉ ☽ 9′ S.

Times of the Planets passing the Meridian.

OCTOBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	h.	′	h	′	h	′	h	′	h	′	h	′
1	0	20	23	57	22	23	0	52	18	53	7	16
7	0	34	0	2	22	15	0	35	18	33	6	54
13	0	47	0	8	22	7	0	17	18	12	6	32
19	0	59	0	13	21	59	23	57	17	50	6	10
25	1	11	0	19	21	50	23	39	17	28	5	49

NOVEMBER.

1	1	23	0	26	21	39	23	18	17	1	5	22
7	1	31	0	32	21	28	22	59	16	37	4	58
13	1	32	0	39	21	18	22	39	16	13	4	34
19	1	21	0	45	21	7	22	19	15	47	4	14
25	0	47	0	52	20	55	21	59	15	21	3	50

DECEMBER.

D.	h.	′	h	′	h	′	h	′	h	′	h	′
1	23	43	0	59	20	43	21	38	14	54	3	23
7	22	57	1	6	20	31	21	16	14	27	2	58
13	22	34	1	13	20	18	20	59	13	59	2	33
19	22	29	1	19	20	6	20	32	13	30	2	8
25	22	32	1	25	19	53	20	9	13	2	1	43

Declination of the Planets.

OCTOBER.

	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
	° ′	° ′	° ′	° ′	° ′	° ′
1	4 15 S.	1 8 S.	8 34 N.	7 12 S.	21 41 N.	21 49 S.
7	8 40	4 10	7 7	7 41	21 38	21 49
13	12 44	7 9	5 39	8 10	21 36	21 49
19	16 22	10 2	4 10	8 39	21 35	21 48
25	19 31	12 48	2 41	9 8	21 34	21 48

NOVEMBER.

1	22 25 S.	15 46 S.	0 57 N.	9 40 S.	21 34 N.	21 45
7	24 7	18 4	0 33 S.	10 8	21 35	21 44
13	24 57	20 4	2 2	10 35	21 36	21 42
19	24 41	21 44	3 30	11 1	21 38	21 40
25	23 0	23 1	4 57	11 26	21 40	21 37

DECEMBER.

1	19 58 S.	23 54 S.	6 23 S.	11 50 S.	21 43 N.	21 33 S.
7	17 39	24 21	7 46	12 13	21 47	21 30
13	17 38	24 20	9 8	12 35	21 50	21 26
19	19 7	23 53	10 27	12 56	21 54	21 23
25	20 57	22 59	11 44	13 15	21 58	21 19

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a globe, and to determine their risings and settings.

ART. XXXIX.—*Summary of Meteorological Observations made at Kendal on June, July, and August,* 1827. By Mr SAMUEL MARSHALL. Communicated by the Author in a Letter to the EDITOR.

State of the Barometer, Thermometer, &c. at Kendal for June 1827.

Barometer.	Inches.
Maximum on the 9th and 10th, - - - - -	30.14
Minimum on the 1st, - - - -	29.27
Mean height, - - - -	29.69
Thermometer.	
Maximum on the 13th, - - -	74°
Minimum on the 7th, 8th, and 25th, - -	45°
Mean height, - - - -	56.98°

Quantity of rain, 4.264 inches.

Number of rainy days, 17.

Prevalent winds, W. and S. W.

On reviewing the phenomena of this month, it appears, that, after the prevalence of winds from the W. and S. W., the thermometer has generally fallen, whilst those from the N. and N. W. have been succeeded by an augmentation of temperature. The maximum of the thermometer is 11° less than in June of last year, when it was then higher than any other month in 1826. The barometer also failed in attaining so great an altitude The mean of the barometer is also less than that of June in 1826, which was 30.02.

July 1827.

Barometer.	Inches.
Maximum on the 6th and 7th, - - -	30.15
Minimum on the 20th, - - -	29.39
Mean height,	29.79
Thermometer.	
Maximum on the 30th, - - -	74°
Minimum on the 12th, - - -	42°
Mean height, - - - - -	59.01°

Quantity of rain, 3.170 inches.
Number of rainy days, 15.
Prevalent wind, west.

