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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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No. XVII.

NOTICES TO CORRESPONDENTS.

PROFESSOR HANSTEEN's Paper on the variation of the Needle will appear in next Number. His comparison of the Leith and Christiania Hourly Observations will also appear in next Number.

We have received the communication of W. J. H. and shall be glad to hear from him frequently.

J. S.'s elaborate paper was submitted to a gentleman who had made the subject his particular study. If he favours us with his address, we shall have the pleasure of communicating with him on the subject.

It would be gratifying to us if Δ could arrange a less circuitous method of communication.

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OF THE

EDINBURGH JOURNAL OF SCIENCE.

No. XVIII.

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THE

EDINBURGH

JOURNAL OF SCIENCE.

ART. I.—*Account of the Structure, Manners, and Habits of an Orang-Outang from Borneo, in the possession of George Swinton, Esq. Calcutta.* By J. GRANT, Esq. Assistant-Surgeon Bengal Establishment. In a Letter to Dr BREWSTER.

SIR,

INDUCED by the encouragement of your friend, George Swinton, Esq., to whom the animal belongs, and hoping that such a communication may not be unacceptable, I do myself the honour of submitting to you a description of an orang-outang that was lately brought to Calcutta.

To Mr Swinton's kindness I owe the ample opportunities I have had of examining the creature at my convenience, as well as much information respecting its habits. The animal was presented to Mr Swinton by W. Montgomerie, Esq. of the Bengal Medical Establishment, who brought it round here from the eastward. With a readiness and politeness, for which I feel much obliged, Mr Montgomerie (who had excellent opportunities for observation) has favoured me with several interesting facts and remarks, which I have had much pleasure in incorporating with my own.

On one or two points (of which more in the sequel) I regret that it is not in my power to afford conclusive testimony. Such as it is, however, I am not without hopes that this paper may serve an useful purpose, in exciting those who are more capable of doing it justice to publish the result of their experience upon a subject of no small zoological interest.

In the month of July 1827, Mr Montgomerie brought the orang-outang in question to Calcutta. In July 1826 it had been brought from *Pontiana*, island of *Borneo*, by some Buggese traders. It was then considerably smaller than it is now, and had all the appearance of being a very youthful animal; but no measurement of him was taken. I have not been able to ascertain his age exactly, or any particulars regarding him previous to his coming into Mr Montgomerie's possession; but since his capture by the Malays he has been for some twelve or thirteen months accustomed to the society of mankind.

Though not equal in stature to the orang-outang described by my late lamented friend Dr Abel in his voyage from China, yet the plate in that work will give a generally correct idea of his portraiture. I have never seen Mr Swinton's orang in the exact attitude represented in that plate, and the expression of the face seems to me somewhat different. In *Griffith's Animal Kingdom* there is an engraving of an orang-outang by Landseer,* in which the attitude and expression usually assumed by the creature strike me as a very happy hit by the artist.

Judging from the figure, the ears of Dr Abel's orang appear to have been larger than those of Mr Swinton's, and the mouth, eyes, palms, and abdomen to have had a yellower tinge than I perceive in the latter. Neither has Mr Swinton's orang that double chin-like pendulous process described by Dr Abel, and represented very prominently in his plate. When the animal, however, exercises himself in climbing, two sacs apparently filled with air become visible on the upper part of the chest, one on each side, near the axilla. They are the same, I presume, with those described by Camper as communicating with the glottis in this animal. Can they be intended to give a greater degree of buoyancy to the creature when springing

* It appears to me that the expression of the eye in Dr Abel's plate gives a more correct idea of the orang-outangs in general which have come under my observation than the plate in Griffith's. In the former the organ seems to be very happily depicted. In the work of the latter it is too round, and wants the wrinkled appearance of the lower eyelid, which existed in all the specimens which I have seen. The other parts of the face in Griffith's convey a better idea of the animal, but the body appears a great deal too meagre, and the abdomen particularly too hairy, of which part, however, a very correct idea is conveyed in Abel's. The extremities are very exactly represented in both.—*Note by Mr Montgomerie.*

from bough to bough and tree to tree? The palms of the hand and soles of the feet of the orang which I am describing, instead of being copper-coloured, as in Dr Abel's individual, are of a flesh-colour, and, though not so fair, resembling a European's. He has nails upon his great toes, so far proving the correctness of Cuvier's opinion that Camper was wrong in concluding that the absence of the great toe nails formed a specific distinction of the Borneo orang-outang.*

The hair is of a dark-reddish brown colour, and points from behind forward, being on the back and upper parts of the shoulders generally about five inches long.

Notwithstanding the great projection of the jaws, the face of the orang-outang is strangely human. Without entering into the prejudices of one class of writers, who appear indignant at this assumed similarity as derogatory to the lords of the creation, or of going into the contrary extreme with those who overrate the resemblance and are apt to theorise upon it, the fact alluded to cannot be denied. Nor is it in his physiognomy alone that this extraordinary animal bears so much resemblance to the human being; his head approaches nearer that of man in shape and volume of brain (judging from the exterior) than the cranium of any other animal. The frontal and parietal regions particularly evince a developement almost equal to that of some negroes I have seen. Of course, I speak discursively and from recollection. I may also be allowed to mention, that in the skulls of some natives of New Holland which I have seen, the diameter between the temples was less than in the head of the orang-outang. It may be also mentioned, that M. Tiedemann, in his examination of the orang-outang's brain, has enumerated a considerable number of points in which it differs from that of the other species of apes; and it is remarkable, that in every one of these it approaches to the human brain. On the other hand, great points of difference between the orang and human brain are specified; but it ought to be borne in mind that some contend that no orang above three years

* Mr Swinton's orang is the only one which I have observed to be possessed of the nail on the great toe; but this is the only particular in which he differs in the slightest degree from the others which I have seen.—*Note by Mr M.*—The great Sumatra orang-outang described by Dr Abel in the 15th vol. *As. Res.* has nails on the great toes.—*J. G.*

old ever found its way to Europe. If this opinion be correct, the comparison of the adult human brain with the orang fœtal one can hardly be deemed quite fair or conclusive. M. Tiedemann perhaps never examined the brain of a full-grown orang.

Although the beautiful play of the features which we call smiling is confined to man alone, yet is the orang-outang capable of a kind of laugh when pleasantly excited. For instance, if tickled, the corners of his mouth draw up into a grin; he shows his teeth, and the diaphragm is thrown into action, and reiterated grunting sounds, somewhat analogous to laughter, are emitted by the animal. * The creature indeed is extremely sensible to tickling in those parts where a human being is, as the armpits and sides. There are two bony ridges observable on the head, one running vertically, and the other crossing it along the calvaria in the line of the ears. The first is of considerable elevation, and very strong, as if formed for the special protection of the longitudinal sinus.

The protuberance of the abdomen, the slenderness of the extremities, and the peculiar expression of the countenance, give a kind of old man appearance to the creature. The physiological purpose of the former peculiarity is not very clear. It does not seem to be a result of obesity, or of an enlargement of the omentum, but of an increased capacity of the abdominal parietes generally.

When the creature is at rest the abdomen assumes that protuberant form which is commonly termed a "pot-belly." This, however, disappears when he swings from a tree, grasping with his hind hands, (if I may use the expression) and his head downwards; for in swinging or climbing a tree, and going from branch to branch, it seems immaterial to him whether he uses his hands or feet, his legs or arms.

When he walks or turns, a strong ligamentous or band-like

* I have observed in this individual, and also in a young female which was in my possession for twelve months, when not excited by any apparent cause, a contraction of the upper lip, showing the teeth, and a play of the features resembling a smile, as if excited by some pleasant idea. She also when tickled (withholding her breath and struggling) would utter a half-suppressed sound, which might be expressed by the letters *Khee,* much in the same way as some some individuals of the human species when placed under similar excitement.—*Note by Mr M.*

ridge rises for the height of about an inch, between the sternum and pubis, in the direction of the *linea alba.*

The nates are flattish, and are bare of hair for a little space round the anus. Between the buttocks there is not that well-defined deep sulcus as in man, and the anus, instead of retiring as in him, protrudes.

The opening of the mouth is large, and the roof of it black. His teeth are neither very white, nor what we should consider in man a good set, but they are large and strong, though somewhat more separate, each from each, than we generally find in the human jaw, which I consider to be mostly caused by the youth of the animal. * There are ten teeth in each jaw, viz. four molars, four incisors, and two canine; the total in both jaws being twenty teeth. Compared to the human jaw the inferior maxilla of the orang is narrower, more massy, and having less of a horse-shoe shape. According to our ideas of beauty, too, the bone is defectively shaped at the symphysis, retiring backward instead of coming forward, so as to constitute what in man would be voted a bad chin. The lips too are different from the human, no less in their form than in their office.

If water is offered to the orang when he is thirsty he opens his mouth, but instead of receiving the fluid at once within his teeth, he protrudes his under lip an inch or two beyond the teeth, pursing the integuments into a kind of hollow or cup, where he receives the water, and whence he draws it into the mouth proper. Both lips have a peculiar muscular action, by which they serve somewhat the office of a proboscis in picking up and holding things. Indeed, any person who has seen the rhinoceros feed, cannot fail, I should suppose, to be struck with the resemblance between the prehensile movements of its labial muscles and those of the orang-outang, when he protrudes them pointedly to examine or seize an object. †

The following are the measurements of the animal, as taken in October 1827:

	Inches.
Height from vertex to heel,	26

* In the jaw of the Great Sumatran orang-outang they are set close.

† Is not this muscularity and thickness of the upper lip peculiar to the orang of Borneo?—*Note by Mr M.*

	Inches.
Length from the acromion process of the scapula to the end of the middle finger,	19
From the top of the sternum to the pubis,	$13\frac{1}{8}$
From the groin to the tip of the second toe,	15
From the wrist to the end of the middle finger,	$5\frac{4}{8}$
Length of palm of the hand,	3
Length of sole of the foot from the heel to the end of the middle toe,	$6\frac{4}{8}$
From the knee to the sole of the foot,	$6\frac{2}{8}$
From nipple to nipple,	$5\frac{2}{8}$
From between the eyes to the insertion of the head on the neck,	8
Greatest circumference of the thigh,	8
Circumference of the foot close to the roots of the toes,	5
——————— round the shoulders,	$19\frac{4}{8}$
——————— round the loins,	$13\frac{4}{8}$
——————— at umbilicus,	18
——————— above umbilicus, or round the paunch,	21
Greatest circumference of leg,	$5\frac{4}{8}$
Circumference of hand over the knuckles,	5
——————— of head above the eyes,	$14\frac{2}{8}$
——————— from ear to ear round the occiput,	$7\frac{1}{8}$
——————— round the chin over the vertex,	$17\frac{4}{8}$
Length of the ear,	$1\frac{4}{8}$
Breadth between eyes,	$\frac{1}{2}$
Span of the arm over the breast,	57
From the symphysis to the base of the ramus of the jaw,	$4\frac{4}{8}$

His weight is twenty-two pounds avoirdupois.

The creature is rather more lively than we might expect an orang to be, according to the descriptions of most authors. Though active, however, gravity and sedateness mark all his actions, and he has the air of a philosopher even when performing his somersets. Being generally chained, he is debarred from satisfying his curiosity with regard to surrounding objects, and it is this that gives an air of liveliness to his actions when set loose. He usually has his habitation in an empty box, where, with the aid of some straw and a blanket, he manages to nestle very comfortably. He is fastened to the box by a chain secured to a leathern collar round his neck, the former being of sufficient length to admit of his moving a few yards in any direction. He is very quick and noticing; and, as far as his chain* will allow him, usually steps forward to meet any person who approaches him, holding out his hand, if a hand be offered to him. Should his chain happen to get entangled or jammed between the box and any other article of furniture, he will unravel its twistings with equal adroitness and patience. †

He examines every thing that comes within his reach in the most attentive manner with his hands, lips, and teeth. Though when he observes a stranger he is generally in motion, and evinces a lively curiosity, yet when alone he is quiet and sedentary. He is fond of human society, and likes to be in the company of Mr Swinton's bearers, whose house adjoins the shed where his box is kept, and where he will often sit with a gravity not unworthy of Diogenes in his tub.

He likes to play with the bearers, and tries to throw them down when they wrestle with him in a sitting posture, which they do to bring themselves on a level with him. He seizes them by the hair of the head, but never with any appearance of a wish to tear it out.

He has a tin jug, out of which he drinks, and which he likes to scrub with a coarse towel, throwing the latter, after the conclusion of the operation, over his shoulders, as he has seen the servants about the house do. He will sit down at table and pick a bone, or drink a glass of wine. His usual and favourite food is plantains and milk; he is also extremely fond of tea. ‡

* He has since got a longer chain, and is perpetually clambering up every thing within his reach, and swinging himself from it. But all this is done with a sedate air. Another remarkable feature of his character is, that he looks you quietly and steadily in the face with a melancholy expression of countenance; whereas the eyes of monkeys in general are seldom fixed on the face of those who may be looking at them.—*Note J. G.*

† When on board ship, it was found very difficult to keep him fast, as he undid every knot that could be tied. He used to look on attentively during the operation of tying it, and set himself loose with his fingers and teeth immediately; and it was only by making fast the yarns of the rope, as in the operation of splicing, that it was possible to puzzle him.—*Note by Mr M.*

‡ The young female which was in my possession, in addition to fruit, was accustomed to have every day a dish of curry and rice, made either of fish or fowl, which she seemed to relish eating with her hand, and after-

He is a good natured animal, soon becomes familiar, and, to those who treat him kindly, affectionate. His activity and quickness might give a stranger a different impression, especially if the creature, as he is apt to do, came up suddenly, grasping him by the leg or arm, or climbing into his lap. On such occasions he makes a show of biting, but it is a mere make-believe kind of playful movement. He will unhesitatingly lay hold of any part of one's clothes with his teeth,* and tear it if he can; but this I believe is caused by his *curiosity*, for he rarely proceeds further; and if a finger is put into his mouth, he will not bite it, although perhaps he would if irritated.

He evidently possesses an insatiable fund of curiosity, and examines every thing that comes in his way. No matter what the article may be, he turns it about in his fingers, smells it, and tries if it is eatable. In examining any thing he is seldom or never satisfied with the sense of manual touch. He first fingers it, then feels it with his lips, mumbling it about perhaps for a few seconds, and finally he tears it with his teeth. This he will do with a bit of wood or charcoal, a straw, or piece of paper. His teeth indeed appear to be the decisive test to which every thing is submitted; and this is the reason, I presume, of his being so apt to make free with a corner of one's dress, which he does, however, in a very good-humoured way, being merely anxious, as it were, to find out what kind of texture it is; and if he should manage to make a small hole with

wards appeared to derive great satisfaction from picking the bones. She was also uncommonly fond of sugar and eggs, which she was in the habit of pilfering whenever she could get loose. The orang in Mr Swinton's possession was also very fond of eggs; but taking advantage of this partiality, I once made them the vehicle of administering calomel and castor oil to him, when he was unwell, and refused almost every kind of food. Since then I understand he will not touch an egg, thus overcoming a taste for an article, which in his natural state must form a principal part of his food.—*Note by Mr M.*

* It is difficult to say from what motive he is so fond of doing this; but the effect no doubt is to tear what he lays hold of. He is sometimes not very nice in his discrimination between the cloth and the person's skin, so that he now and then bites one unintentionally, but never severely. An angry word makes him quit his hold. He is certainly, upon the whole, of a mild and timid disposition.—J. G.

his teeth, he is very apt to put in a finger to enlarge the rent, seemingly very well pleased with his own feat.

Although submissive and tractable to man, generally speaking, he does not seem afraid of animals. A dancing bear having been brought into Mr Swinton's Compound, formed an exception to this self-possession; for on the animal being made to cry out and dance on his hind-legs by his keeper, the poor orang appeared considerably startled, and instinctively retreated some paces.* Two monkeys belonging to the same person were next introduced to him. At first he appeared to take no notice of them, but sat unconcernedly near a short upright stake stuck in the ground. The monkeys at first appeared somewhat afraid of him, but he looked at them with seeming indifference. At length he took hold of the string by which the monkeys were leashed together and tied to the post, and began pulling them towards himself with one hand, while with the other arm he grasped the stake mentioned above as a kind of *point d'appui.* While holding them thus he appeared to survey them with much attention and gravity. He was several times interrupted, however, in his contemplations by his frolicsome friends, who, having got over their first apprehensions, began to get bolder and more familiar, venturing so far as to give him an occasional slap on the head, and even to tumble him over. This our orang bore with the best temper in the world; but to prevent their pranks as much as he could, took good care to keep the stake between himself and them. A little stick being given him, he held it menacingly towards his monkey visitors, still keeping hold of the string to which they were fastened, and making a show as if he would beat them. The monkeys appeared to be kept in good order by the appearance of the ferule; and it was highly amusing to see them crouching and grinning at our *Homo sylvestris,* who stood up gravely

* The animal while at Singapore had a young individual of the small ash-coloured Sumatran baboons as a playmate, with which he amused himself by catching and throwing it down, pretending to bite it, but never appeared to hurt it in the least. His active companion retaliated in the same way, but would after a little break loose from him, and bound away to the length of his chain, soon returning, however, to renew the sport. They appeared to be remarkably good friends, and never seemed to have any quarrel even at meal times.—*Note by Mr M.*

looking on, as if reflecting upon his own superiority in the scale of being to the creatures before him. Indeed, during the whole interview the grave and commanding attitude and bearing of the orang, compared to the levity and apparent sense of inferiority of the monkeys, was very striking; and it was impossible not to feel that he was a creature of a much more elevated order and capacity.

A dog of the spaniel kind appeared much frightened at the orang, but surprise was evidently mixed with its feelings of dread; for though scared and inclined to run away, it still lingered near to look at the formidable stranger. The other, on the contrary, bounded towards the dog, making a grunting kind of noise, stretching out his arms to catch him, and apparently taking much pleasure in the dog's surprise and dread. In all this there was no trace of hostility or malignity. The orang seemed playfully inclined, and I doubt not would have done the dog no harm, had he succeeded in getting hold of it.

Sometimes his actions are so grotesque that it is impossible not to smile at them. So irresistibly ludicrous are his movements occasionally, that even the native spectators, proverbially sedate and grave as they are, cannot help yielding to hearty laughter at their droll effect. These exhibitions are highly enhanced by the air of solemn gravity that characterizes the actor throughout. It ought, however, to be always borne in recollection, that the tricks and habits described are those of a young animal. It would be as philosophical to predicate the future character of a man from the gambols of a child in the nursery, as to judge of the habits and peculiarities of the adult orang from the playful or eccentric movements of a young one.