This has been a very sultry month, though the thermometer has not marked during any part of it greater heat than 74°, which was the maximum of last month. On the 30th we had a very heavy thunder storm, though unattended with any great weight of rain. The wind has been for twenty-five days in the W. and N. W.

August 1827.

Barometer.	Inches.
Maximum on the 23d, - - -	30.18
Minimum on the 15th, - -	29.10
Mean height, - - - - -	29.81
Thermometer	
Maximum on the 3d, - -	68°
Minimum, on the 6th, 10th, 20th, and 23d, -	46°
Mean Height, - - -	56.61

Quantity of rain, 5.214 inches.
Number of rainy days, 12.
Prevalent wind, north-west.

This month has been marked by a most unusual prevalence of winds from the N. N. E. and N. W.—At this period of the year these currents seldom occur, much less prevail. But .060 inch of rain has fallen since the 16th ; prior to that date we had rain almost daily, and in considerable quantities.—The barometer has kept high, and has been a faithful index of the changes which have taken place. The temperature of the air, particularly in the nights, has been much greater than might have been expected, considering the extraordinary prevalence of the winds from the north &c., from which quarters the temperature is usually low. The wind has been in the N. W. twelve days, in the W. 7, N. E. 5, N. 3, S. W. 3, and S. E. 1 day.

ART. XL.—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 instruments is 300 feet above high water-mark at Leith. The morning and evening observations were made about 10 A.M. and 10 P.M.

JUNE 1827.

D. of Week.	Day of Month.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
F.	1	57	48	52.5	48	61	54.5	28.98	29.37	
S.	2	57	46	51.5	45	62	53.5	29.30	29.36	.31
S.	3	56	46	51	41	59	50	29.40	29.42	.17
M.	4	55	47	51	41	61	51	29.56	29.55	.05
T.	5	55	48	51.5	45	56	50.5	29.08	28.96	.05
W.	6	55	45	50	43	58	50.5	29.31	29.62	
T.	7	57	49	53	39	65	52	29.72	29.84	
F.	8	64	55	59.5	46	67	56.5	29.95	30.07	
S.	9	67	59	63	53	72	62.5	30.17	30.17	
S.	10	62	55	58.5	53	73	63	30.18	30.06	
M.	11	66	53	59.5	50	72	61	30.06	30.03	
T.	12	66	56	61	50	74	62	30.05	30.10	
W.	13	63	54	58.5	51	71	61	30.04	30.02	
T.	14	63	51	57	50	69	59.5	29.87	29.75	
F.	15	57	52	54.5	47	67	57	29.67	29.53	
S.	16	66	59	62.5	46	71	58.5	29.43	29.43	
S.	17	60	51	55.5	55	70	62.5	29.58	29.68	.03
M.	18	60	55	57.5	44	67	55.5	29.75	29.70	.03
T.	19	57	47	52	48	61	54.5	29.53	29.38	.22
W.	20	56	48	52	42	59	50.5	29.35	29.36	.05
T.	21	56	47	51.5	45	60	52.5	29.42	29.80	.16
F.	22	56	47	51.5	45	62	53.5	29.62	29.75	
S.	23	61	50	55.5	45	64	54.5	29.81	29.91	.06
S.	24	57	51	54	47	65	56	29.92	29.93	
M.	25	60	52	56	43	67	55	29.91	29.83	
T.	26	62	55	58.5	45	67	56	29.78	29.60	
W.	27	64	55	59.5	52	65	58.5	29.38	29.21	.26
T.	28	62	52	57	51	64	57.5	29.22	29.32	.11
F.	29	65	55	60	49	67	58	29.30	29.32	
S.	30	61	51	56	47	67	57	29.41	29.50	.12
	Sum,	1803	1539	1671	1406	1963	1684.5	888.71	889.57	1.62
	Mean.	60.1	51.3	55.7	46.87	65.43	56.15	29.624	29.652	