I saw him once very indignant at not getting as much tea as he wanted. A European woman happened to place a small saucer of lukewarm tea before him, of which he partook with great relish, sipping it out of the vessel, or dipping his fingers into the liquid and then sucking them. In the course of a minute or two, the woman passing again, he applied for more tea, which he got and drank. A third time he made a like application, and was similarly gratified. At length the woman's stock of tea was exhausted. The poor fellow, however, was far from contented, and thought himself not well used in being so stinted. Accordingly, as the woman repeatedly passed near him, he solicited with all the mute eloquence in his power for more tea. Some cold water was put into his saucer, but he was not to be so imposed upon; he poured it angrily* out on the floor, (taking care, however, not to break the saucer,) whined in a peculiar manner, and threw himself passionately on his back on the ground, striking his breast and paunch with his palms, and giving a kind of reiterated *croak*. This action he repeated several times, giving himself very heavy falls on the back of his head and spine, striking against the floor with a violence which could not have failed, I should suppose, to hurt a human being, but which appeared to give him no pain whatever.

His restlessness rendered it difficult to take exact measurements of him. He appeared suspicious of such movements as he could not comprehend, being seemingly afraid that some injury might be inflicted upon him. Thus, when I wanted to take measurements of his head and body, he held the former down firmly, and crouched himself up into a ball. The poor fellow felt really afraid that some violence was going to be done him, and seized hold repeatedly of the tape with which I was measuring him. This he would retain in his hand until forcibly deprived of it; but when he became a little more familiar with me, he regained his self-possession, and permitted me to make my examinations with less trouble.

Dr Abel has so accurately described the walk of the Bornese orang-outang, that it would be superfluous to dwell upon it here. His movements in the erect position are awkward, waddling, and unsteady. When released from his chain, he immediately makes for the house, and attempts to get up stairs to the room, where he is occasionally allowed to partake of his master's breakfast. He moves, as has been accurately described, by using both hands and feet, doubling his long fingers, and resting on his wrists. Sometimes he throws his weight on his hands, and then swings his feet forward together. At other times he has a waddling gait, when using

* It is not so much anger against others as vexation and despair. On such occasions of disappointment he rolls about like a passionate child.

his feet only, and attempting to walk upright. Losing his balance, he throws himself upon his head, and thus frequently advances by performing a few somersets in the direction of the place he is making for. Generally he keeps in a sitting posture. When he gets tired for a time of that, he springs up, takes an upright walk round his box, leaps into it, lolls at his ease, draws his blanket round him, bites the corner of it, takes up a straw, looks contemplatively at it, tears it with his fingers, bites it, throws it away, jumps out of his box again, and, as a sailor hauls at a rope, drags the box by the chain to some other spot. In this way, if permitted, he would move all round the room or court-yard very soon.*

Monkeys in general evince much surprise on seeing themselves in a looking-glass. Our *Homo sylvestris*, however, exhibits no emotion whatever at the reflection of his own rueful countenance. This is rather remarkable, considering the curiosity that he exhibits upon any other point. Were the mirror small enough, it would in all likelihood undergo as usual the *experimentum dentis*. Not finding it possible to do so, the looking-glass is soon laid down by our orang as unworthy of farther speculation.

He appears to know himself by the name of "*Maha Rajah*," (as he is always called,) raising his head and turning round when so addressed. He seems also to understand what is said as to giving him food. His plantains are kept by the bearers, who live, as already stated, in a shed close to his box; and when his master calls to "Maha Rajah," from the verandah of an upper room, the creature evidently shows he comprehends that the call is to him, for he goes forward in the direction whence he is hailed and looks up in his face; but when Mr Swinton calls to the bearers to give Maha Rajah a plantain, he always turns towards the quarter from which he expects it.

* The animal when on board ship during the voyage from Singapore was generally allowed to go at large with the chain about his neck, which from its length encumbered his motions, he would therefore take it in his hand or hind foot, carefully disentangling it if it got foul of any of the ropes. The chain, however, prevented his ascending high in the rigging, but he used to go up a short way, and with one hand laying hold of the end of a loose rope, would amuse himself by swinging backwards and forwards.—*Note by Mr M.*

When standing upright, it is not easy to determine what is the exact length of the orang's arms; but I believe I am not far wrong when I state that the tips of his fingers nearly touch his ancles. He is far from being insensible to the temperature of the atmosphere. He likes to bask in the mild rays of the morning sun, but when they begin to become more powerful he retires into the shade of a tree or wall. Of late, as the weather has got colder, he appears to cherish his blanket and his straw more and more. Indeed, from all I have heard, the orang-outang, notwithstanding his hairy covering, seems ill adapted to bear extremes of heat or cold, especially of the latter.

This leads me to suppose, that in the wild state the orang-outang depends upon a less precarious residence than the branch of a tree. It is not improbable, therefore, that he may choose for his habitation some sheltered nooks of the forest, caverns, and hollow trees. In such retired places the females probably bring forth and nurture their young; and it is not inconsistent with what we know of the sagacious habits of the animal, that in such retreats they may also lay up stores of food.

It is obvious at a glance of the orang-outang that his proper *locale* is the forest. Nature has formed him more for a climbing than a walking animal. But notwithstanding the awkwardness of his gait in advancing on a flat surface, I am inclined to believe that he proceeds more habitually in the erect position than is generally imagined. Where absolute evidence cannot be produced we may sometimes lean to tradition; and unless there were some foundation for it, I can hardly imagine that the belief which prevails on this point with a number of persons, Europeans and natives, whom I have spoken to on the subject, would be so general as it is. One cause of this belief, however, is not at all unlikely to arise from the orang being confounded with the long-armed Gibbon (from Borneo also) who can walk upright with more ease it would seem than the orang-outang. From all I have been able to learn, the natives of the eastern islands themselves assume it as an undoubted fact, that these animals are accustomed to walk in the erect posture. I consider the following passages in Dr Abel's account of the capture of a gigantic orang by Captain Cornfoot on the island of Sumatra as corroborative of this belief. " On the approach of the party he came to the ground; and, when pursued, sought refuge on another tree at some distance, exhibiting, as he moved, the *appearance of a tall man-like figure*, covered with shining brown hair, *walking erect with a waddling gait*, but sometimes accelerating his motion with his hands, and occasionally *propelling himself forward* with the bough of a tree."—" It seems probable that the animal had travelled from some distance to the place where he was found, as his legs were covered with mud up to his *knees*." * If the quadrupedal attitude be the natural one of the orang-outang on a level surface, is it not rather surprising that he should not have taken to it in the hour of danger? It is clear, too, that he had walked bipedally through the mud; for if his arms had been equally marked, (which they would have been if employed as feet) I presume the circumstance would have been mentioned. If it be objected that this is not quite a sequence, since, if the mud was sticky, he would have been more entangled with four hands in it than with two; still we have the fact of his travelling bipedally over the ground and between the trees, where there was *no* mud, and where his appearance was, as stated, that " of a tall man-like figure walking erect." The use of a *bough* or stick to help him in his erect progression is also remarkable. It appears, too, that orangs use the same for defence and offence, for the animal of the orang race, described by Wurmb in " *the Batavian Transactions*," we are told, made a desperate resistance with the branch of a tree before he was overpowered.

The appearance of the teeth of the orang would almost lead one to imagine that he may be a carnivorous as well as a fructivorous animal. To speculate further, however, upon that point, in the absence of more certain data, would be idle.

Should Mr Swinton's orang live long enough, he may be destined to solve an interesting question, upon which, in the present state of our knowledge, it is not easy to come to a satisfactory conclusion, viz. are we to consider Dr Abel's orang

* *Asiatic Researches*, vol. xv. see also this *Journal*, No. viii. p. 194.

which died in England as identical in kind with the gigantic one killed by Captain Cornfoot's party in Sumatra; or is the orang now in Mr Swinton's possession a young one of the gigantic race?

Mr Montgomerie, if I rightly comprehend, in the following observations, appears inclined to the opinion, that the orangs we usually see are young ones of the gigantic race.

"In regard to the subject in dispute concerning the identity of the orang-outang of Borneo, the gigantic Sumatran orang, and the Pongo of Wurmb, I have little evidence to bring forward that can be of use in clearing up the matter; but during my residence at Singapore, I saw at least ten or twelve Borneo orangs, of various ages and sizes. The largest, judging from recollection, I should suppose to have been about three feet in length from the crown to the heel. I had also a female in my possession for upwards of a year, during which time she grew up as much as a child would have done in the same period; but I regret that no measurement was taken to enable me to speak positively to its size at the time of its death, but it was fully higher than the one now in the possession of Mr Swinton. In making a preparation of its cranium, I found the teeth corresponding to the *permanent anterior molares* of the human subject were quite formed, but had not penetrated the gum. She had not shed any of her milk teeth. It showed no symptoms of catamenia while with me, nor were the mammæ at all apparent.

"I have not been able to ascertain that any measurement was taken of Dr Abel's orang at the time of its death; but supposing it had gone on to increase in height at the same rate it did from September 1817 to May 1818, it ought to have been three feet high, and from its great analogy to the human species we may allow it to have been at that time six years of age, and if it increased in the same ratio of four inches a-year, which is actually less than the rate of its growth for the last eighteen months of its existence, it would by the time it had attained its sixteenth year * have been six feet four inches high;

* This is allowing a short time for the animal to acquire its full stature. Tall individuals of the human race continue to grow for a much longer period.—*Note by Mr M.*

and I have, therefore, little difficulty in bringing myself to believe the gigantic orang of Sumatra to be the adult of this species; but I should consider the cheek pouches and posterior callosities of Wurmb's Pongo, as well as its colour, peculiarities sufficient to distinguish it from either the Borneo or Sumatran orang.

"During Sir Stamford Raffles' last visit to Singapore, he sent over to Borneo a country-born Frenchman, (a native I believe of Chandernagore,) for the purpose of collecting subjects of natural history. Amongst others which he brought was the skull of a large ape, said to be that of an adult orang-outang. It was certainly the skull of an aged animal, judging from the complete ossification and almost obliteration of the sutures; but on comparing it with the cranium of the young female, which died while in my possession, I was inclined to question the identity of the animals to which they belonged; for after making every allowance for disparity of age, there was a much greater difference of shape between the old and young than of any other animal which has come under my observation; the facial angle in the large one being many degrees more acute, and the bones of the face bearing a much greater proportion in size to those of the cranium than in the smaller. The skull was more compressed laterally, and the frontal arch less full and prominent; the lower jaw of the larger was also of amazing strength, and deeper proportionally than in the smaller. The teeth were at least twice the size and strength of the largest human ones I ever saw. The canine teeth were more elongated than in the human species, but not so much so as those of carnivorous animals.* The space which the zygomatic arch enclosed was very great, and the temporal muscle must have been of immense size, and would enable the animal to make most forcible use of its enormous teeth;—the action of this muscle would no doubt tend to compress the cranium laterally. I feel very much inclined to believe that this must have been a skull of the species which Wurmb calls the Pongo, although it was not positively

* The canine teeth and incisors of the gigantic orang killed by Captain Cornfoot's party were as large, or larger rather than those of a lion. This was also the case in Wurmb's orang.

asserted to have been that of an orang-outang, by the man who brought it over; but I believe he did not see the animal to which it belonged. I have every reason to fear that this specimen, along with that of the young female which I gave to Sir Stamford Raffles, was lost in the destruction of the ship Fame.

" Griffith, in his *Animal Kingdom*, " mentions Malacca as one of the habitats of the orang-outang; but during my residence to the eastward I had never heard of one having been found on any part of the Malay Peninsula, nor do the Malays themselves consider it a native of these parts. Those with whom I have conversed on the subject, however, had never travelled far inland, their journey being confined to the banks of the navigable rivers. The interior of the Peninsula is thinly peopled by the Orang Benooa, a race of men very similar in face and figure to the Malays of the sea coast, but they are Pagans, speaking a different language, and having very little communication with them; and only when in want of rice or tobacco, descending to barter for these articles their Kayoo Garoo, (Eaglewood,) Ratans, and other productions of their forests. It is not likely that the conversations of such men would fall upon the subject of the natural history of the country, and there are no doubt many animals unknown to Europeans, and even to the Malays themselves, in the aboriginal forests of the country, as a proof of which the existence of an animal of such a size as the orang of Sumatra has only been just brought to our knowledge though the west coast of that island has been resorted to by Europeans from the earliest period of European commerce in the east."

As to the orang-outang of Bontius, it appears to have been a fabulous one, or, as Wurmb conjectures, a negro of Kakkerlak * was mistaken for one. Wurmb, too, distinctly asserts (which has been confirmed by after experience) that Pongos and Jockos, or orang-outangs, came to Java exclusively from Borneo, and that they were no more to be found on that island, than the lions and elephants to be seen in some old maps of Java.

The orang-outang of the larger kind, or Pongo of Buffon, he states, (see *Batavian Transactions*, vol. ii.) is not common

* *Chacrelas* of Buffon.

even in its native country, Borneo, and that great pains had been taken for twenty years to procure one, before the individual described by himself was caught.

For the following description of the animal, freely translated from the original Dutch of Wurmb, I am indebted to a learned friend.* "The head of the large orang-outang of Borneo is somewhat pointed from without upwards. The snout projects, and on each cheek is a broad fleshy dewlap (Kwabbe) which widens towards the side in proportion to the thickness of the head. The ears are small, naked, and lie flat on the head. The eyes are small and prominent. The nose, without being remarkably raised, consists rather of two long separated apertures sloping towards each other. The mouth has thick lips, and has no pouches within. The tongue is thick and broad.

"In each jaw in the front are four broad cutting teeth between two thick projecting canine teeth, situated higher in the jaw. The face is of a blackish-brown colour, without hair, except a very thin beard. The neck is very short. The breast is much broader than the hips. There is no appearance of a tail, nor any projecting callosities near the rump. The penis appears to be retracted into the body. The hands are long, and the palms, as well as the fingers, blackish-brown, and without hair. The legs are short and thin, but strongly formed. The feet are like the hands. The toes and fingers are set with black nails like those of man, except the nails of the great toes, which are much smaller and shorter. † This may perhaps arise from their having been more used. The breast and back are not bare, but all the remaining parts of the body, except those already mentioned, are covered with brown hair, which in some places is nearly a finger long. Under the skin of the neck and breast were found two sacs, one of which covered the greatest part of the breast, which, as well as a smaller sac which was involved in the large, communicated with the windpipe."

In a zoological work written by Mr Foucher D'Obsonville,

* H. H. Wilson, Esq. Secretary to the Asiatic Society of Calcutta.

Note.—The nails on the great toes of the large Sumatran orang-outang (the hand and foot of which are in the Museum of the Asiatic Society,) are well-defined, and resemble in size and shape those on the other toes.

a French gentleman, who travelled in Sumatra in the year 1767, there is also a description of an orang, which I do not think I should be justified in overlooking. He was about four feet eight or ten inches (French) high. The resemblance and conformation of the bones of the head altogether struck Mr D'Obsonville as being little different from the same parts in many Tartars and negroes. He had very little beard. His breast was tolerably broad; his buttocks not very fleshy; his thighs short, and his legs bowed. These last defects in proportion, when compared to ours, are in fact found amongst various people, * and seem to result from their manner of living, from crouching on their hams, and from being carried in their infancy on the backs or hips of their mothers." I have never had an opportunity of seing the orang-outang except crouching or standing, but though, as I was informed, he walks habitually upright, he takes advantage in his state of liberty of hands and feet when he wants to run or leap a ditch. It may be this kind of exercise perhaps which contributes to keep the arms so very long. His genital parts were tolerably proportioned; his penis, in a quiescent state, about five inches long, appeared to be that of a man without a visible prepuce.

"I have never (proceeds M. D'Obsonville) seen the female orang-outang, but was informed their breasts were somewhat flat; that their sexual parts, resembling those of women, were subject to catamenia. The term of their gestation is supposed to be about seven months, which calculation has probably been made from such as have been taken pregnant, for they do not propagate in a state of servitude."

The following general observations have some claim to attention, as founded, it may be presumed, on information picked up by M. D'Obsonville on the spot. "They (orang-outangs,) wander in the woods, or upon mountains of the most difficult access, where they live in small societies, and take every precaution for their subsistence or defence that can be expected from men absolutely savage. Of this I cannot doubt, after

* *Note.*—The defect of bowed legs is very apparent among the lower caste of children in this country. It is partly caused by the manner in which they are carried in infancy on the hips of their mothers, or sisters and brothers, and partly by the poorness of their diet.—J. G.

what I have myself seen of the polity observed among monkeys. In a word, the Malays, like the other Indians, rank the orang-outang among the last class of the human species, and pretend that in a state of liberty they freely propagate with ours,* and add, this mixture is fruitful. I confess I find nothing improbable in this selection of hearsays, not even in the opinion, which, founded upon certain characteristic resemblances of consanguinity, perceives the last order of the human species in these at least doubtful beings.

Almost all the eastern orangs seen in Europe came, I believe, from Borneo, and were of the average height of two feet and a half, or three feet. The orang-outang described by Edwards, on authority not stated, is called young, and its height was about two feet and a-half. In the plate of it there is no trace of a paunch or protuberance of abdomen. The expression of the face, too, is different from that of any orang I have seen, and the colouring is by far too yellow. Edwards quotes the account of a voyage to Borneo, taken by a Captain Bateman in 1718, in which was figured and described an orang, said to have had no hair save on those parts where it grows on human bodies. If the account is to be depended upon, this is certainly making a marvellously near approach to the human species. On a point where no motive for deception is very apparent, we have hardly a right to question the veracity of Captain Bateman; but no other observer that I am aware of has been so fortunate as to see an unhairy orang-outang.

The orang described by Voesmaer came from the eastward, and its height was two Rhenish feet and a-half, or about thirty-one inches.

The instances I have referred to strike me as being in favour of Shaw's† remark, that the orang appears to admit of considerable variety in point of colour, size, and proportions, and that there is reason to believe that there may be two or

* *Note.*—There is a story current in Calcutta which may as well be mentioned, of a woman belonging to one of the dependencies of the Sultan of Pontiana, (Borneo,) who ran away on account of some fault she had committed, and lived for several years with the orang-outangs. It is added that they treated her very kindly, but were very watchful lest she should escape.

† *Shaw's General Zoology.*

three kinds, (of the orang proper,) nearly approximated as to general similitude, but yet specifically distinct. I am free, therefore, to confess, that though unable to make up my mind fully from the data I have had access to, or even perhaps to give good reasons for so thinking, I find myself rather sceptical as to the little orangs seen in Europe and elsewhere having been all young ones of the gigantic race ; or of the individual in Mr Swinton's possession being identical in kind with the large one of Captain Cornfoot, or even of Captain Cornfoot's great orang being identical with Baron Van Wurmb's Pongo. This impression, rather than conviction, however, I venture to mention with great diffidence, when I reflect on the high authorities in favour of an opposite opinion.

Camper conceived the average height of the orang-outang to be about four feet. Is it unreasonble to suppose that there may be at least two kinds, one averaging from seven to eight feet in height, and the other from four to five ?

The inquiry would no doubt be considerably elucidated by a perfect knowledge of the *age* of the orangs, as there is much obscurity on the point; nor do I comprehend upon what data it has been asserted, that *all* the orangs seen in Europe were young individuals, not exceeding three years of age at the utmost.* How so important a fact came to be so positively ascertained, we are not informed. True, the animal imported to England by Dr Abel was shedding his teeth when he died, giving sufficient evidence of his youth, but not, I conceive, of his exact age. Mr Montgomerie, we have seen, seems inclined to the conclusion, that it was six years old. If this opinion be correct, Mr Swinton's orang, by a parity of reasoning, is about five years old. If, on the other hand, the assertion alluded to be more correctly grounded, the creature is only about two years old. His juvenility is not only demonstrated by the state of his teeth, and the fact of his having two less in each jaw than Dr Abel's, but by the smallness of the genital organs, his less comparative girth, and slenderness of limbs, his docility and activity.

The analogy between his growth and that of a human being would seem more specious than just. Where are we to look for

* *Griffith's Animal Kingdom.*

a two-year-old child of the human species possessing the strength, agility, and sinew, and perfect ossification of the head, exhibited by this orang-outang child? Does it seem *a priori* probable that this orang will in the course of a few years shoot up into a giant of eight feet? Let it be recollected, too, that the giant orang of Sumatra was concluded by Dr Abel, and upon fair grounds, to have been a youth; so that it is possible he might not have attained his full stature at the time of his death.

The general conclusion to which Dr Abel came was, that the giant orang of Sumatra was identical with the animal described by Wurmb under the name of Pongo. There are two or three reasons for dissent on this point. In the *first* place, Wurmb's animal was supposed to be full grown. *2dly*, Wurmb's animal had dewlaps or hanging fleshy processes (Kwabbe) on the cheeks, and the Sumatra orang had not. *3dly*, According to Geoffri's description of it, the Pongo of Wurmb has scarcely any apparent forehead, and the bony box which contains the brain is uncommonly small. The general shape of the head has been likened to the half of a pyramid, thus ◺. Captain Cornfoot's orang, on the other hand, had, comparatively speaking, a high and prominent forehead, a large cranial box, and the shape of the head was somewhat spherical or pear-like. And, *fourthly*, considering his height, the Pongo of Wurmb was a more robust animal than even Captain Cornfort's.

The animal of Wurmb, as well as I can understand from description, appears to have been inferior in cranial developement even to Mr Swinton's young orang. The length between the forehead and back of the head in the former is stated to have been $6\frac{5}{8}$ inches, in the latter it is 8 inches. I am aware it may be urged that this difference may be attributed in a great degree to the youth of the latter.

For fear of extending this paper too much, I have not included a copy of the measurements of Wurmb. The height of the Pongo when it was examined by him was three feet ten inches; but this, it is stated, differed from the measurement taken at Borneo, which was forty-nine inches. A different measure is supposed to have been used, or the discrepancy might have been caused by the animal's shrinking while lying in spirits. The circumference of the thigh of this four feet high animal was one foot five inches and two-eighths. While the breadth of the skin of the Sumatra giant, of from seven and a half to eight feet high, across the middle of the thigh, was only one foot.

The orang described by D'Obsonville appears to me to have been an adult. At least, in no other domesticated orang have I heard of the penis having acquired such a length as five inches in a state of rest.

I am also permitted by my friend Captain Gillespie (Aid-de-camp to the Right Honourable the Governor-General) to mention that he saw an orang-outang near four feet high, or between three and four feet, in the possession of the Honourable Mountstuart Elphinstone, Governor of Bombay. It was in every respect (but size) he says, like Mr Swinton's orang, and in the course of two years had not apparently grown an inch. As no exact measurements, however, are referred to, I merely mention the circumstance, without laying much stress upon it. Supposing however, the fact to be stated with the utmost accuracy, it is in favour of the idea, that there may be a gigantic and medial, or common variety of orang-outang. The animal alluded to is described as being very fond of woollen clothing. It delighted in enveloping itself in the folds of a blanket, and so completely would he do so sometimes as to have no part visible but his eyes. He certainly was considered a full grown animal. I am hardly warranted, however, in using a masculine designation, as Captain Gillespie cannot be positive as to the sex of the creature. It appeared to exhibit considerable emotion on the approach of young ladies, evincing an anxiety to be with and caress them. I am not without hopes of learning more particulars respecting this individual, as Captain Gillespie supposes it to be still alive.

The absence of precise phraseology has involved occasionally in some degree of obscurity the history of the orang-outang. Among such terms as Pongo, Jocko, and Chimpansé, used by travellers or naturalists, it is not always easy to find out the precise animal meant. In the eastward, too, I have no doubt that the orang-outang has been sometimes confounded with the long armed Gibbon.* Leaving the black African *Simia satyrus*

* A species of orang-outang is said to exist in Assam, a specimen of which is shortly expected in Calcutta. It will probably prove to be the Gibbon alluded to in the text.

in possession of his title of Pongo, as also the somewhat anomalous individual described by Wurmb, it is desirable for obvious reasons, that when the Asiatic *Simia satyrus* is described, we should adhere to his Asiatic designation of orang-outang.

In conclusion, it only remains for me to apologize for such defects as I fear will be found in this paper. My motives in writing it, independent of the interruptions by other busy avocations, will, I trust, be indulgently remembered in mitigation of such errors. I have, however, endeavoured to state such facts as fell under my observation fairly, and to reason upon them impartially.

I beg to subscribe myself, with great respect, Sir, your most obedient, humble Servant,

J. GRANT,

Assistant-Surgeon Bengal Establishment.

CALCUTTA, *30th November* 1827.

NOTE.—We shall be happy to hear again from Mr Grant regarding the future history of the orang-outang in the possession of Mr Swinton. It is possible that there may be two species, a gigantic one, like that described by Dr Clarke Abel in a former number of this *Journal,* and a smaller one, identical with the Pongo of Wurmb. As to their walking habitually in the erect position, however, a point which Mr Grant seems inclined to support, the anatomical structure of the tribe precludes the possibility of this; and this structure, not much better fitted for motion on all fours, indicates, what is found in fact to be the case with all the known species, that their habitation must be in forests and among trees,—a habitat necessarily implying an organization of members for climbing, and for which their posterior extremities, equally adapted for prehension with the anterior, are wonderfully adapted. Many of the Mammalia, when acting on the defensive, rear upon their hinder legs, or sit upon their haunches; and it was quite natural for the large specimen killed by Captain Cornfoot, to approach his assailants in the erect position, thus leaving, besides his teeth, his two arms free, to be used for his protection. As to any fancied resemblance to human communities, implied in apes being generally found in numbers together, it may be observed, that most frugiverous animals are gregarious, associating for mutual protection; and, upon the whole, it seems now to be the general opinion, that any intelligence the ape displays beyond the dog is to be attributed solely to the particular structure of his members, enabling him to mimic with effect human attitudes.

ART. II.—*Account of a New Reflecting Telescope.* By the Right Honourable LORD OXMANTOWN, M. P. &c. Communicated by the Author.

THE following considerations induced me to make the experiments on the specula of reflecting telescopes which I am about to describe. The reflecting telescope would be almost a perfect instrument, could we devise means of freeing it from spherical aberration; it would then retain merely the defects necessarily arising from imperfections in the workmanship, and perhaps some others of a much more trifling nature, such as those derived from the inflection of light. The refractor, however, is not only affected by the spherical aberration in common with the reflector, but also by the different refrangibility of the rays of light. Both of these defects may indeed be in a great degree corrected by giving curves of proper radii to the lenses which compose the object-glass. The spherical aberration may by this be almost entirely obliterated, but a considerable portion of the chromatic aberration still remains, owing to the irrationality of the spectra formed by the different kinds of glass, of which the object-glass is necessarily composed, the different coloured rays not being refracted by each in the same proportion. The refractors until lately were limited to a very small scale, owing to the impossibility of procuring suitable glass of large dimensions; and although a new process has lately been discovered on the continent, which has considerably extended the limits of their construction, still I believe that large pieces of glass, of a tolerably homogeneous nature, are procured with great difficulty; and there seems to be but little prospect of our being able, with the present state of our knowledge, to construct efficient refractors, at least with glass lenses of apertures at all approaching the late Sir William Herschel's reflectors. I have been thus minute in stating my reasons for making the following experiments, as many practical men whom I have spoken to seem to think that since Fraunhofer's discoveries, the refractor has entirely superseded the reflector, and that all attempts to improve the latter instrument are useless.

Two modes have been hitherto adopted for diminishing the spherical aberration in reflectors, the one by rubbing down the outer surface of the speculum from the edge to the centre, so as to make its figure approach to that of a paraboloid, the other by increasing the focal length in proportion to the aperture. It is certainly extremely probable that a very skilful workman, who has devoted the greater part of his life to the construction of reflectors, may succeed in some instances, particularly when the instrument is what is technically termed a dumpy, in forming a surface approaching to the paraboloid, which will perform better than one which is truly spherical; but when we consider the extreme accuracy necessary, and that a true surface can only be obtained by the process of polishing, when two motions are combined, the one in some degree at right angles to the other, and that a spherical surface is the only surface which can be formed by these two motions,* it will be evident that when we attempt the parabolic form we abandon an essential requisite to the formation of an accurate surface. It is scarcely worth while remarking, that in every attempt to improve a speculum of an accurate spherical figure I have invariably rendered it worse;—these attempts were not on very dumpy instruments. The other method of diminishing the spherical aberration by increasing the focal length in proportion to the aperture is certainly unexceptionable; but it will be immediately evident that it has its limits, and that instruments become unwieldy after they exceed a certain length. I will now immediately proceed to describe one of the instruments I have constructed, with a view of diminishing the spherical aberration without introducing either of these defects.

In Fig. 1, Plate I. AB is a brass plate turned true on both sides by means of a slide apparatus, which at the same time renders its sides parallel. The dimensions are seven inches by five-eighths thick. CD is another brass plate, made true by the same means, one-half an inch thick. The two plates were then screwed together in a temporary manner, their centres coinciding; three holes were then bored through them one-

* A plane is a spherical surface with an infinite radius, or in practice with a very great radius, and is extremely difficult to execute.

fourth of an inch diameter, accurately perpendicular to their surfaces. The two plates were then unscrewed, and the holes in the plate CD were carefully tapped with a tap, having one-sixtieth of an inch interval between its threads. Three cast steel spindles were then accurately turned, the shank EF being made to fit the holes of the plate AB, and the screw GH nicely to fit the holes in the plate CD. It is almost needless to observe that the flanches, and indeed every part of the spindles, must be very carefully turned. The three cast steel spindles were then put through the holes in the plate AB, till their flanches rested on it. They were secured there by washers IK, put on the shanks of the spindles at the back of the plate, and the washers were retained in their places by milled nuts LM. To prevent the washers from shaking as the steel spindles were turned backwards and forwards, which would loosen the milled nuts, each washer was provided with a screw in its side O, which enters the groove P in the shank, and keeps it steady. The plate CD was then laid upon the three screws GH of the spindles, which were then gradually turned round in succession by a key fitting their other ends till the plate CD reached within about the one-eighth of an inch of their flanches. To prevent the spindles from shaking either in the plate AB, or CD, lateral holes were drilled reaching the principal holes *o*, *o*, *o*, *v*, *v*, *v*. These were stuffed with small bits of leather, which were kept constantly pressed against the spindles by small screws. This precaution is essential. Besides, screws were inserted at the back of the plate through the holes marked *i i i*, which were screwed against the plate CD, to prevent the possibility of its shaking in the slightest degree during the operation of grinding and polishing the speculum.

The mechanism being now complete, a speculum was cast one inch thick. This was secured to the plate CD by three small screwed wires cast into it, by a groove in the plate CD, and by a cement composed of resin, wax, and sulphate of lime. A ring of speculum metal was also cast one inch and a-half thick, which was secured to the plate AB in a similar manner, leaving a very minute interval between it and the piece of speculum metal it surrounded. The whole together formed a speculum of six inches aperture, and two feet focal length, which was ground and polished in the common way, till by repeated trials it was found to be of a good spherical figure. The small screws *i i i*, were then drawn back, the speculum placed in the tube, and the spindles turned round a certain number of times, by which the centre part of the speculum was made to approach nearer the plate AB, by a quantity ascertained in a manner I shall presently point out. The two images were then made to coincide, and the image was then found to be apparently as distinct as either image had been when separate. It is necessary to observe, that, in order to effect the adjustment properly, each image must be brought to the same degree of brightness, which can be accomplished by shades on the mouth of the telescope, and that no higher power should be used than each metal, when separately employed, can bear with distinctness.

I rather think that instruments of this construction will pretty frequently require adjustment; however, this is easily effected in the space of two or three minutes. The first I attempted consisted of a solid metal surrounded by two rings. Owing to a defect in the mechanism it required very frequent adjustments, the smallest shock displacing the images. The one I have described is almost entirely free from this defect, remaining in perfect adjustment even after very violent shocks. I have a speculum like the first I made, consisting of three parts, which is almost ready for grinding; and I expect it will turn out well. I have not yet perceived any ill effects from expansion and contraction, which was the difficulty I most apprehended. Whether they will become perceptible in instruments of higher powers, or whether, if perceived, means may or may not be devised of obviating them, can only be ascertained by future trials. On my return from Parliament, if other avocations do not interfere, I propose to construct a speculum in three parts of eighteen inches aperture and twelve feet focal length;—this will be giving the experiment a fair trial on a large scale. It may perhaps be as well to observe, that I do not think the principle of subdividing the aberration can be applied with advantage to small instruments. The object to be gained by it is a diminution of the focal length with a given aperture and power, and this is by no means desirable in small instruments, as it forces us to make use of deep eye-glasses, which are on many accounts objectionable.

To compute the respective lengths of the curves composing a compound speculum, such as has been described, so that the aberration of the whole speculum may be equally divided between them.

Let E, Fig. 2, be the centre of the surface. Let a ray proceed from Q and intersect the axis in V. Let q be the geometrical focus of rays proceeding from the point Q.

Let q represent	E Q,	Let q' represent	E v,
q'	E q,	θ	R E A
f	E F,	v	ver sin θ

Then considering q' a function of ver. sin θ, v being of course $= 0$ in each coefficient, we have

$$q' = q' + \left(\frac{d\,q'}{d\,v}\right) v + \frac{1}{1.2}\left(\frac{d^2\,q'}{d\ \ v^2}\right) v^2 + \text{\&c.}$$

which by proper substitutions becomes

$$* \; q' = \frac{q f}{q+f} + \frac{q^2 f v}{(q+f)^2} + \frac{q^3 f v^2}{(q+f)^3} + \text{\&c.}$$

The aberration being $q'-q'$ is evidently represented by this series without its first term, which expressed geometrically amounts to

$$\frac{\text{Q E}^2}{\text{Q F}^2} \cdot \frac{\text{A N}}{2} + \frac{\text{Q E}^3}{\text{Q F}^3} \cdot \frac{\text{A N}^2}{4\text{ E F}} + \text{\&c.}$$

which, when the rays are parallel, becomes

$$\frac{\text{A N}}{2} + \frac{\text{A N}^2}{4\text{ E F}} \ \text{\&c.}$$

It is evident that the first term of this series will afford a sufficiently near approximation for compound specula; if we therefore represent the ver. sines of the arcs DO, DP, DQ. Fig. 3, by AN, AN,′ AN,″ the problem becomes, Given AN = AN′ — AN = AN″ — AN,′ the length of the arc DQ and its radius, to find the lengths of the arcs DO and DP.

Example.—Let a be the arc DQ = 3 inches, r its radius = 48 inches, x the seconds in a, then † $x = 206265\,\frac{a}{r} = 206265\,\frac{1}{16} = 12891''$, which in degrees amounts to $3^\circ\ 35'$ whose v. s. = .0019550.

$\frac{1}{3}$ of which = .0006516, corresponding to arc, $2^\circ\ 4' = 7440''$ = 1.77 inches.

* *Coddington's Optics.* † *Lardner's Trigonometry.*

$\frac{2}{3}$ of which $= .0013034$ corresponding to arc $2° 54' 30''$. $= 10470 = 2.44$ inches.

Arc DO $= 1.77$ inches, and DP $= 2.44$ inches.

It is evident that the arc PO must be drawn back, a quanty equal to $D'C' = \frac{1}{2}$ DC, and DO must be drawn back 2 $D'C' = DC$.

ART. III.—*Observations on the Styles of Building employed in ancient Italy, and the Materials used in the city of Rome.* Communicated by a Correspondent.

SIR,

HAVING felt much interested in a very learned essay of the distinguished Italian Antiquary, Antonio Nibby, on the materials employed in the construction of the ancient edifices in Rome, I had long cherished the idea of presenting you with a translation of it, with some additions from my own observations Learning that a paper on the same subject had appeared in the sixth number of the *Edinburgh New Philosophical Journal*, and being anxious to see what had already been published in this line of inquiry, I procured that number of the work, and what was my surprise to find that a Mr C. T. Ramage, A. M. of Naples, comes forward with a mangled translation of part of Signor Nibby's paper, without the smallest allusion to the source whence he had derived the whole information of his performance ; nay, that it is all rendered, word for word, from Italian into English, with very small attention to the idioms of the two languages, and with *three* short interpolated passages of his own, which serve to betray how unfit he was to do anything but translate on such a subject, as I shall endeavour to illustrate in the note below.* Feeling anxious

* The work of Nibby is his "*Trattato preliminare dei Materiali usati negli Antichi edificj di Roma,*" prefixed to his erudite work on the *Forum* and *Via Sacra.* The first paragraph is of course varied in Mr C. T. Ramage's translation, though exceedingly slightly ; but when the author arrives " in medias res" the version becomes perfectly verbal, as the commencement of the second paragraph (merely as a specimen of the whole) will sufficiently prove to any one acquainted with the two languages. " La calce facevasi, come ancora oggi, colla pietra calcarea, o con quella chiamata da Vitruvio, silice, che forse corresponde al nostro palombino o pietra

to expose the plagiarism of Mr Ramage, and knowing how little justice he had done to the Italian work, and flattering myself that I could add some scientific details of interest, especially to the part of the work which treats of ornamental stones, I resolved upon transmitting to you the present paper, passing lightly over the ground which Mr R. has already preoccupied in so strange a manner. I shall therefore make, *first*, a few remarks on the construction of edifices of various

calcarea compatta. La calce tratta da questa ultima pietra serviva per la costruzione de' muri, quella, che si traeva dalle pietre porose usavasi negl' intonachi."—NIBBY. "The mortar was made as it is at present, either from common limestone or from a stone which Vitruvius calls silex, and which may perhaps correspond with our compact calcareous limestone.* That which was obtained from the last was employed in the construction of walls, while the other was used as plaster."—RAMAGE. As to the translator's interpolations, the first occurs at the bottom of page 246 and top of 247, in which he mentions that the mortar is so hard, that at Baiæ the foundations of the houses below water are preserved, while those on the shore have "entirely disappeared," which by the way is not correct; but he has omitted by far the most curious fact, and which most belongs to his argument, that the sea has washed out the stones formed in squares of a few inches, and left the mortar projecting in the most curious manner, forming cells of a honey-comb appearance. His next original lucubration proves that he is not a very profound classical scholar. He says that the caves hollowed out of tufa, near Naples, are supposed to have been inhabited by the "Cummelii mentioned by Homer."—Without supposing that the translator is able to read Homer, he might have learned from Eustace, Forsyth, and every traveller, not to say every sixpenny guide-book, that the "Cummelii" are inventions of his own brain, and that it is of the Cimmerians Κιμμέριοι, *Odyss.* 11, 14. that Homer speaks. The next and *last* original sentence of our author is at page 249, in which, as usual, he falls into another error; he says, that the Romans employed large quadrilateral masses of travertine in their edifices *without cement.* Now, it is quite certain that the Romans employed cement even when the largest blocks of this stone were used, though it may escape a superficial observer, (such as I presume Mr R. to be.) I have seen the mortar perfectly distinct in the Colisseum, which I examined with that particular view. We see then that Mr C. T. R., A. M., is not very fit to come out of leading strings; and if he *will* translate, he will find much good employment in that line, but let him candidly own that he does so, and avoid mangling papers as he has done this one, by cutting off all the classical allusions with which the erudite antiquary, whose steps he pursued ("*haud passibus æquis,*") illustrates his work.