JULY 1827.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even	Mean.	Min.	Max.	Mean.	Morn.	Even.	
S.	1	60	52	56	46	62	54	29.45	29.44	.06
M.	2	65	54	59.5	45	67	56	29.51	29.38	
T.	3	56	53	54.5	43	64	53.5	29.48	29.67	.71
W.	4	62	51	56.5	48	69	58.5	29.86	30.00	
T.	5	63	57	60	45	71	58	30.13	30.18	
F.	6	65	56	60.5	42	67	54.5	30.19	30.20	
S.	7	65	57	61	55	67	61	30.24	30.15	
S.	8	64	59	61.5	55	70	62.5	30.11	30.05	
M.	9	64	53	58.5	55	65	60	29.85	29.85	
T.	10	62	53	57.5	53	67	60	29.55	29.63	
W.	11	60	50	55	43	68	55.5	29.85	29.95	
T.	12	60	49	54.5	41	65	53	30.01	30.04	
F.	13	65	53	59	45	71	58	30.02	30.00	
S.	14	63	57	60	49	68	58.5	30.06	29.98	
S.	15	65	55	60	50	72	61	29.93	29.85	.10
M.	16	71	63	67	50	77	63.5	29.82	29.75	
T.	17	68	59	63.5	55	71	63	29.70	29.61	
W.	18	62	55	58.5	50	67	58.5	29.65	29.60	
T.	19	63	51	57	50	64	57	29.50	29.56	.17
F.	20	60	53	56.5	49	63	56	29.28	29.43	.10
S.	21	60	51	55.5	47	63	55	29.60	29.71	
S.	22	59	54	56.5	48	63	55.5	29.75	29.78	
M.	23	62	59	60.5	51	69	60	29.85	29.82	
T.	24	70	61	65.5	52	70	61	29.74	29.64	.05
W.	25	66	52	59	57	66	61.5	29.61	29.71	
T.	26	62	52	57	47	66	56.5	29.71	29.68	
F.	27	62	58	60	45	68	56.5	29.85	29.81	.64
S.	28	66	56	61	49	71	60	29.71	29.96	
S.	29	70	64	67	51	74	62.5	29.93	29.68	.44
M.	30	69	54	61.5	54	71	62.5	29.31	29.60	
T.	31	65	59	62	51	67	59	29.90	29.90	
		1974	1710	1842	1521	2105	1812	923.01	924.41	2.27
		63.68	55.16	59.42	49.06	67.84	58.45	29.774	29.820	

AUGUST 1827.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
W.	1	65	61	63	51	66	58.5	29.72	29.71	
T.	2	66	60	63	52	63	57.5	29.60	29.48	
F.	3	65	55	60	54	68	61	29.29	29.30	.38
S.	4	63	53	58	48	71	59.5	29.40	29.78	
S.	5	57	56	56.5	46	61	53.5	30.01	30.17	.19
M.	6	60	55	57.5	38	63	50.5	30.27	30.18	
T.	7	62	53	57.5	44	63	53.5	30.15	30.01	
W.	8	67	51	59	50	67	58.5	29.99	29.82	
T.	9	68	59	63.5	46	70	58	29.73	29.48	
F.	10	58	57	57.5	54	61	57.5	29.28	29.22	.65
S.	11	60	53	56.5	46	63	54.5	29.17	29.32	.06
S.	12	59	52	55.5	44	63	53.5	29.39	29.50	.92
M.	13	60	54	57	48	64	56	29.53	29.39	.03
T.	14	55	50	52.5	49	56	52.5	29.30	29.24	
W.	15	50	53	51.5	50	62	56	29.21	29.22	.50
T.	16	49	51	50	48	50	49	29.56	29.77	1.26
F.	17	53	50	51.5	48	56	52	29.92	30.03	.76
S.	18	57	51	54	43	59	51	29.98	29.88	
S.	19	54	52	53	50	57	53.5	29.93	29.95	
M.	20	54	52	53	49	57	53	30.01	30.06	.02
T.	21	57	50	53.5	50	63	56.5	30.10	30.10	
W.	22	56	48	52	47	60	53.5	30.19	30.26	
T.	23	68	54	61	42	73	57.5	30.19	30.13	.02
F.	24	58	54	56	46	65	55.5	30.10	30.01	
S.	25	56	52	54	48	59	53.5	30.08	30.10	
S.	26	56	55	55.5	46	58	52	30.10	30.05	
M.	27	64	55	59.5	53	66	59.5	30.11	30.15	
T.	28	56	46	51	46	66	56	30.13	30.25	
W.	29	58	53	55.5	44	66	55	30.18	30.10	
T.	30	58	58	58	51	63	57	29.95	30.07	.10
F.	31	60	52	56	53	62	57.5	30.23	30.23	
		1829	1655	1742	1484	1941	1712.5	924.80	926.76	4.89
		59.	53.39	56.20	47.87	62.61	55.24	29.832	29.899	