* A Mineralogical tautology of Mr Ramage.

ages existing in Italy; then allude to the materials of which they were built, especially in a mineralogical view, which Nibby did not think it in his way to describe, and of which Mr R. was probably incapable; and then notice the principal marbles, porphyries, and granites, employed for decoration. I shall use Nibby for a text book, but take a more extended view than he has done, with the aid of my own observations, the works of Ferber and Breislak, and a book hardly known in this country, "*Brocchi, Suolo di Roma.*"

The walls termed Cyclopian are generally understood to be the works of the inhabitants of Italy before the time of the Romans, and exhibit a very rude though massive style of building. Figs. 4 and 5, Plate I. exhibit the appearance of this construction, as I have observed them at Fiesolè, and at Fondi, near Terracina.* The walls of Pæstum, in Magna Grecia, may be considered of Greek origin in extremely remote times, and have a very peculiar construction. Their thickness is divided into *five* parts, see Fig. 6, consisting of four walls of vast quadrilateral masses, A A A A, without any cement, and the interior B filled up with loose and unshapely fragments: with such prodigious strength they have been built, that many portions remain in perfect preservation. In coming to the Roman history, we find that little change in the method of construction took place during the history of the kings and the greater part of the republic. Immense quadrilateral masses of the stone of the district and of the Alban Mount, probably in all cases without cement, were employed, of which we have abundant proof in the Mammertine prisons,† the wall of Servius, the Cloaca Maxima, the enclosure built at the mouth of the canal leading from the Alban Lake, (which probably bears a date of the fourth century of Rome,) and some chambers

* Simond, in his new work, (*Voyage en Italie, &c.* vol. ii.) has an engraving of a gate at Ferentino, exactly resembling the latter. Cyclopian walls also occur at Cora, Præneste, Cortona, &c.

† Mr C. T. Ramage, in translating the Italian words "*Carcere Mammertino,*" gives us a valuable specimen of his Latinity by rendering it *Carcer Mammertin*um," p. 250; he must be informed that *carcer* is masculine and *Mammertinus* taken adjectively. He likewise talks of *Basilic*os; we beg to remind him that *Basilica* is of the first declension, and the plural usually employed is *Basilicæ* in English; it could never be *Basilic*os.

near the same place, very improbably called the prisons of Marius; also in the ancient wall at the Forum of Nerva in Rome. Afterwards, though for buildings of very great solidity like the Colisseum, quadrilateral blocks were used, a minute covering to the wall called "*opus incertum*" was introduced towards the end of the republic. It was merely a covering for the interior mass of the wall, and was composed of small irregular polygons, as represented at Fig. 7. We have a beautiful example in the temple of Vesta at Tivoli, in the church of St Theodore in the forum, and at Preneste; likewise in the north of Italy, in a temple disinterred last season at Brescia, and in the villa of Catullus on the Lago di Guarda. * After a short time, two other styles of building succeeded the "*opus incertum*," viz. the "*opus reticulatum et lateritium.*" These continued in extensive use for two centuries between Augustus and Caracalla. The specimens we have of them are innumerable. The former was an exterior facing to the wall like the "*incertum*," but the pieces were perfectly rectangular, and set lozengewise, as shown at Fig. 8; the pieces being small, were made of any stone most easily attainable; at Rome, of tufa,—at Tivoli, travertino,—at Preneste, limestone, &c. As it could not be employed for the *corners* of buildings, these were generally made of large flat bricks. Of this workmanship we have examples in the gardens of Sallust and baths of Titus at Rome, and at the villas of Mecænas and Adrian at Tivoli, besides many beautiful specimens in southern Italy, as at Cicero's Formian Villa, the Tomb of Virgil, and the buildings on the Bay of Baiæ, whose remarkable appearance is mentioned in the first note of this paper. The common brickwork, or "*opus lateritium,*" was yet more generally employed. In the Augustan age, the bricks were little more than an inch in thickness, and triangular, and always of red clay. Under Tiberius, the clay was mix-

* This villa of Catullus affords an excellent example of the practical use of a knowledge of the different styles of building. It is quite evident that on the Sirmian promontory are two sets of building totally unconnected, a confusion between which has much puzzled antiquaries. The one next the lake is almost Saracenic building, while that on the top of the hill, a little way off, presents exactly the *opus incertum* of Vitruvius, which, as it seems not to have been long employed, fixes the date so exactly to that of Catullus, (first century, B. C.) as to leave little doubt as to its authenticity.

ed with yellow, and the bricks were thicker. In the time of Nero, red and yellow bricks were promiscuously used, but they were thinner than either of the last, and with very little mortar, which under Augustus and Tiberius equalled a fourth of the thickness of a brick. The temple, commonly called that of Rediculus, near Rome, shows that some fanciful ornaments in brick (or *terra cotta*) were now employed, particularly an Etruscan border which surrounds that edifice. When the decline of the empire advanced, the bricks became unequal, and the quantity of cement interposed increased, as for example in the Baths of Constantine. As very perfect specimens of the "*opus lateritium*," I may mention the House of Sallust, the lower part of the Baths of Titus, (where it is beautifully fresh,) and Adrian's Villa. In the latter we have some excellent examples of the alternation of this with the reticulated work. See Fig. 9.

As the decline of the fine arts increased, the bricks were mixed with fragments of tufa, &c. as may be seen in the circus, commonly attributed to Caracalla, but built by Maxentius, and the Hippodrome of Constantine at the church of St Agnese, near the Ponte Lamentano; likewise in many of the Christian churches and basilicæ built at that period, and in some portions of the existing walls of Rome. Afterwards fragments of more ancient edifices were employed for the construction of new ones, as may be seen in many works approaching the middle ages; at last, instead of bricks, small rectangular fragments of the commoner and softer stones were employed, which has been termed the Saracenic construction, which continued from the ninth to the fourteenth centuries, and of this we have examples in part of the walls of Rome built by Leo IV., and a fortress of the middle ages beside the tomb of Cecilia Metella erected by Boniface VIII. After this hasty outline of the methods of construction, it is our next business to notice the materials employed by the Romans in their edifices, confining ourselves of course to Rome and its vicinity.

To nothing certainly has the preservation of the works of ancient grandeur in Italy been more owing than to the admirable materials which the soil afforded for mortar. The lime was obtained, according to Nibby, (see the foot-note, page 23,) from a porous limestone for plastering walls, and from a compact limestone called Palombino by the moderns,* and employed for building. It was mixed with sand, which, according to Vitruvius, (lib. ii.) was either " *arena fossicia*," or "*fluviatica et marina*," three parts of the former, and two of the latter, being used for one of lime. The first is known all over the world by the name of Pozzuolana, from the town of Pozzuoli near Naples, where one species is most abundantly found. It is one of the most plentiful, as well as most important productions of the soil of Rome, and has infinitely contributed to the stability of the remains of antiquity, especially where large fragments of stone were not employed. To describe its nature, phenomena, and uses, would require an entire paper; I shall, therefore, only remark, that it is a volcanic production, and still formed by volcanos now in action, (See *Dolomieu, Catalogue des Produits d'Etna*,) and that its principal varieties, according to Vitruvius, are the " nigra, cana, rubra, carbunculus." I am rather at a loss how to translate the last, unless it mean cindery or scoriaceous. Brocchi calls the Pozzuolana " *tufa granulare*." All the catacombs near Rome are cut out of this material. The sea and river sand was never used but in default of the other. The following were the stones employed in masonry by the Romans.

I. Tufa, the " *lapis ruber*" of Vitruvius, and λιθος ερυθρος of Strabo. The ancient quarries of this stone may be seen at Cervaretta on the bank of the Anio. It was, as Nibby observes, much used for foundations, but likewise, when employed in great masses, to resist as much as possible the action of the air, which readily decomposes it, for entire buildings, chiefly in the earlier ages of Roman greatness, as in the stupendous aqueduct of Claudius, and the Temple of Fortuna Virilis. Brocchi justly remarks, that " *saxum quadratum*" is its speci-

* Not being acquainted with this Palombino, I cannot state the distinction more fully. Ferber calls the *Palombino antico* " white and compact, neither scaly nor crystalline." Were I to hazard an opinion, I should consider it to be the very hard secondary limestone which abounds near Tivoli, and the kind first mentioned above, a limestone of snowy whiteness, and therefore well fitted for plaster work, which I have seen carried by horses in panniers across the Campagna, being brought, as I understood on inquiry, from a very considerable distance in the centre of the Apennines.

fic name, and not applicable to any kind of stone cut in rectangular masses, in the same way as "*quaderstein*" is applied in Germany to a species of sandstone. It is a distinct volcanic production, and common more or less to all volcanos, though very various in its aspect and characters. Herculaneum is covered with a similar formation of modern date. Brocchi calls it "*tufa litoide*," and remarks as to its construction, that it is a compound of heterogeneous materials, containing fragments of black lava, limestone, &c. It contains also white farinaceous leucites, scales of brown mica, with crystals of black and greenish augite, as well as felspar. Its fracture is earthy in small pieces, passing into conchoidal in the large. It is sufficiently hard for many purposes of building, but is considerably liable to decomposition by the atmosphere. Though differing considerably in colour and aspect, in constitution it considerably resembles the trap tufa of Arthur's Seat, near Edinburgh.

II. Peperino, another volcanic production nearly connected with the last, was brought from the Alban Mount. Its colour is greenish gray, resembling ground pepper, whence its name, though some say it is from Piperno, a town in the Apeninnes, where it is said to abound.* It resists the air much better than tufa, and is a valuable building stone, as the tear and wear of near three thousand years on the Cloaca Maxima and Mammertine prisons amply prove. It abounds in imbedded masses, crystals (chiefly decomposed,) &c. A variety of it, which, except from locality, hardly requires separate notice, is,

III. The Pietra Gabina, or "Saxum Gabinum," brought from Gabii, twelve miles from Rome. Its colour resembles Peperino, but it is said to be harder, and more porous, and to have been used by the ancients for millstones. I must confess that I am not acquainted with the characteristic distinctions of this stone. It was esteemed, as well as the last, for being proof against fire, on which account Nero commanded Rome to be rebuilt after the great conflagration, with one or other of these stones. "Ædificiaque ipsa certa sui parte, sine trabibus, saxo Gabino Albanove solidarentur: quod is lapis igni impervius est."—*Tac. Ann.* xv. 43.

* See *Burton's Antiquities of Rome.*

IV. The Travertine, (corrupted from "lapis Tibertinus,") was the most beautiful and durable stone used by the Romans in their edifices. The old quarries are still seen beside the Anio, near the Ponte Lugano. It is a substance daily forming by the incrustation of reeds and other objects, with calcareous matter from springs, abounding with sulphuretted hydrogen, especially at the little lake called the Solfatara, whence the famous milky stream flows, known by the name of the Aqua Albula. Several mistakes have occurred with regard to the nature of travertine. The distinguished Simond in his work on Italy, just published, shows how little of a geologist he must be; he confounds it with Peperino; and says "Peperino, espece de *tuf volcanique* que l'on voit se former dans la campagne de Rome *près des eaux souffrées.*" A man's ideas of geognosy must be rather confused when he imagines that *volcanic* rocks may be daily forming by the action of springs! Breislak too falls into an error, when he considers that the Anio at present forms true travertine. The productions of its waters, called "confetti di Tivoli," are far softer, and are properly calcareous sinter, while the travertine is calcareous tufa. The former is known under the name of calcareous alabaster, and is of very slight hardness. It is admirably calculated for a building stone, as it hardens on exposure to the air; and, originally white, acquires a slight tint of orange, most excellently adapted for picturesque effect in the numerous ancient edifices composed of it. It was first used for the ornamental parts of the edifices built of softer stones, as may be seen in the Tabularium on the capital, which is perhaps the earliest instance of the employment of this stone, as it was not used of course till Tibur came into the possession of the Romans. When compact masses of the stone are chosen, not interrupted by vegetable petrifactions, it is admirably calculated for durability, as may be seen in the exquisite capitals of the Temple of Vesta at Tivoli. This stone is not peculiar to Rome; a variety of it occurs at Terni, and it is found in great perfection near the city of Pæstum, where it is produced by the impregnated waters of the river Salaro. The temples and walls of that amazing city are built entirely of this stone, and the admirably perfect remains of the former are a sufficient comment on its durability. The reddish colour which it assumes at Rome is undoubtedly owing to the presence of iron in the sulphureous springs, which is decomposed, as pyrites always are, by exposure to the weather.

V. Silice, or selce, as it is known to the Italians, is not the true silex; but ancient lavas and basalts. It was known by the same name to the Romans, as is universally admitted; but will be illustrated by the accompanying interesting inscription of Trajan, on a milestone of the via Appia, which every one knows was paved with basalt:—

VI
IMP CAESAR
DIVI NERVAE
FILIVS NERVA
TRAIANVS AVG
GERMANICVS
DACICVS
PONTIF. MAX.
TRIB. POT. XIII
IMP. VI. COS. V. P. P
XVIII. SILICE SVA PECVNIA
STRAVIT

This inscription I copied at Mesa in the Pontine Marshes. The streets of Rome and all the *viæ* in the neighbourhood were paved with this lava, from the famous Coulée of the Capo di Bove, where immense quarries anciently dug may still be seen. The Via Ostensis may still be seen near Ostia, paved with this same lava, which comes from the Capo di Bove, two miles from Rome, and therefore carried sixteen or seventeen miles, and certainly not from the Alban Mount, as Ferber imagines, which is greatly farther distant. According to Daubeny, in his excellent work on volcanos, this coulèe "appears to consist of an intimate mixture of augite and leucite, either in crystals or granular masses, the former of a bottle green colour, passing into brown, the latter white or azure." I must refer to the work itself for the mineralogical and geological peculiarites of this remarkable formation, taking leave at the same time strongly to dissent from the author, as to the source from whence he takes its origin. A treatise has been published expressly on this kind of stone, "*Lupi, del selce Romano.*"

VI. Pomice, Pumex, Pumice. This stone, which Nibby mentions as employed for vaults and cupolas on account of its lightness, has occasioned some discussion. He says "questa pietra traevasi dalle vicinanze del Vesuvio," and mentions no authority for the circumstance of its being carried all the way from Vesuvius. Nibby appears to be no mineralogist himself; and I am inclined to suspect, that, knowing of no pumice near Rome, he supposed that it was brought from that volcano. Now pumice is by no means an abundant production of Vesuvius. Dolomieu *(Isles Ponces, p.* 31, *note,)* confesses, that in a cursory view of the environs of Naples, he was not aware of the existence of pumice there, and Breislak mentions its occurrence, *(Campanie,* vol. 1re,*)* only in one place of the mountain, though it is more frequent in Ischia.* It was doubtless from a knowledge of this rarity of pumice, that made the editor of the Journal in which Mr C. T. Ramage's *translation* of Nibby appeared, remark in a note, "The pumice mentioned above is, we presume, vesicular lava, not the pumice of geologists." Now pumice is a substance so perfectly well known in Italy, that it is extremely improbable that it should be confounded with the other substance, (though by ignorant foreigners it sometimes is,) by Sig. Nibby, (Mr Ramage's name it of course does not rest upon, being a mere cypher,) though indeed nothing but an inspection of the vaults of the Colisseum and royal palace to which that gentleman refers, can properly decide the question, and my memory does not so far serve me in the present case. But I think it, on the whole, much more probable that it is a true pumice, since it is found much nearer than Mr Nibby imagines, namely, in the very Campagna di Roma. My authority is the testimony of Brocchi, *(Suolo di Roma,* pp. 203, 204,*)* whose words I literally translate. "In these places" near the Sepolcro dei Nasoni, &c. near Rome, "pumices are most abundant, which are sought in vain on the mountains of Albano and Tuscolo; and they become much more abundant as we proceed northward from Rome. At the issue of the Acqua-traversa, on the road to

* I have in my possession a specimen of pumice from Vesuvius, and another from Cumæ. It is extremely rare in Etna. See *Spallanzani's Travels,* and *Dolomieu, Catalogue des produits d' Etna.* Most of the pumice of commerce comes from Lipari.

Storta, there are strata in the middle of the tufa to the height of $2\frac{1}{2}$ feet. Remarkable masses are seen near Bracciano and Anguillara, as also in the environs of Caprarola and Bagnassa, at the foot of the hills of Cimini, where they are as well preserved as *those of Lipari!*"

We shall now proceed to a brief detail of the stones used as ornamental by the Romans, beginning with the true marbles.

The *marmor Lunensis* is that of modern Carrara, so called from its vicinity to Luna, a seaport of Etruria, whence, as Strabo informs us, it was shipped with great ease, and conveyed up the Tiber to Rome. He adds that it was white, with veins of a bluish colour, and was excavated in great masses for tables, and for columns of a single piece, with which the greater part of the edifices in Rome were enriched. Mammurra, an officer under Julius Cæsar, decorated his house on the Cælian with columns of this marble, which was the first instance in Rome.* The distinction of the different white marbles requires much practice. That of Carrara is very highly crystallized, sparkling, opaque, and hard; when polished it does not take the lustre of the Greek marbles. The Hymettian marble, which was taken from Mons Hymethus, now Trelo, near Athens, was much esteemed for its whiteness, and was used for the altars and temples of the gods, as Xenophon informs us. Of it were the "trabes Hymettiæ," which Horace alludes to as being in the highest esteem at his time. It was the first foreign marble which was seen in Rome. Lucius Crassus the orator brought six columns of it, twelve feet high, to his house on the Palatine, ninety-one years before our era.

The Pentelican marble, also white, frequently with greenish veins, came from Pentelica, in Attica, now Pendeli. It is little spoken of by the Roman writers, but seems to have been highly esteemed by the Greeks. It was therefore probably little used in Rome; but Plutarch† tells us that the Temple of Jupiter Capitolinus, when rebuilt by Domitian, was decorated with columns of this marble brought from Athens. Ac-

* *Pliny*, xxxvi. 6. † *In Poplicola*, c. xv.

cording to Olivier, in his travels, where it lies upon the schistus it is white and very fine-grained.