INDEX TO VOL. VII.

DESCRIPTION OF PLATES IN VOL. VII.

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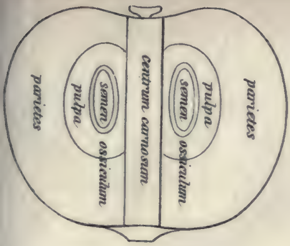
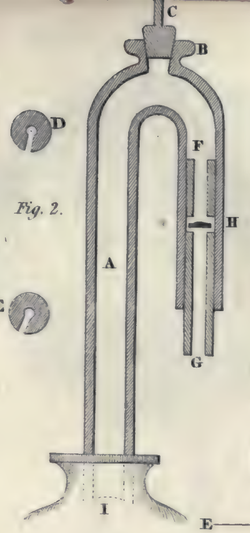
Fig. 1.





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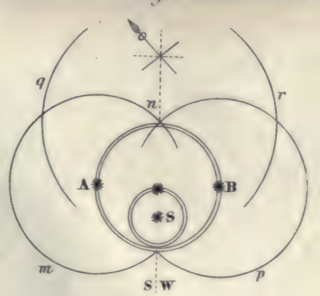

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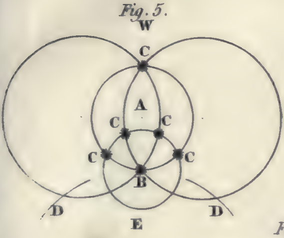

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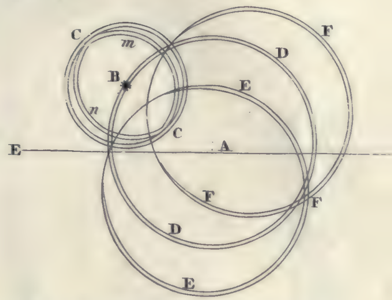

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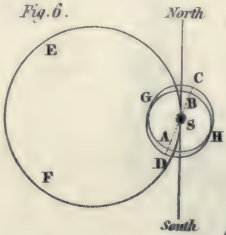

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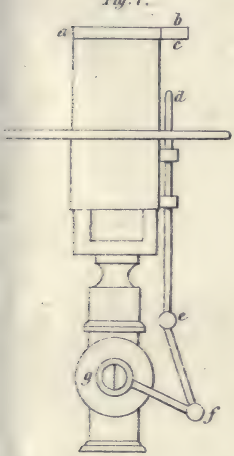

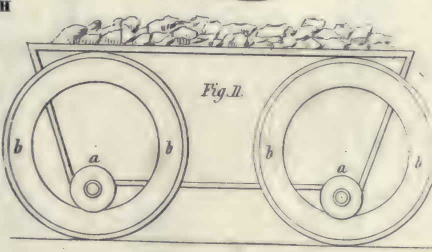

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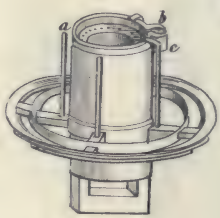