The Parian marble, extremely celebrated among the ancients, was found in the hill of Marpessa in that island, the "*Marpesia cautes*" of Virgil.* It was noted for its whiteness—"lapis candidissimus qui dicitur Parius." Antoninus. It was principally used for statues; † but the mausoleum of Adrian, as we learn from Procopius, ‡ was encrusted with it. In colour it inclines to yellowish-white, while the Carrara marble is bluish-white. It appears to be in lamellar concretions, which sometimes vary in opacity.

The Tasian marble was white, but stained, and chiefly used for building about the time of Nero.

Such are the principal white marbles of the ancients. It is alleged that some of the most famous statues are cut from Dolomite or magnesian limestone; but I am not aware which, if any, of those now mentioned have this character. In fact, it is not agreed out of what marble the best statues are executed, so minute are the differences of the white marbles.

Of the coloured marbles, the first we shall notice is the Carystian, corresponding to the modern Cipollino. It was quarried near Carystos, now Castel-Rosso, in Eubæa (Negroponte,) and was of a greenish colour, in lines or sinuous strata (*Undosa Carystos*, Statius.) It was much used in Rome, and was early introduced. Fine columns of it occur in the Temple of Antoninus and Faustina, and others, which once stood in the Church of St Paul, are now extremely injured by the fire which destroyed that gorgeous edifice. Very fine ones adorned the Temple of Peace, one of which now stands before St Maria Maggiore. It is one of the commonest marbles in the ruins of ancient edifices.

The Africano of the moderns, which Nibby considers equivalent to the Chian marble of the ancients, would seem more naturally to correspond to the "columnas ultima recisas Africa" of Horace. Indeed, the derivation which the Italian antiquary gives of the modern name, from the predominance of

* *Æn.* vi. 471. † Αριστη προς την μαρμαρογλυφιαν, Strab. x.

‡ *Bellum Gothicum*, i. 23.

black in the marble, resembling the negro's colour, appears to me absolutely ridiculous, and unworthy of the great penetration of the author, especially as the stone is a mixture of black, red, and white, in which the former does not forcibly strike the eye. It is one of the most beautiful of the ornamental stones, and is a *breccia*, consisting of a basis or ground containing fragments of numerous colours. A difference in the basis gives rise to several varieties of this marble, of which two beautiful ones are preserved in two pedestals in the Vatican Museum. Pillars of this marble adorned the Basilica Ulpia and the Forum Trajanum. Among the finest specimens existing are those in the palace of Caserta, near Naples, taken from the Temple of Jupiter Serapis at Pozzuoli. Nibby has not stated his reasons for identifying the Africano with the Chian marble; and I therefore pay the utmost deference to his opinion, as his decisions are generally the result of sound induction from facts. Ferber informs us that a modern marble, similar to the Africano, is found at Serravezza. The marble named Porta Santa Antica is only a variety of this species.

The Pavonazzetto, anciently the Phrygian marble, was very highly esteemed, but now very common in Rome. Splendid pillars of it formerly existed in the Basilica of Paulus Emilius, in the Forum, as Pliny tells us. "Nonne inter magnifica Basilicam Pauli columnis e Phrygibus mirabilem," which are probably the same as lately ornamented the superb Church of St Paul's, though now cruelly shattered by the conflagration. There are others in the Pantheon. The Dacian prisoners on the Arch of Constantine are sculptured in this marble.

The Nero Antico, or Tenarian marble, has always been in the highest repute, and is now extremely scarce in Rome. It is that species of limestone called Lucullite by mineralogists, and is probably the kind of which the Consul Lucullus was so fond that it took his name.

One of the most admired marbles, though not very rare in Rome, is the Giallo Antico, which corresponds to the Numidian, the Libian, and the Punic* of the ancients. It was one

* "Marmor Numidicus."—*Plin.* v. 3.

"Et certant vario decore saxa
Quæ Phryx et Libys altius cecidit."—*Mart.* vi. 43

of the first introduced and most esteemed marbles in Rome. Its colour is a very fine yellow. "Hic nomadum lucent flaventia saxa." When exposed to the influence of strong heat, it becomes orange (*Giallo Antico Brucciato.*) Of this marble we have eight splendid columns in the Pantheon, which unfortunately are not seen to their bases, and seven smaller ones in the Arch of Constantine; but it is very rarely found in large masses. I must admit that its tint of yellow is mixed with a little red; and when veins traverse it, as they frequently do, they are of a crocus, or reddish saffron colour. It is much used in small fragments with green porphyry in pavements, which has a beautiful effect.

The Rosso Antico is probably the rarest of all true marbles. Nibby imagines that it is a vein in the last mentioned stone, since it is met with almost entirely in small pieces. The famous statue of the Dancing Faun in the Vatican, and some steps in the small church of St Praxides, near St Maria Maggiore, are, I believe, quite unique in size. Its colour *when polished* is pretty nearly true blood-red.

Such are the principal antique true marbles. We shall now mention some other ornamental stones, some of which are often falsely considered as marbles.*

The Verde Antico is one of the stones best known and most prized, under the title of marbles. The green part, however, from which it takes its name, is serpentine. It is mixed with patches of white and black. It was the Atracian or Thessalian marble of the ancients, as Nibby satisfactorily proves. The darker varieties which have least white are most prized. Splendid columns of this marble (though small, as this stone is never found in large masses) decorate the Church of St John Lateran, and were found in the baths of Dioclesian. Even small fragments are rare among the ruins.

The calcareous alabasters were much used by the ancients; and as the sources whence they derived them are unknown, the fragments found in ancient buildings are exceedingly priz-

* The Lumachella, or shell marble, is excessively rare in modern Italy, though I do not know whether it was used by the Romans. In the Campo Santo at Bologna I saw two small pillars, which I was told were the only ones in Italy, except at St Mark's at Venice.

ed. This substance is an aqueous deposit, and consists of curved lamellar coats. It is the true calcareous sinter of mineralogists, such as is now deposited by the Anio at Tivoli, and called *Confetti di Tivoli.* The cream-white opaque oriental alabaster is most commonly seen, but extremely valued. I have been surprised to observe in this country a calc sinter found in considerable pieces at the Dropping Well, in Yorkshire, so extremely beautiful when polished, that it would puzzle an experienced eye to know it from the true oriental.

The *Alabastro Fiorito*, or flowery calcareous alabaster, is still more rare and beautiful. It has undulating markings from purplish veins which traverse it. There is a beautiful specimen of this kind cut into a small stag in the Vatican Museum. Four twisted columns of extremely transparent calcareous alabaster support the high altar of St Mark's at Venice.*

The "Pietro di Paragone," or Touchstone, stands by itself amongst the hardest stones, though both Nibby and Ferber place it among the marbles. It was the Lydian marble of the ancients, and the true Lydian stone of mineralogists, which is a species of flinty slate of great hardness. It was brought from Lydia; but Ferber tells us, that a kind exactly similar is found at Bergamo. It is at present in great repute for pillars, &c. The small church of the "Scalzi" at Venice is particularly rich in it. It is often traversed by small veins of quartz. It is perfectly black.

Of antique porphyries I shall only notice two varieties. The first is the green porphyry, one of the most beautiful of the ornamental stones. It is the "Marmo Lacedemonio" of Nibby, who, as an antiquary, places it among the marbles. His decision is well supported by the authority of the classics, who mention its hardness (hic dura Laconum saxa virent," Stat.); and its use along with porphyry of a red colour in pavements, which is so universal, (" Stravit et saxis Lacedemoniis ac

* Nibby does not mention the varieties of alabaster; he only particularizes the Theban, which contained spots of gold. The above remarks are chiefly from my own observation. In the Museum of the University of Edinburgh is a most splendid collection of antique alabasters, collected and presented by the father of the late Earl of Hopetoun.

porphyreticis plateas in Palatio," Lamprid.); and Sir William Gell has found the true green prophyry in abundance near Sparta. It is universally known in Italy under the name of serpentine, though quite unconnected with the serpentine of mineralogists. It is a very compact felspar porphyry. The colour of the crystals approaches mountain green set in a much darker ground, which is between grass green and blackish green. I have, however, a specimen from the ancient city of Ostium, in which the ground is so much mixed with brown as to be of a light dusky colour. It is found in Rome in considerable abundance. Some parts of lanes, &c. are entirely paved with it, but it is never seen in considerable masses. I do not recollect ever seeing the smallest pillar made of it. In the baptistery of St John Lateran two small red porphyry columns have capitals of the green variety. It was much used, as we have already noticed, for Mosaic pavements, particularly in churches, &c. about the time of Constantine. The red species of porphyry was the only one known under that name to the ancients, and, in fact, gave rise to it from its purple colour. It is excessively hard, and was not introduced in Rome till a late period, but afterwards became so common that it obtained the name of Pietra Romana peculiarly. It was sometimes used in statuary, as may be seen in the Dacian captives at the Pitti Palace, Florence, and in other instances, but was more generally used for sepulchral urns, sarcophagi, &c. Of the latter we have two superb examples in the Vatican, taken from the tombs of Helena and Constantia. The latter has figures, (though in bad taste) executed upon it in surprising relief. But the most superb specimen of this stone is the Tazza or flat basin in the Vatican Museum, hewn out of one piece, and measuring forty-six feet in circumference. The basis or ground of porphyry is a mixture of much red, a little blue, and a considerable portion of brown; in short, nearly what is termed cherry-red by mineralogists. The crystals have a faint tint of the same colour passing almost into white. Ferber divides the porphyries into many subspecies and varieties with which I am not acquainted, and must be very rare. He properly considers the serpentine of Italy as a green porphyry. I may mention by the way, that I have seen a large *boulder stone* of this substance in the court of the museum at Naples, which is of considerable size, and, being partly cut up, appears to be very fine.

Basalt, called also by the Greeks λιθος βασανιτης, was only used in Rome for statues and vases. It was found in Ethiopia; but large masses of it are very rare. Pliny (xxxvi. 7.) informs us, that the largest piece known in his time was the statue of the Nile with sixteen infants round it, which is well known in the Vatican Museum, and was formerly kept in the Temple of Peace, that great repository of art and literature. By far the largest pieces known, however, are two statues in the gallery at Parma, or rather colossal fragments, from the Farnese Gardens on the Palatine at Rome. The one represents Hercules, and the other Bacchus supported by a Faun. They must be at least ten feet high and of proportional size. Two fine lavers for bathing are preserved in the Vatican of this material; and in the Church of St Januarius at Naples is a splendid Bacchanalian font carved in green basalt, which belonged to a temple in Egypt. Ferber enumerates no less than ten species of ancient basalt, but which, I suspect, it would be difficult distinctly to recognize. One variety must be necessarily distinguished from the common or grayish black; it is of a peculiar and lively green, and of extreme hardness. There is a very fine example of it in the bust of Scipio Africanus in the casino of the Rospigliosi palace at Rome. The two Egyptian lions at the foot of the Capitol stairs are generally referred to as the principal specimens of the true basalts, but are somewhat anomalous. They have red veins passing through them, which Ferber considers as granite; but I conjecture that they are probably merely ironshot, and cannot be considered a separate species. When artists wish to repair Egyptian basaltic statues they employ the lava of the Coulée at Capo di Bove.* Is not this alone sufficient to exhibit the utter absurdity of the Wernerian hypothesis, which, while its most strenuous supporters have been forced to consider the latter a true lava, have pronounced the former an aqueous deposite? A substance described by antiquaries as nearly allied to basalt is the *lapis obsianus*, the obsidian of the moderns, which was sculptured by the Egyptians into figures of gods, &c. I imagine that Ferber means to describe the

* Breislak, *Campania, &c.* ii. 257.

same as a species of basalt, under the title of "Basaltes nigerrimus maculis ex hornblende viridescenti;" and the Italian "Pietra d'Egitto, Pietra Nefritica." He has, however, most probably made some confusion. We have only a word or two to say on the granites.

Ferber is wrong in saying that the oriental granite in no respect differs from that of the Alps. It is in fact a sienite, which contains hornblende in place of mica, as is universally the case in the granites of Egypt, and consequently all the obelisks and other monuments at Rome. The granite of Switzerland contains talc or chlorite instead of mica, and is named Protogene. I have in my possession a curious specimen from Rome, which contains abundance of quartz, apparently no felspar, with hornblende, chlorite, and mica. This is probably the "granitō Nero e bianco." There are two other species, the only ones mentioned by Nibby, the red and the gray. The first was used for obelisks, and is most abundant. The largest obelisk in Rome is that at St John Lateran, of which the single shaft measures 109 feet. Eight most superb columns of this granite decorate the Church of S. Maria Degli Angeli, in the Baths of Dioclesian, which, enormous as they are, have part of their bases buried under the pavement. The gray granite was likewise much esteemed. We have fine specimens of it in the broken pillars of the Temple of Venus at Rome; and the portico of the Pantheon is composed partly of this, partly of the former species. When small-grained, the Italians call it *granitello.* Ferber mentions a green granite with which I am quite unacquainted. He seems to intimate that it contains crystals of hornblende in a pale green basis. The only true green granite now known comes from Siberia, having the felspar verdigris green, (of that variety called Amazon stone,) and it would be singular if a similar species was known to the ancients. Had he not been so particular in describing the aspect of it, *(Travels, &c.* p. 229,*)* we might have suspected it to be the *granito di gabbro* of the Italians, or Diallage rock.

I have now, Sir, finished the survey I proposed to lay before you of this extensive and interesting subject. I have been obliged to curtail my remarks, and to suppress many facts to bring them within the limits of one paper; but I believe this account will be found more comprehensive and accurate than any I am acquainted with in our own language. I have departed very much from the essay of Nibby, which I at first proposed to myself as a rigid guide, in order to amend his arrangement, which shows little knowledge of mineralogy, and to add various more general and physical remarks than he, as an antiquary, thought it necessary to do. Besides, that, for obvious reasons, I was desirous not to follow him too closely, although I only profess myself a follower and humble imitator of his work: I have embodied almost all the facts he mentions, in the preceding pages, but the original contains some antiquarian researches I have omitted, and much valuable classical authority, which renders it well worthy of a careful perusal, and I beg to recommend it strongly to your readers.

I am, Sir, your most obedient servant, Δ

April 29, 1828.

ART. IV.—*On Botryogene, the native Red Iron-Vitriol of Fahlun.* By WILLIAM HAIDINGER, Esq. F.R.S. Ed. Communicated by the Author.

A DESCRIPTION of a red salt of iron was some time ago given by Berzelius, and published along with an analysis of it, from which it appeared that the substance was deserving of a place in our mineralogical systems. Very little, however, could be then made out of its physical properties. Through the kindness of Professor Berzelius in Stockholm, and Mr Pohlheimer in Fahlun, I have been furnished with specimens of this interesting substance, and thereby enabled to supply the deficiency of the former accounts of it. To the description I propose to add an abstract of the paper by Berzelius,* which has never been published in any English journal.

* Analys af ett fossilt salt frän Fahlu grufra, och Insjö sänkning, af J. G. Gahn och J. Berzelius. *Afhandlingar i Fysik, Kemi och Mineralogi*, iv. p. 307.

The regular forms of botryogene belong to the hemiprismatic system of Mohs. The usual crystalline forms of it are represented in Plate II., Figs. 1 and 2. Fig. 3 is the projection of the latter upon a plane parallel to the base, and viewed in the direction of the axis; in which figure the parallelism of the edges of combination is more easily seen than in the perspective view of it in Fig. 2 itself. From the admeasurement of the edges, between P and q, P and g, and between g and g, I obtained the following angles:—Inclination of

n on $n = 125° 22'$ P on $g = 113° 37'$ f on $f = 81° 44'$
q on $q = 141° 0'$ g on $g = 119° 56'$ y on $P = 125° 31'$

The pyramid Fig. 4 may be considered as the fundamental form of the series of crystallization, to which the combinations Figs. 1 and 2 belong. In this pyramid the lines $a : b : c : d$ are in the proportion of $1.98 : 3.62 : 5.59 : 1$. The secondary faces occurring in nature, expressed by the crystallographic signs of Mohs, are: $\mathrm{P} - \infty$ for P, $-\frac{\mathrm{P}}{2}$ for n, $-\frac{\frac{3}{4}\bar{\mathrm{P}}\mathrm{r}+1}{2}$ for y, $\bar{\mathrm{P}}\mathrm{r}-1$ for q, $\mathrm{P}+\infty$ for g, $(\mathring{\mathrm{P}}\mathrm{r}+\infty)^3$ for f, and $\mathring{\mathrm{P}}\mathrm{r}+\infty$ for u.

The form of the crystals is in general pretty distinct; yet they were too imperfectly formed in the specimens I examined to permit any thing more than an approximation to the real angles within ten minutes of a degree. They are not above two lines in length; and the faces of the prisms f and g are striated parallel to the axis. The inclined faces are more perfectly formed.

Cleavage takes place with considerable facility parallel to the faces g. There are traces also parallel to f.

The lustre of botryogene is vitreous. It is translucent. Its colour is a deep hyacinth-red, which, however, in compound and massive varieties, passes into ochre-yellow, which is likewise the colour of its streak.

It is sectile, and becomes a little shining in the streak. The hardness is = 2.25...2.5, a little inferior to alum. The specific gravity I found = 2.039. It is but slowly soluble in water, and does not therefore possess so powerful an astringent taste as the common vitriol of iron.

The crystals of this substance are usually aggregated in reniform and botryoidal shapes, consisting of globules with a crystalline surface. A small specimen about half the size of

Fig. 5, which is in the cabinet of Mr Allan, in fact more nearly resembles a bunch of grapes than any thing else I ever saw in the mineral kingdom. The trivial name *botryogene*, from βοτρὺς, a bunch of grapes, and γιγνόμαι, I produce, alludes to the tendency of this salt to produce such imitative shapes. It is the more necessary to give it a name, as it has not been provided as yet even with a chemical denomination.

It occurs in the great copper mine at Fahlun, in Sweden, in the level called Mellanrums-Ort, as a coating on gypsum or iron-pyrites, along with Epsom-salt, sulphate of the peroxide of iron with excess of base, and the common green vitriol. When exposed to a moist atmosphere, it becomes covered with a dirty yellowish powder. It remains unchanged in a dry atmosphere.

Before the blowpipe it intumesces, and gives off water in the glass tube, leaving a reddish-yellow earth behind, which, according to the flame employed, may be changed into protoxide or peroxide of iron. With salt of phosphorus it yields a red glass, which loses its colour on cooling. Boiling water dissolves part of it, leaving a yellow ochre, which, therefore, is an integral portion of the mixture. The solution, nitric acid being added to it, may be precipitated by muriate of baryta, but not by nitrate of silver. Caustic ammonia, with which the salt is digested in a stopped bottle, takes away all the acid, and leaves the iron in the shape of a black powder, slightly greenish. The iron, therefore, is contained in the salt, not as a pure oxide, but as a compound of the protoxide and the peroxide, which is black when pure, and produces red solutions.

The following are the results of three analyses:—

	I.	II.	III.
Persulphate of iron with excess of base, - - - -	6.77	6.85	48.3
Bisulphate of the protoxide and peroxide of iron, - -	35.85	39.92	
Sulphate of magnesia, -	26.88	17.10	20.8
Sulphate of lime, - -	2.22	6.71	0.0
Water and loss, - - -	28.28	31.42	30.9

The second analysis is the most correct as to the water. Berzelius conceives the water in the sulphate of magnesia to contain five times the quantity of oxygen contained in the base, and hence infers, that, in the bisulphate of the protoxide and peroxide of iron, the ratio of the oxygen in the water and in the base is that of three to one. For the rest he considers every thing, except that of salt of iron, as foreign to the mixture, even the sulphate of magnesia, which amounts to from 17 to 27 per cent.

One of the minerals occurring along with botryogene is a bright sulphur or lemon-yellow crystalline powder, which I suppose to be the persulphate of iron with excess of base, mentioned by Berzelius. A similar mineral, also in the shape of a yellow crystalline powder, is found at Goslar, in the Hartz. It is there called Misy, a name given to it also by Professor Hausman.* At all events, it will be advantageous to keep this name for the substance, when once it will be better described, and received as a species of its own in the mineralogical systems, and not to apply the name of Misy to the red salt above described, as is done by Leonhard.† Misy is an old name occurring in Pliny.‡ It is difficult to ascertain the exact original meaning of it, if it did not refer to the decomposed alum-slate, impregnated with various kinds of salts.

Art. V.—*Account of the Great Cavern of Boobon in the Cossyah Mountains.* By M. Duvaucel.‖

It is well known that there is a subterranean cavern at the foot of the Cossyah Mountains; but very few Europeans have seen it, because it is out of the Company's territories; and I am convinced your numerous readers will peruse a description of it with interest.

This immense excavation, which seems to be made by the passage of the rain waters across the rocks, is without doubt the largest that is known. Neither the grottos in Germany, nor the cavern of St Patrick in Ireland, nor that of Bauman

* *Handbuch*, § 1058. † *Ibid.* § 113. ‡ Lib. xxxiv. cap. 12.

‖ Having referred to this paper in a brief notice of the Cave of Boobon in this *Journal*, No. xv. p. 54, and having found that M. Duvaucel is a traveller of veracity as well as a learned naturalist, we are persuaded that our readers will be gratified with the following translation from the description of the cave originally published in French in the *Calcutta Journal*.—Ed.

in Brunswick, nor Antiparos, nor Pen-park Hole, in the county of Gloucester, nor Devil's Hole in the county of Derby, are of such vast extent; and Boobon is at once one of the most gigantic and frightful monuments of the power of time united with the action of the elements.

The entrance to the cavern of Boobon is in the midst of a pile of secondary rocks. It is a narrow opening, through which we descend without danger by sliding down some stones, which are arranged like steps. We reach the ground some feet below the opening. The first view presents all the confusion of a sudden slip of earth, and we walk at first across rude blocks of stone, which have deep and narrow paths between them; but this inequality disappears as we continue to advance, and the road, at first so broken, irregular, and painful, becomes at last practicable in nearly the whole breadth.

The vault sensibly inclines to the right and left, and the waters which accumulate at the latter side leave there a vast number of stalactites, like large planks, very close together, and lying in a vertical direction.

Other stalactites, as various in their forms as in their size, are attached to the top of the vault, and the ground is covered with innumerable stalagmites; and in this immense work, which nature has produced so slowly, we recognize one of the most ancient productions she has formed since the consolidation of the globe. The height of the cavern is everywhere about fifteen feet, and its width, which is from twenty to twenty-five feet, is contracted at different places only by rocks, which are converted by the stalactitic deposites into the shapes of men or animals, which pass among the inhabitants of Cossyah for beings metamorphosed into stone. These superstitious people look upon this cavern as the work of Satan, and as the abode of several wicked gods. In passing before each diabolic work, they take care to cry out, and to strike their hands to frighten the demons. On reaching a certain depth they will not advance without great fear. In one word, the cavern of Boobon is to the Cossyahs what the grotto of Trophonius was to the Greeks.

After walking three hours a distance of about four miles, without finding any change in my route, my guides took fright, and refused to proceed any farther. I had observed that the flame of the torch which lighted us wavered always in the same direction, as if impelled by a current of air. I imagined from this that the cavern had a second opening, and by dint of entreaty I prevailed upon the Cossyahs who accompanied me to go a little farther; but I was wrong in my conjecture, and after an hour's search for the new opening, I retraced my steps, and had no proof of its existence.

The route which we followed in this gloomy labyrinth was divided by narrow paths, which led to deep precipices. I had the curiosity to examine one of those, the approach to which seemed the most practicable, and after having tied two lanterns to the end of a ladder of rope, I let drop twenty fathoms in the interior of the hole. The entrance, as far as the fourth fathom, was sufficiently narrow to allow me to touch the rocks either with my hands or my feet; but towards the fifteenth fathom, the pit appeared to widen considerably. At sixty feet I perceived nothing but a frightful abyss, in spite of the oscillations of my ladder from the violent shakes; and arriving at the ninetieth fathom, I found myself suspended over the top of an immense vault, which appeared to me to be formed like a reversed cone. The feeble light of my two lanterns did not allow me to see the bottom of this frightful precipice; but I believe it to be of very great depth, beause I heard the fall of a stone which I threw down at the end of twelve seconds.

The atmospheric air of this abyss differed very little from that of the cavern, which was but one degree less than the external air, and where the temperature of the water was itself only two degrees below that of the air.

When I had ascended to the large cavern, I struck the ground with force in several distant places. I heard a sonorous noise, which made me conclude that the whole cave, and perhaps the mountain itself, rested upon a subterraneous place; and if my idea is correct, the cavern of Boobon, already so extraordinary from its vast extent, is still more so from the singular circumstance or phenomenon of its having one part formed by the primitive fire, and the other part formed by the pluvial waters! They find near these places basaltic fragments, and stones filled with black points of a vitrified substance, which are volcanic productions; but these without doubt are conveyed thither by the waters of a small river in the vicinity of the mountain.

Mountains of Cossyah, 19*th October* 1821.

ART. VI.—*Additional Observations on the Cavern of Boobon, with a* PLAN. By DAVID SCOTT, Esq. Communicated by the Author.

THE description of the Sylhet cave called Bhoobin by the natives, as published in the *Calcutta Journal*, gives, as far as I can recollect, a very good idea of it, although I cannot help thinking that some of the adventures of the explorer, such as hanging down by a rope in an unfathomable abyss, &c. &c., are not inaptly designated by Dr B. as fabulous. Trusting to that account, we went fully prepared with ropes, ladders, &c. &c. but found no occasion to use them, except just at the mouth of the cavern; and we were assured by the guides that we had penetrated farther into it than any preceding travellers. I have since seen a gentleman who accompanied the French naturalist on *one* of his visits to the cave, and yet knew nothing of his swinging like a pendulum in the way described. It, however, appears that the latter went several times to examine it; and, as the various lofty vaulted chambers of which it consists, would have exactly the appearance mentioned, if looked down into from an opening in the top, the circumstances mentioned may after all be true. I send you a plan of the cave, for the perfect accuracy of which I cannot, however, vouch; for although I took the bearings with a compass as I went along, some discrepancies occurred between them and those taken on the way back, which I had not time to reconcile, the want of oil compelling us to run for it. From the point E, Plate I., Fig. 10, to the mouth of the cave A, we took exactly one hour to return; and, as you may suppose, under the above circumstances, we lost no time in making the best of our way out. More than half the distance was good walking ground, the rest uneven, with several ascents and descents; but, upon the whole, I cannot estimate the distance from the mouth to the fork at less than one and three-fourths or two miles. From the mouth of the cave there proceeds (at the season we visited it, March,) a cold blast of air. The temperature was 69°, while the thermometer in the shade on the outside stood at 80°. From this I conjecture that there must be a communication with the superior part of the mountain, through which this cold air descends. This supposition is, nevertheless, not unattended with difficulty, as the limestone rock, in which such crevices are usual, is capped by sandstone of full 1000 feet in thickness,—an inference, however, which I do not draw from actual observation on the spot, but from those made at some distance to the east and west, where the face of the hill presents very similar appearances. At the extremity of the branch C, and at various other places where any accumulation of soil had taken place, I examined it, in hopes of finding fossil remains, but without success. The greater part of the floor is quite bare and dry, the rock limestone of the common Sylhet kind, containing marine remains. The stalactites are superb, hanging in rich festoons from the top and sides, and forming in many places ribbed arches, resembling the interior of a Gothic church. There are also many of a pyramidal form, rising from the floor; and one of these is worshipped by the natives of the plains, as representing the lingum, annually in the month of Magh. I regretted extremely being obliged to return without exploring to their extremities the remaining branches. In point of size there seemed to be no diminution, as far as we proceeded, the hall from which we returned being as lofty and spacious as any of the preceding ones. These halls resemble empty vaulted Gothic buildings. They are from sixty to a hundred feet in height, and about the same or more in breadth and length. These are connected by passages, from twelve to thirty feet in height, and about the same breadth, formed apparently by one of the strata of the limestone rock in its natural inclined position, leaning against another more upright, in this form,  sometimes from the left, and sometimes from the right, according to the different turns taken by the cave, but without, as far as I could judge, any great regularity in the direction of the dip.

Reference to Plate I., Fig. 10.

A. The mouth of the cave low and narrow.

BB. Lofty vaulted chambers from 60 to 100 feet in height.

C. Branch explored to the extremity where the thermometer stood at 71° Fahr.

DD. Branches not fully explored.

E. On our return we took one hour to walk from this point to the mouth of the cave.

ART. VII.—*On the Chalk Formation of Denmark.* By Dr G. FORCHHAMMER. Communicated by the Author.

THE north of Europe possesses, with regard to geognostical phenomena, several highly interesting facts, and a closer investigation into the nature of the Scandinavian transition formation has thrown light upon those of other countries. But these older formations have so much engaged the attention of the geologists, that the few traces of mountains of a more recent origin have hardly met with any notice, and may be said almost entirely to have been neglected until within the last few years. They deserve, notwithstanding, some attention from their peculiar nature, and from some rather unexpected facts which they exhibit. I intend, therefore, to give an account of some rocks which have been comprehended under the name of the chalk formation of Denmark; but in order to be better able to compare them with those of other countries, it will be necessary to give a short sketch of some older secondary rocks in the south of Sweden, and on the island of Bornholm.

It is well known that the peninsula of Norway and Sweden is almost entirely void of secondary rocks, except in its southernmost parts, in the province of Scania, where such are found. But these are of a very recent kind; and rocks corresponding to mountain limestone, the red marl, the coal formation, the magnesian limestone, the lias and oolite of Great Britain are entirely wanting. A coal formation occurs indeed both in Scania (at Hoganaes,) and on the island of Bornholm, but it is by no means analogous to that of Britain. It has a great geognostical resemblance with the iron-sand of England, except that, instead of the mere traces of coal which are found in it in England, it contains in Scandinavia real beds of coal. It is succeeded by green sand and chalk marl. Like the English formation it consists of beds of fine white micaceous sand, alternating with thin beds of clay, of a soft yellow sandstone, of ironstone nodules, and occasionally of thin beds of limestone. Coal occurs in numerous beds, but till now they only have been found of an inferior kind; besides a small formation of basalts and olivine, and large depositions of kaolin, which enters sometime into the composition of a sandstone, are connected with it. This formation has partly been considered as analogous to the old coal formation, and described as such, partly as belonging to the real brown coal formation, (plastic clay.) But it agrees neither with the one nor the other. The striking difference that none of those rocks which in Britain immediately cover the coal formation are found here; that all traces of lepidodendron and syringodendron are wanting, while impressions of small ferns, and leaves, and branches of dicotyledonous plants are frequent, distinguishes it sufficiently from the older coal formation. The frequent repetition of parallel beds of coal, the occurrence of ironstone, and the antecession to green sand and chalk, exclude certainly the *argile plastique.* It is, however, only with great difficulty that the relative situation of these different members is ascertained. An enormous waste covers the whole; sand, loam, pebbles, and large rolled masses of primitive and secondary rocks are heaped up to a considerable height upon all these formations. Seldom have the rivers cut through this upper bed, and only a few detached spots furnish an occasion for the geologist to make his observations, and to try to combine by analogy what nature does not allow him to connect directly. It is not my intention to enter more minutely into the facts respecting this formation, which is reserved for another paper. It is sufficient here to mention what secondary formations, anterior to the chalk, form the southernmost point of the Scandinavian peninsula.

On the Danish island of Saltholm near Copenhagen, and on the opposite coast of Scaane at Limeham, a limestone occurs, which belongs to the chalk formation, and either replaces the chalk-marl, or is interposed between that and the chalk. It consists of a grayish-white limestone, which in some places is hard enough to be polished, in others already approaches to chalk; it contains beds of smoke-gray flint in nodules, with a splintery fracture, and passing into hornstone. Of fossils it contains a flat corallite, which seems to be the characteristic petrifaction of this bed; besides several echinites occur, and several terebratulæ. On the island of Saltholm these beds dip gently to the south-west, and the line of its bearing is from Saltholm to Limeham south-east, as it occurs on both places almost on the level of the sea. On the coast of Sealand, opposite to Saltholm, no trace of rocks *in situ* occur, but such a number of fragments of a similar limestone, but much richer in fossils, are found, that many limekilns are constantly occupied in converting them to quicklime.

The first place on the coast of Sealand where solid rocks again make their appearance are the cliffs of Steven, (Stevensklint) well known to the sailors of the Baltic as a very dangerous place, until some years ago the erection of a lighthouse has almost entirely prevented all shipwrecks on these coasts. The cliff extends for five or six English miles along the shore, with a mean height of about sixty or seventy feet. It is with very few exceptions perpendicular; and only on three places along the whole cliff a footpath leads up to the higher plateau. The fishermen make use of ropes and ladders to descend to their boats, which they screen against the impetuosity of the sea behind huge masses of the rock fallen down from the precipice. Under the cliff there is generally room enough for a narrow footpath; but in several places the rocks descend perpendicularly into the sea, and the wanderer must betake himself to his boat, or make use of the contrivances of the fishermen to ascend to the upper surface.

The lowermost bed of this cliff, which, with very few exceptions, may be observed along its whole extent, is chalk; it is very soft, and formed sometime ago a considerable exportation to the ports of the Baltic. It is very distinctly stratified, and divided into beds of one, two, or three feet in thickness. Beds of nodular flint occur parallel to the stratification, and twelve, sixteen, or twenty feet distant from each other. The flint has a conchoidal fracture, and is very hard; generally of a dark smoke gray-colour. These beds of flint continue with a very great regularity, and the principal one, distinguished by its great thickness, ($1\frac{1}{2}$ foot,) and its vicinity to the upper surface of the chalk may be observed from one end of the cliff to the other. It has a very slight dip to the S. W. In whatever direction we may consider this bed of flint and those beneath it, it appears constantly in a straight line, which makes a very great difference between the flint of the chalk and those of superior beds, to be described hereafter. Above the large bed of flint some perturbations begin. The beds appear on the perpendicular section of the cliff in curved lines, bent in every direction. This increases towards the upper surface of the chalk, which at an average is about ten feet distant from the large bed of flint, but by no means parallel to it. It represents an undulating surface, which in some places seems to cut the irregular small beds of flint, and thus seems to announce that the surface is not in its original state, but more or less altered by powers unconnected with its formation. This, however, remains still doubtful, on account of the irregular depositions of the upper beds of the real chalk, and may also be well explained by the original irregularities, without supposing a destruction some time posterior to the deposition of the chalk. Before I proceed to describe the following bed, I must say a few words about the fossils of this chalk, which are not so very common. Remains of Alcyonia and other sponge-like animals, seem to be the most frequent and characteristic fossils of this stratum ; they are partly converted into flint, partly into pyrites. A Terebratula, an indetermined bivalve, *Ananchytes ovata*, Flustra, Eschara, occur. Several different corals, mostly in a broken state, occur likewise.

The undulating surface of the chalk is covered by a thin bed (to the utmost of six inches thickness,) of a bituminous clay, which contains in the vicinity of the chalk much pyrites and carbonate of lime. Of fossils a Zoophyte has been found, the teeth of a Squalus, a Pecten, and impressions of an undetermined bivalve. Some slight traces of impressions of leaves are met with. This bed occurs in most places of the cliff. Where it disappears as a bed, it has dispersed itself through the upper part of the chalk, in small veins, of a line in thickness. By the decomposition of the pyrites, the whole assumes the appearance of an iron-ochre ; and in this state it is met with about twelve English miles from the cliff at Herfölge, but exactly in the same geognostical position as on the cliff itself.

Upon this bed a limestone follows, which differs considerably from the chalk. It is hard, yellowish-white, divided into large granular masses. It is a little sonorous. It passes, however, both into chalk and into the following rock, and resembles much some specimens of chalk-like limestone from under the basalts at the Giant's Causeway in Ireland. The most remarkable phenomenon this limestone offers is the complete difference of its petrifactions from those of the chalk, and the close analogy which they bear to those of the *calcaire grossier*, although they are perhaps not the same species. Although it is only about a year since I discovered this bed, yet a considerable number of fossils have been found; and no doubt it will furnish a great number, since every observer that visited the cliff and paid some attention to this bed has discovered some new ones. I will give here an enumeration of those genera which I observed partly myself, and partly owe to the kindness of my friend Mr William Lund.

One species of Patella; one species of Cyprea; one species of Fusus; two species of Cerithium; one species of Ampullaria; one species of Trochus, (the *Trochilites Niloticiformis* of Schlotheim;) one species of Serpula; one species of Dentalium; one species of Arca; one species of Mytilus; one species of Spatangus; one species of Favosites; one species of Turbinolia; the teeth of fishes; besides several univalves and bivalves and corals, of which the genus is not determinable, on account of their bad state of preservation.

The limestone in some places is full of small round green grains. This bed seldom exceeds three feet in thickness; now and then it is only a few inches, but nowhere it seems entirely wanting. By its fossils, its green particles, and its great external difference from the chalk, it seems to be analogous to the *calcaire grossier* of the vicinity of Paris. Its proper position upon the chalk is on the whole cliff everywhere evident, and no real chalk is found again above it; but it is covered by a limestone, which is almost entirely composed of fragments of broken corals.