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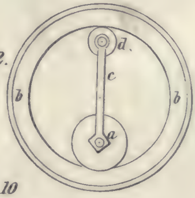

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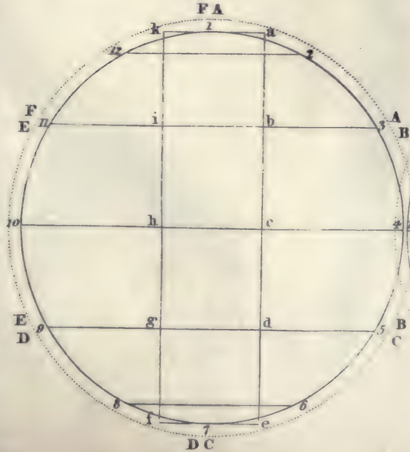

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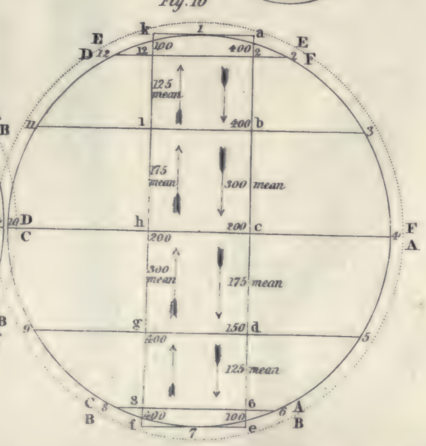

W.H.Lizars sc.

PLATE II.

LERNÆA ELONGATA GR.

twice the nat. size

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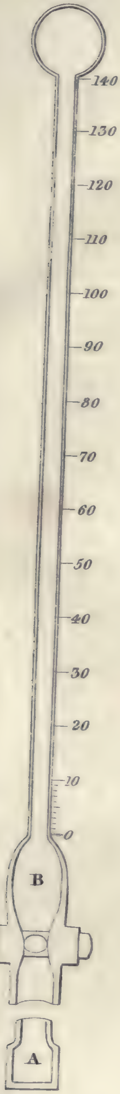

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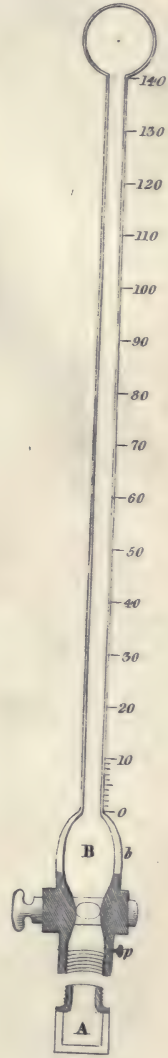

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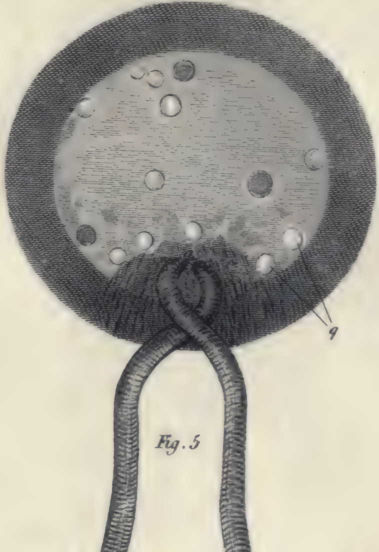
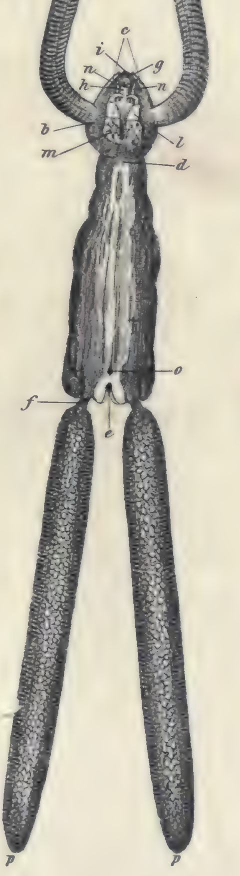
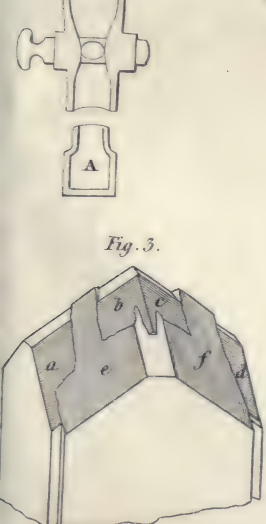