The coral limestone forms in many places the uppermost part of the cliff, and has a thickness of thirty or forty feet. By beds of corneous flint it is divided into a number of subordinate beds. But the regularity which was so striking in the real chalk, the parallelism of the subordinate beds, has entirely disappeared. The beds of flint are constantly bent, and in whatever direction the cliff may show its sections, the beds of flint form curves. They include large ellipsoids, placed above and at the side of each other, and these ellipsoids are again divided into subordinate beds by flint, of which the layers thuscut each other. This law of stratification, so perfectly different from that of the real chalk of Stevensklint, seems to prove that the coral limestone belongs to a new series of rocks. Its proper position upon the small limestone bed is everywhere evident; and not the least doubt can remain concerning it, as the natural sections allow a full investigation of these beds. It is very remarkable that this bed contains the most characteristic fossils of the chalk formation, viz. Ananchytes ovata; Ostrea vesicularis; Belemnites mucronatus; besides two species of Terebratula, one of Crania. Of the Ananchytes ovata many broken specimens occur; but many also in such a state of preservation, that they cannot be derived from other perhaps destroyed beds of the chalk. In some places this fossil is so frequent, that the limestone seems altogether to consist of it, and I think some hundreds might be collected in a cubic foot of the stone. It occurs indiscriminately both in the limestone and in the flint. The carbonate of lime which involves these broken corals and the other fossils, has some resemblance with the chalk. It seems, however, to contain more clay and some carbonate of iron. It has in a high degree the property of hardening on the surface when exposed to the air, while the original white colour is changed to grayish-yellow, and of resisting remarkably well all further weathering. Sharp angular masses lie under the cliff, and although much exposed to the action of the waves, they keep their sharp angles. The flint occurs in continued beds, not in nodules, like that of the real chalk. In some places, where the cliff is highest, the coral limestone is covered by a new bed, which consists of angular broken pieces of coral limestone and of flint, cemented together by calcareous spar. This bed is without stratification; it overhangs in huge angular masses the lower beds of the cliff, principally near the village of Tomestrup.

It is difficult to ascertain exactly how far these strata extend into the country. In the small town of Storeheddinge, about two English miles from the cliff, all pits pass through the coral limestone; and in the village of Herfolge, about two

English miles from the town of Kjoge, and twelve miles from the cliff, quarries are opened, which pass through the coral limestone, the Cerithium limestone, and the thin bed of clay to the chalk. It is even asserted that limestone was found in laying the foundation of the road from Copenhagen to Kjoge, but of what nature is now unknown.

About ten English miles to the S. W. of Stevensklint lies one of the highest hills in Sealand, upon which the village and church of Taxoe is situated. To the west it sends out a range of hills which continue for several miles; to the other sides it descends more or less rapidly into a plain. On the summit of this hill, close to the village, many quarries are opened, which supply a considerable exportation to several places of the Baltic. It consists of alternating beds of a compact splintery grayish and yellowish-white limestone, and of beds entirely composed of corals, both broken and in their natural situation. In the cavities between the coral branches, shells, principally of small terebratula and pecten, occur in great perfection, and, as it appears, still in the same place and situation where they formerly lived. The whole mass of limestone makes entirely the impression, both by its external form and its composition, of a large coral rock of a former sea. The two varieties of limestone before-mentioned are, however, not the only ones, although they are the most frequent, and the others only are exceptions. In the upper part some beds occur alternating with the common compact variety, which consist of small pieces of broken corals cemented together by a chalk-like marl, a rock resembling very much the coral limestone from Stevens, and other beds, which are not to be distinguished from the chalk that forms the cliffs on the island of Moen. The stratification of this limestone is interesting. In the quarries which lie on the highest part of the hill, the dip is westerly, under great angles, varying from 60° to 70°. On the slope of the hill the dip is easterly, and the angles only from 5° to 15°. No place could be found where the one direction passes into the other, although the quarries which show the different direction and dip of the strata lie close to each other, and consist of the same kind of limestone, with the same fossils.

The number of fossils which this limestone contains is astonishing. The following list is an enumeration of the genera which have been found. No doubt their number will be greatly increased when more attention shall be paid to them.

A crab. (*Brachiurites rugosus* of Schlotheim.) This is one of the most characteristic fossils of this limestone. It is very frequent, and generally in a good state of preservation. Among my specimens I have found one with much sharper outlines, and without the numerous depressions of the shell, which have given occasion for its trivial name. It is perhaps a new species; perhaps only a young specimen of the common crab of Taxoe. Teeth of fishes; Crania, a species having the form of a horse shoe; three species of Ostrea; one species of Pecten; one species of Mytilus; one species of Arca; one species of Cardium; four species of Terebratula; four species of indeterminable bivalves; fragments of a Cutillus; one species of Nautilus, *Nautilit. Danicus*, Schlotheim; three species of Trochus or Solarium, one of which is the *Trochilites Niloticiformis* of Schlotheim; one species of Cerithium? two species of Fusus, of which one is rather doubtful; one species of Buccinum? two species of Cypræa, the one *Cypræacites spiratus*, Schlotheim, the other *Cypræacites bullatus*, Schlotheim; one species of Capulus; one species of Spatangus; one species of Echinus or Cidaris; fragments of a Pentacrinites; one species of Turbinolia; one species of Favosites; a number of other corals which have not yet met with sufficient attention. The limestone of Taxoe has, together with the Cerithium limestone of Stevensklint, the following fossils:—The *Trochus Niloticiformis* of Schlotheim; the Turbinolia; the Favosites.

The nature of the rock in these two places, at Taxoe and in the middle of the cliff at Stevensklint, approaches, besides, in many instances so closely to each other, that we are obliged to consider these two kinds of limestone to be identical, although the beds are extremely different in thickness. The limestone at Taxoe is covered by a bed of grayish white marl, containing broken pieces of limestone, and which undulates like the surface of the hill.

In the south part of Sealand no other solid rocks occur; but on the neighbouring island of Moen a chalk-like rock forms on the east side cliffs, of a height amounting to 400 feet.

Already a superficial view of the cliff shows a great difference between this and that of Stevensklint; while at the latter place the rock, for an extent of six miles, continues uninterruptedly, the cliffs of Moen are often interrupted by stones covered with turf and wood; and this difference in external appearance is owing to a quite different composition of the rock. The principal mass which it forms is also generally called chalk, although there is some difference between this and that from Stevensklint. It is much harder; it cannot be used for writing, although it soils the fingers on touching. It appears thus like an indurated marl. There occur in it beds of flint in nodules, in no way different from those of Stevensklint as to the nature of the flint; but the beds thereof have by no means the regularity of those of Stevensklint. They are bent in every direction, with more or less curvature, and are in general showing a tendency to form ellipsoids like the coral limestone of Stevensklint. It is rare that they occur in continued beds; but in one place, at the foot of the highest point of the cliff called Dronningstoel (Ocean's Stair) such beds are seen, which show ellipsoidal contractions and expansions. This chalk-like rock rests in some places on a blue marl and a sand, with large masses of rolled granite, gneiss, hornblende rock, &c. In other places it includes the sand and the marl, and in still other places it is covered by them. Till now it has been supposed that this rock of Moen was entirely identical with the chalk of Stevensklint, and both termed members of the great chalk formation of the Baltic. This position, however, upon a sand vastly different both from green sand and iron sand, which both occur in Denmark, gives an additional interest to these chalky cliffs. I have twice lived for some days on the spot, and repeatedly visited the interesting places, and thus fully convinced myself that no error has crept into my observations. If my conviction, however, was only founded upon a single spot, a deception was possible; but there exist so many instances of this superposition in the whole cliff, that one serves for the explanation of the other. One of the principal places is a recess close to the foot of a huge projecting rock, which is called Taleren, (the speaker, on account of a very clear echo which formerly was heard there.) It forms a slope, inclosed on both sides by high and almost perpendicular walls of the chalk-like rock, the slope inclining under such an angle as to make it difficult to ascend. On ascending, I observed a bed of smoke-gray clay, dipping on the left hand side under this chalk, with an angle of 35° to 70°. In some places it is immediately covered by the chalk; in others a bed of variable thickness is interposed, consisting of round fragments of chalk and quartzy sand, cemented together by carbonate of limeinto a half friable paste. In other places the smoke-gray clay passes into the chalk in the form of small veins, and thus proves that they nearly originated at the same time. The clay is slaty, and its stratification is parallel with the plane of junction between the chalk and clay. This bed of bluish-gray clay is between 6 and 8 feet thick; below it lies a bed of yellow sandy clay and yellow sand, thicker than the former. There appear first stripes of yellow sand in the bluish-gray clay, parallel with the beds of it; when afterwards the sand becomes predominant, the bluish clay forms similar and parallel stripes in it, thus proving the connection between all these sandy and clay beds with the superposed chalk-like rock. The yellow sand and loam are full of large masses of granite, gneiss, hornblende rock, granular sandstone; and I have by no means been able to find any difference between this sand and loam and that which, through a great part of Denmark, forms the upper surface, for both consist of a yellow iron-shot sandy clay, and both contain large masses of rolled granular primitive and secondary mountains.

On the other side of the recess, the grayish-blue loam dips under a very small angle under the chalk. Thus a superposition is very evident in this place. It might be objected that rain-water had deposited the gray clay and sand, after having excavated the chalk. But the veins of gray clay passing into the chalk, the extreme regularity of the depositions of different coloured sand and clay, their parallelism with the superposed chalk, leave no doubt that it could not be a deposition posterior to the chalk. The rain-water carried away the softer clay and sand, and thus formed the recess in which the newer depositions, carried down by the rain-water, instantly are recognized by their utter want of regularity. On many other places a similar superposition may be observed. In one instance, a large bed of yellow sand and bluish-gray clay are completely inclosed in the chalk; in other places, the boundary between chalk and clay is parallel to the beds of flint in the chalk. In one instance, there occurs a bed of conglomerate, where the large rolled primitive rocks are cemented together by a brownish yellow clay, the bed being parallel to the boundary between the chalk and sand. The fossils of Moen are those of the chalk. I have seen the following: Three species of Pecten; two species of Terebratula, (of which one, probably *T. Defrancii*, is in the collection of his Highness the Prince Christian of Denmark.) *Ostrea vesicularis*; one species of *Gryphæa*; *Ananchytes ovata*; *Ananchytes pustulosa*; *Cidarites variolaris*; *Belemnites mucronatus*; four species of *Flustra*; one species of *Turbinolia*, which seems to be the same as that from Taxoe and Stevensklint. The *Ananchytes pustulosa*, the *Cidarites variolaris*, and the *Turbinolia*, are in the rich collection of his Highness the Prince Christian of Denmark.

There occur still another range of hills on this island, much lower, however, than the cliffs now described. It has a south-west and north-east direction, and forms partly low cliffs on the east side of an arm of the sea called the Noer. They consist of a white marl, softer than the rock from the real cliff, containing rarely fossils, but alternating with the similar bluish-gray marly clay, as that which is found accompanying the chalk of Moen. I consider these beds as small depositions of a similar kind as that of the cliffs of Moen; and many other beds of the same kind occur in different places of Denmark, viz. at Holsteinburg on Sealand, at Sneghog in Jutland, at Caleling in Jutland, &c. all of which are beds of white soft marl, accompanied with bluish gray clay, and subordinate to the great deposition of sand, gravel, and boulder-stones of this country. *

If we recollect the facts now related, we may consider the succession of strata in the eastermost part of Denmark as follows:

* I have convinced myself that the chalk of Rugen is of a similar nature, and forms subordinate beds in the gravel. It is principally evident on the promontory on which the ruins of Arcona still are visible, where a huge mass of chalk, at least fifty feet thick, rests upon bluish-gray clay, with small broken pieces of flint and granite, subordinate to loam and sand.

1. *Chalk* of Stevensklint, completely analogous to that of England; 2. a bed of clay; 3. a bed of limestone, containing such genera of fossils as are generally considered characteristic of the tertiary rocks; 4. a deposition of chalk-like limestone, with the fossils of the chalk formation; 5. sand, loam, gravel, with boulder-stones containing subordinate beds of a chalk-like marl, with fossils of the chalk formation; and we might consider all these beds now mentioned as belonging to the same formation. But the limestone of Taxoe, which is evidently interposed between No. 1 and 4, is, if we allow fossils to serve as a principal point of determination, evidently of a newer formation. It is however pervaded by strata which, as to their fossils, are analogous to the chalk, but differ so widely in point of stratification from the common chalk, from which it is only separated by a bed of a few feet thickness. The enormous curvatures of the corallite-limestone, described before, can by no means be the result of an elevation or a destruction of the originally regular strata, occasioned by earthquakes or similar causes, because the chalk beneath it is quite regularly stratified, and deviates very little from the horizontal plane; while the upper limestone, which, for four or five miles along the coast, everywhere may be seen resting upon it, shows such great irregularities, which, therefore, must be occasioned by some power confined to the formation of this rock, and which was not in activity during the formation of the chalk. Similar irregularities are found in all the cliffs; and the direction of the strata at Moen, but on a still greater scale, and similar irregularities, show the enormous depositions of sand, loam, gravel, whose surface consists of an irregular succession of round hills, and basin-shaped valleys, representing the undulations of a stormy sea. Many reasons concur to make it highly probable that this sand and gravel belong to the tertiary formation. No such depositions are known to exist in the latter period of the chalk, while the *argile plastique* has such beds. On the island of Rugen this gravel and loam has subordinate beds of brown coal. It contains both in loose sand and in concrete masses the fossils of the *calcaire grossier*, not only the genera agreeing, but even many species.

Thus we are in a dilemma to choose between two opinions equally different from those which are now generally adopted. We find an alternation of strata which, singly observed, would be considered as belonging to the chalk and to the tertiary formation. The principal reason which would lead to such a result would be the nature of the fossils observed in these beds; but since they have formations alternate, they cannot form any sufficient ground for separation, and we may consider them either altogether as being parts of one formation, or make a division, and consider the one as real chalk, the other as belonging to the tertiary formation. If the latter is the case, and I am of opinion that such a division is fully warranted, the line which separates the two formations can nowhere be drawn, except where, in the cliffs of Stevensklint, the bed of clay commences; and we consider the upper bed of Stevensklint, the cliffs of Moen, the cliffs of Rugen, notwithstanding their fossils, as belonging to the tertiary formation. The reasons which lead me to make the division in the place mentioned, are the different laws of stratification above and below this point, although it cannot be denied that the one passes into the other by degrees,—the first appearance of such fossils as are considered belonging to the tertiary formation,—the nature of the rock, which approaches a great way to that of the tertiary formations of other countries.

ART. VIII.—*An account of the services which the little bird called Trochilos renders to the Crocodile.* By M. GEOFFROY ST-HILAIRE.

ON the 28th January 1828, M. Geoffroy St-Hilaire communicated to the Academy of Sciences of Paris, a paper upon two species of animals called Trochilos and Bdella by Herodotus.

The author began by announcing that his memoir was, properly speaking, only a commentary on a short passage from Herodotus.

"When the crocodile," says this great historian, "feeds in the Nile, the inside of his mouth is always covered with bdella (a term which the translators have rendered by that of *Leech.*)

"All birds *except one* fly from the crocodile, but this one bird, the Trochilos, on the contrary, flies towards him with the greatest eagerness, and renders him a very great service; for every time that the crocodile comes to the land to sleep, and when he lies stretched out with his jaws open, the Trochilos enters and establishes itself in his mouth, and frees him from the bdella which he finds there.*

"The crocodile is grateful, and never does any harm to the little bird who performs for him this good office."

This passage is one of those which has most exercised the sagacity of commentators. Some have looked upon it merely as a pleasant story, while others, in order to justify Herodotus, have pushed their zeal so far as to create an animal which could impose upon the crocodile, and be capable of all the actions attributed to the *Trochilos.*

M. Geoffroy St-Hilaire proposes to show that Herodotus has been defended as awkwardly as he has been attacked unjustly.

During his long residence in Egypt M. Geoffroy had repeated occasion to ascertain that the story of Herodotus, though correct in substance, was inexact only in some particular details. It is perfectly true that a little bird does exist, which flies incessantly from place to place, searching everywhere, even in the crocodile's mouth, for the insects which form the principal part of its nourishment. This bird is seen everywhere on the banks of the Nile; and Geoffroy having succeeded in procuring one, recognized it as belonging to a species already described by Hasselquist, under the name of *Charadrius Ægyptius.* There is in France a bird very like it, if not precisely the same, namely, the *small ringed plover.*

With his slender beak this bird can take nothing but the smallest insects, the spawn of fish, or those molecular debris, those fragments of animal *detritus* which the action of the waters throws incessantly upon the banks.

* The following is the original of the passage in Herodotus:—

Ἄτε δὴ ὦν ἐν ὕδατι δίαιταν ποιεύμενον, το στομα ἔνδοθεν φορέει πᾶν μεστὸν βδελλέων. τὰ μὲν δὴ ἄλλα ὄρνεα καὶ θηρία φεύγει μιν. ὁ δὲ τροχιλος εἰρηναῖον οἱ ἐστι, ἄτε ὠφελεομένω πρός αὐτοῦ. ἐπεάν γὰρ ἐς την γὴν ἐκβῇ, ἐκ τοῦ ὕδατος, ὁ κροκόδειλος, καὶ ἔπειτα χάνῃ, (ἔωθεε γάρ τοῦτο, ὡς ἐτίπαν, ποιέειν πρὸς τὸν ζέφυρον) ἐνθαῦτα ὁ τροχῖλός ἐσδύνων ἐς τὸ στόμα αὐτοῦ, καταπίνει τὰς βδέλλας· ὁ δὲ, ὠφελεύμενος, ἥδεται, καὶ οὐδὲν σίνεται τὸν τροχῖλον.

If the Trochilos is in reality the little plover, the animals described by Herodotus under the name of bdella cannot be *leeches*, (besides, leeches do not exist in the running waters of the Nile,) but a very small insect of that species which swarm in those damp and warm regions, known by the name of *gnats* in Europe, and of *maringouins* in America.

Myriads of these insects dance upon the borders of the Nile, and when the crocodile reposes on the land he is attacked by their innumerable swarms. His mouth is not so hermetically sealed to prevent them from introducing themselves; and they penetrate in such vast numbers, that the inner surface of his palate, which is naturally of a bright yellow, appears to be covered with a brownish-black crust. All these sucking insects drive their stings into the orifice of the glands, which are numerous in the mouth of the crocodile. It is then that the little plover, who follows him everywhere, comes to his succour, and delivers him from these troublesome enemies; —and that without any danger to himself, for the crocodile is always careful when he is going to shut his mouth to make some motion which warns the little bird to fly away.

At St Domingo there is a crocodile which so nearly resembles those of Egypt, that M. Geoffroy could not distinguish them without great difficulty. This crocodile is also attacked by the *gnats*, from which he would have no means of delivering himself, (his tongue like that of the crocodile of the Nile being fixed) if a bird of a particular species did not give him the same assistance that the crocodile of the Nile receives from the little plover.

These facts explain the passage in Herodotus, and demonstrate that the animal which is there called *bdella* is not a *leech*, but a flying insect, similar to our *gnat*.