Fig. 6

Fig. 7.

Fig. 3.



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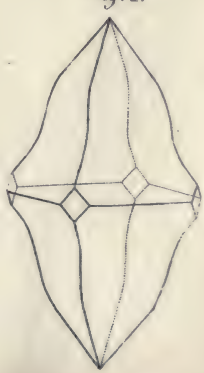
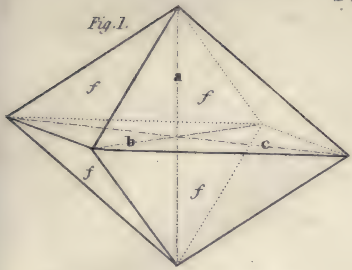


R.E. Grant delt.

PLATE III.

Fig. 1.



STERNBERGITE

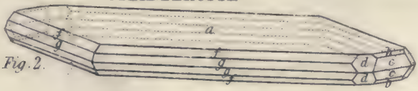
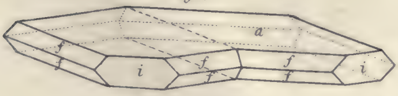


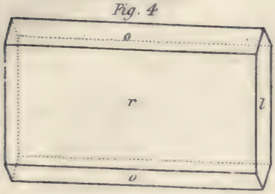
Fig. 2.

Fig. 3.



POLYHALITE

Fig. 4



DAVYNE

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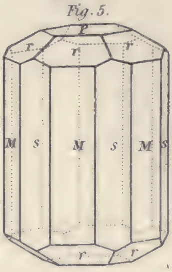

VAUQUELINITE

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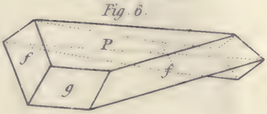
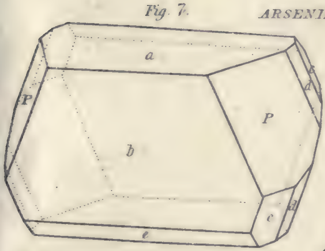


Fig. 7.

ARSENIATES AND PHOSPHATES OF SODA



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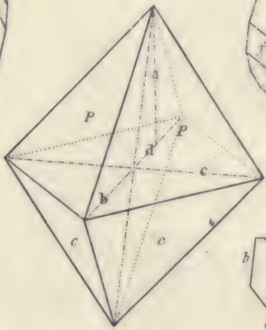

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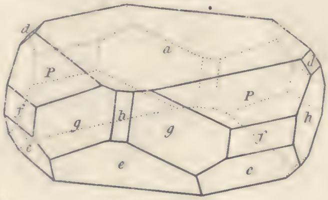

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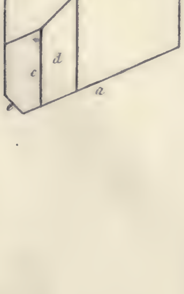

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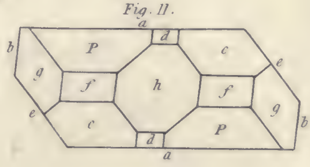
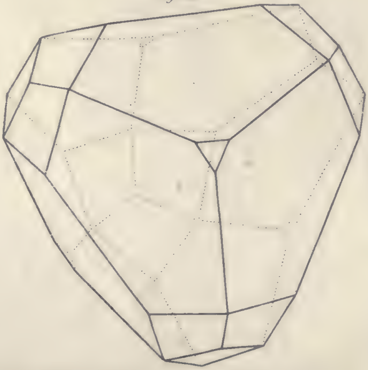


BISMUTHIC BLENDE

Fig. 12



W.H. Lizars sc.

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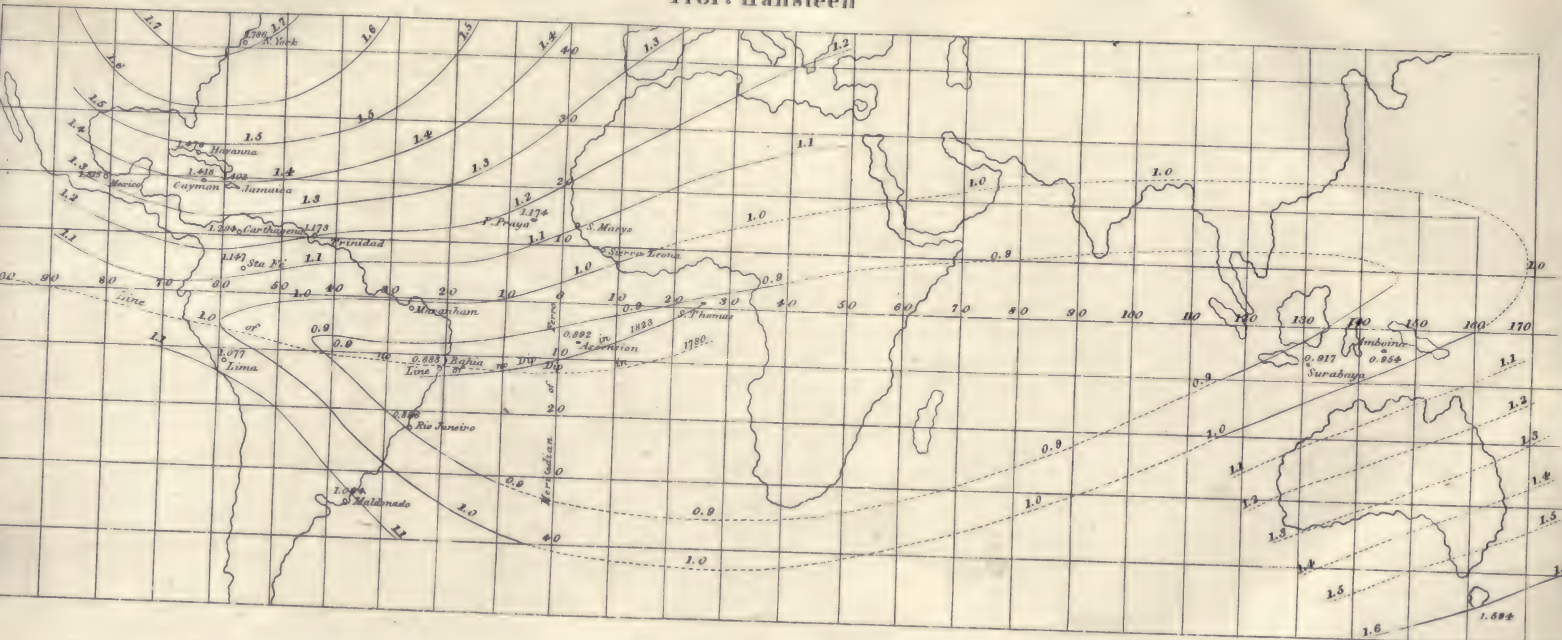
— by —
Profr. Hansteen



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