It is certain indeed that the word *bdella* signified in Herodotus's time a *sucker*, but lately this term has been restricted, and is now especially used to denote a *leech*. This consideration permits us, strictly speaking, to suppose that Herodotus was not mistaken in the facts he has related; but we can scarcely suppose that he knew positively what were the animals which tormented the crocodile. If he had known them, he would have called them by the particular name of *conops*, which he has given them in chapter 95, in which he mentions their numbers and their excessive inconvenience; and since, contrary to his usual precision, he has contented himself with employing the word *bdella*, (vague in his time,) we ought to conclude, that he did not know which kind of sucker incommoded the crocodile; and this confirms M. Geoffroy in his idea, that Herodotus had drawn up what he has said of the crocodile from the information which he obtained from the priests of Memphis.

Herodotus is not the only ancient author who speaks of the services which the crocodile receives from the Trochilos. Aristotle also mentions it, only he mistakes the nature of the service which it performs. "When the crocodile," say he, "has his mouth open, the Trochilos flies in and *cleans his teeth.* The trochilos finds there something that nourishes him. The crocodile feels the benefit he derives from him, and he never does any harm to the Trochilos. When he wishes him to fly away, he moves his neck, in order that he may not bite him." *

Pliny, speaking of the same fact, which he admits like his predecessors, gives another explanation of the actions of the Trochilos. "The crocodile," he says, "opens his mouth as wide as he can, and it is deliciously affected by the pecking of the bird." † M. Geoffroy St-Hilaire enters upon discussions which we are not able to lay before our readers, respecting this sort of compact between the most dangerous of the lizards, and the very little bird which assists him; that is to say, upon the mutual harmony established between them,—a harmony so necessary, that the crocodile, incapable of sustaining alone the attacks of these dangerous enemies, would behold his race extinct if the Trochilos were to cease to give them his assistance.

It is proper to add, that the ties of good will which existed between the crocodile and the Trochilos were known to the remotest antiquity, and never during succeeding ages were they called in question. Herodotus, Aristotle, and in later times Pliny, Ælian, Philon, and many writers of the first ages of the Christain era have described them without reserve, and without trying to modify them. Of late it has been other-

* Aristotle's *Hist. Animal.* lib. 9, cap. 6.

† Pliny, lib. 8, cap. 25.

wise. Modern authors have shrunk from the marvellous character of the phenomena. They either denied the fact itself, or they disfigured it to render it explicable. They went so far as to make the Trochilos a bird of the size of the thrush, armed with scales and thorns upon its back, and upon the ends of its wings. Thus in wishing to limit the power and the resources of nature, they were led even to ridicule a truth to which the immediate observation of facts has in our own day conducted us.

ART. IX.—*On the Diurnal Variation of the Barometer at Paris.** By M. BOUVARD, Director of the Royal Observatory of Paris, &c.

HAVING been favoured by M. Bouvard with a copy of his Memoir, "*On the Meteorological Observations made at the Royal Observatory of Paris*," which was lately read before the Academy of Sciences, we are enabled to lay before our readers an account of some of the interesting results which he has deduced from these observations.

These observations were not made by M. Arago, as has been generally believed on the authority of Baron Humboldt (*Relation Historique*, 5^e Livraison, p. 305,) but by Joseph Marie Bouvard, the brother of our author, and agent to the Board of Longitude, who since 1808 has been specially charged with the meteorological observations at the Royal Observatory.

The length of M. Bouvard's memoir will not permit us to follow him very minutely in his inquiry; but we shall endeavour to extract the most valuable of his results.

"It has been long known," says M. Bouvard, "that the barometer experiences, in our climate as well as at the equator, a periodical daily variation, which becomes sensible when a sufficient number of observations are combined, in order to compensate the fortuitous effects of accidental causes. A single month is sufficient to exhibit it; and it may thus be found that it attains its greatest elevation at 9^h A. M., and then falls

* See this Journal, No. iv., p. 336; viii., p. 290; xv., p. 113; and xvi., p. 218.

till 3h P. M. From this epoch it rises again, reaches its second maximum at 9h P. M., and falls a second time, in order to exhibit on the following day the same fluctuations. The excess of the greatest height, which takes place at 9h A. M., above the smallest, which takes place at 3h P. M., indicates the extent of this atmospherical tide at the place where the observation is made. But in order to obtain that value, the observations of several years are necessary.

The general result of these observations, reduced to the zero of temperature, * are as follows—

Mean of eleven years, from 1816 to 1827.	9h A. M.	November.	3h P. M.	9h P. M.	First period.	Second period.
	mm.	mm.	mm.	mm.	mm.	mm.
January,	758,106	757,779	757,429	757,690	0,677	0,261
February,	758,165	757,868	757,236	757,557	0,929	0,321
March,	756,203	755,987	755,406	755,823	0,797	0,500
April,	755,253	754,881	754,243	754,780	1,010	0,537
May,	755,253	754,991	754,440	754,786	0,813	0,346
June,	757,307	757,084	756,600	756,875	0,707	0,275
July,	756,554	756,174	755,817	756,140	0,737	0,323
August,	756,807	756,492	755,953	756,271	0,854	0,318
September,	756,773	756,421	755,972	756,432	0,801	0,460
October,	754,772	754,547	754,021	754,522	0,751	0,501
November,	755,822	755,700	755,277	755,660	0,545	0,383
December,	755,152	755,009	754,703	754,950	0,449	0,247
Mean,	756,347	756,078	755,591	755,950	0,756	0,373

This table contains the mean heights of the barometer for the different months of the year for *eleven years*, from 1816—1826, at the epochs of the daily periods. This arrangement of the results shows not only the differences in the heights which exist at different hours of the day, but also those which take place every month at the same hours. Hence it appears, as M. Ramond long ago remarked, that the selection of the hours and the months of observation ought not to be a matter of indifference, when we wish to determine the mean pressure of the atmosphere at a given place.

* In making this reduction, M. Bouvard has followed M. Ramond in correcting the mean monthly heights of the barometer by the mean height of the thermometer for the same month. This method is much less laborious than that of correcting each observation.

According to this table the greatest heights of the barometer during the year take place in *January*, and the smallest in *April* and *October*. The excess of the maximum of the height above the minimum is 3.39 millimetres, a quantity which indicates that the uncertainty of the mean absolute height of the barometer at Paris ought to be about 0.15 of a millimetre more or less.

This table also shows that the extent of the barometric period is not the same for each month. Its variation does not appear to have any connection with that of the height of the barometer, for this period preserves the same value, whilst the mercury passes from its greatest to its smallest height. But in examining the results for the 132 separate months, we find, as M. Laplace had already recognized from calculations which I had communicated to him some years ago, that the mean result of the diurnal variations from 9^h A. M. to 3^h P. M. in November, December, and January, was in each year regularly less than in the three following months of February, March, and April. The mean variation indeed of eleven years was $0^m.557$ for the three first months, and $0^m.940$ for the three last. The mean of the first six months was $0^m.748$, nearly equal to the mean daily variation of eleven complete years. The other six months present nothing similar; but we find $0^m.752$ to be the mean daily variation of the months of May, June, and July, and $0^m.802$ for that of August, September, and October, the mean of these six last months being $0^m.777$. There is, therefore, some annual cause yet unknown which increases in February, March, and April, and diminishes in November, December, and January, while it preserves an intermediate value during the other six months of the year. This phenomenon is well established. It cannot be the effect of chance; and it will be interesting to discover the principle on which it depends.

It would be in vain to seek in the daily variations from 3^h P. M. to 9^h P. M., a phenomenon analogous to that which we have mentioned as existing in the period from 9^h A. M. to 3^h P. M. The last column of the table shows that the value of this period scarcely changes $0^m.3$ in the year, and that its oscillations follow a regular law.

It now remains for us to determine the value of the period from 9^h P. M. to 3^h A. M., and that of 3^h A. M. to 9^h P. M.; but the observations are not very numerous.

The observations fitted for this purpose are 495 in number, from 1815 to 1826 inclusive. The following are the results:—

	Period from 4^h A. M. to —— 9^h A. M.	Period from 9^h P. M. to —— 3^h A. M.
1816, ——	$0^m.475$	— $0^m.085$
1817, ——	0 .364	+ 0 .232
1818, ——	0 .522	— 0 .075
1819, ——	0 .287	+ 0 .129
1820,	0 .388	— 0 .383
1821,	0 .459	— 0 .195
1822,	0 .437	+ 0 .163
1823,	0 .388	+ 0 .005
1824, ——	0 .505	— 0 .023
1825, ——	0 .438	+ 0 .358
1826, ——	0 .507	— 0 .032
Mean,	0 .434	— 0 .008

The period from 4^h A. M. to 9^h A. M. is thus rendered evident; but that from 9^h P. M. to 4^h A. M. is not established by the observations. M. Bouvard considers it probable that this uncertainty may arise from the *maximum* in the *evening* and the *minimum* in the *morning* not taking place at 9^h, and from the hours at which the observations were made.

Of the *four* daily barometrical periods the best established is therefore that of from 9^h A. M to 3^h P. M. Its value, we know, is not the same for all climates, and it diminishes as the latitude increases.

M. Bouvard then gives the table of the daily variation for different latitudes from Humboldt, which we have already published in No. viii. p. 300. He substitutes in it his own result for Paris, viz. $0^m.76$, in place of 0.70, as given by Arago, and the result of M. Gambard for Marseilles.

In order to give our readers a complete view of the results, we have drawn up the following table, including the results obtained by our correspondent Δ for Rome, and the results given by Mr Daniel in his *Meteorological Essays*.

		Latitude.	Height in Toises.	Daily Period Obs.	Calc.
———	St Thomas's,	0°24′ N.	——	$1^{m}.85$	2.00
Humboldt & Bonpl.		23° N. to 12° S	1500	2 .55	2.00
La Condamine,	Quito,	0° Lat.	1492	2 .82	2.00
Duperry,	Payti,	5°	——	3. 40	2.00
Boussingault and Rivero,	Sto Fe de Bogota,	4° 35′ N.	1366	2. 39	2.00
Do. - -	La Guayra,	10° 36′ N.	——	2. 44	1.90
Given by Mr Daniel,	Sier. Leone,	8°29 N.	——	1. 82	1.94
	Trinidad,	10° 39 N.	——	1. 57	1.90
	Jamaica,	17° 56 N.	——	1. 45	1.72
Dorta, Freycinet, and Eschwege,	Brazil, Rio Janiero, & the Indian Missions,	22°54 S.	——	2. 34	1.56
Baron Von Buch,	Canaries,	28° 8 N.	——	1. 10	1.37
Coutelle,	Cairo,	30° 3 N.	——	1. 20	1.30
△ - -	Rome,	41° 54 N.	——	0. 70	0.82
Gambard,	Marseilles,	43° 18 N.	——	0. 72	0.77
Marqué-Victor,	Thoulouse,	43° 34 N.	——	1. 20	0.76
Billet, -	Chamberry,	45° 34 N.	137	I. 00	0.69
Ramond,	Clermont-Ferrand,	45° 46 N.	210	0. 94	0.68
Herrenschneider	Strasburg,	48° 34 N.	——	0. 80	0.58
M. A. Bouvard,	Paris,	48° 50 N.	——	0. 76	0.57
Nell de Breauté,	LaChapelle,	49° 55 N.	——	0. 36	0.53
Daniel, -	London,	51° 31 N.	——	0. 38	0.48
Bessel and Sommer,	Konigsberg,	54° 42 N.	——	0. 20	0.38
Captain Parry,		74° 00 N.	——	0. 00	0.04

In comparing these observations it is not easy to trace any other law than that the daily variation diminishes from the Equator to the poles. From the observations given by M. Bouvard the mean amount for the Equator may be taken at about 2.75 millimetres; whereas in the table given by Mr Daniel it is only 1.85 millimetre. Taking the mean at two millimetres or one-fiftieth of an English inch, the observations may be pretty nearly represented by the formula,

$$2^{m} \times \cos.^{3} \text{ Lat. for millimetres, and}$$

$$\overset{\text{Inch.}}{0.\ 04} \times \cos.^{3} \text{ Lat. for English inches.}$$

The results obtained by the first of these formulæ are given in the last column of the preceding table. The errors in excess and defect are tolerably well balanced over the quadrant of latitude. In 74°, where Captain Parry's observations were made, the formula makes the daily variation only about the 600th part of an English inch.

ART. X.—*On the Influence of Wind on the Height of the Barometer.** By M. A. BOUVARD, Director of the Royal Observatory of Paris, &c.

THE direction of the wind exercises a very great influence on the height of the mercury in the barometer. The winds from the *south* cause it to *fall*, while those from the *north* make it *rise*. This fact is well established by eleven years' observation at the Observatory. The following table contains the mean height of the barometer reduced to the zero of temperature for 9^h A. M. *Noon*, and 3^h P. M. The direction of the wind was determined either by the direction of the clouds or by that of the vanes placed on the Observatory.

Winds.	No. of Observ.	9^h A. M.	No. of Observ.	Noon.	No. of Observ.	3^h A. M.	Period.
		m					m
SOUTH	657	752,687	682	752,976	690	752.615	0.072
S. West	688	753,654	727	752,382	710	752.650	1.004
WEST	887	756,092	853	756,081	866	755.678	0.415
N. West	363	759,120	335	758,670	358	757.439	1.681
NORTH	528	760,143	483	759,761	459	759.368	0.775
N. East	390	759,890	378	759,891	374	759.232	0.658
EAST	302	757,960	324	757,045	332	756.717	1.243
S. East	203	754,358	231	754,599	224	753.949	0.409
	4018	756.738	4013	756.426	4007	755.956	0.782

From these results it appears that the mean heights of the barometer are lower during south winds, and that they increase as the wind goes by the west *from the south to the north*, where they reach their maximum. They afterwards diminish gradually in passing *from the north to the south by the east*. It is

* This article forms one of the sections of M. Bouvard's Memoir already referred to in p. 72. See this *Journal*, No. iv. p. 241.

evident also that the daily period is almost nothing from observations influenced by the south winds; that it is very great under the *north-west* and east winds; and that the mean is nearly equal to that which was deduced from the whole observations of eleven years, as given in a former paper, (p. 72.) In whatever way, therefore, we combine the observations, the daily period subsists, and always shows itself nearly with the same value.

If we unite the observations at different hours when under the influence of the same winds, we shall obtain the following results:—

Winds.	Number of Observations.	Height of the Barometer. m
South,	2029	752,757
South-West,	2125	753,227
West,	2606	755,950
North-West,	1056	758,412
North,	1470	759,776
North-East,	1142	759,672
East,	958	757,221
South-East,	658	754,300
	12044	756,414

This table shows in the clearest manner the influence of the wind on the heights of the mercury in the barometer. The smallest height corresponds to the *south* wind, and the greatest to the north wind. The difference is $7^{m}.019$. M. Burckhardt, by means of the observations of Messier, found the same difference to be $5^{m}.146$.—*Connoissance des Temps*, 1805, p. 345.

If we take a mean term between the heights which correspond to opposite winds we shall obtain results which are nearly equal.

		m
Mean of the heights which correspond to winds of	South and north,	756,267
	South-west and north-east,	756,450
	West and east,	756,585
	North-west and south-east,	756,356

Hence we may conclude, that, in order to determine exactly the mean height of the barometer, we should, in our climate, employ as much as possible an equal number of observations made during winds of opposite directions.

Art. XI.—*Report on Double Stars, from a Review of the Starry Heavens made with the Great Achromatic Telescope of Fraunhofer, addressed to* Prince Lieven, *Curator of the University of Dorpat.* By F. G. Struve, Director of the Observatory.

It was in the observatory of Dorpat that the observations of Herschel on double stars were first repeated. Since the year 1820, (as will be found in the second volume of the Observations of Dorpat) I have endeavoured to prove that the companions of the double stars ξ of the great Bear, and p of Serpentarius, in whose relative position Herschel had remarked the most considerable changes, had a circular motion round the principal star. The former had described 227° of its circle since 1781, and the latter 281° since 1779, from which it results that the duration of their revolution is sixty and fifty years, and consequently less than the revolution of the Georgium Sidus round the sun. This motion of the stars round one another is necessary, in order that two neighbouring stars which mutually attract each other may not meet; and it demonstrates without doubt that the fixed stars are subject to the laws of gravitation, which the clusters of stars made us only conjecture. It is very remarkable that the fixed stars whose revolutions are known to us are among those whose proper motions are the greatest.

These observations have been completely confirmed by the measurements on the same subject taken in England by Mr Herschel Jun. and Mr South, and which are published in the *Philosophical Transactions* for 1825 and 1826. These measurements include all the double stars already known (which I have collected in a catalogue for the year 1820, published at the Observatory of Dorpat) and several stars newly discovered; and they present a series of observations which may be ranked among the most remarkable of modern times.

The motion of one fixed star round another ought to occasion different phenomena. Herschel has lost sight of the companions of several stars which previously he had distinctly seen double. It is probable that the principal star covers the other, or at least that they are so close to each other that they cannot be separated by the best glasses. Two stars of the third magnitude are in this respect the most remarkable, namely, ζ Hercules and δ Cygni. All attempts which have been lately made to see these satellite stars have failed. *γ Virginis* is at present a double star of the first class, whilst Herschel had reckoned it one of the third. Other stars which were single have become double: Thus ζ Orionis is now a double star of the first class, which is easily recognized, while Herschel had decidedly seen it single. This phenomenon is explained by the slowness of the apparent revolution of the satellite star. Herschel has also directed the attention of astronomers to the difference of colour in the double stars; but many persons look upon this difference as depending upon the observer. The new observations made in England and at Dorpat have fully corroborated those of Herschel, in showing that the bright star is very often *yellow*, while its companion is *blue* or *violet.*

It was in the year 1824 that the great achromatic telescope of Fraunhofer arrived at the Observatory of Dorpat. It is a monument of the progress of astronomy in Russia. Four observatories completely furnished with instruments have been founded within the last twenty years in this empire; namely, at Dorpat, Abo, Warsaw, and Nicolajef; so that there are at present more establishments of this kind in Russia than in any other kingdom in Europe. To make use of the great telescope of Fraunhofer in prosecuting farther inquiries into the double stars was an employment not unworthy of this noble instrument. The new measurements made in England and at Dorpat already exceeded in exactness those of the great astronomer who discovered Uranus, owing to the improvement in micrometers; but the achromatic telescopes made use of were well known to be inferior in an optical point of view to the reflecting telescope of Herschel. A telescope, therefore, which could in this respect stand a comparison with these instruments, and which had a decided superiority in its micrometric apparatus, was well fitted to give a greater extension to preceding discoveries. What appeared to me most important was to attempt with Fraunhofer's telescope to make a survey of all the stars of a certain brightness in the part of the Heavens within reach of my telescope, in order to observe which among them were double. I was in hopes that by making this survey of the Heavens in a regular manner I should increase the number of double stars, gain perhaps more positive knowledge of the method of distinguishing those stars which are physically and optically double, and finally deduce some general views respecting the manner in which these stars are distributed throughout the celestial vault.

It is under the equator alone that the whole vault of the Heavens can be perceived, owing to the rotation of the earth, while at both the poles one-half only can be seen. In the latitude of Dorpat $121\frac{1}{2}°$ of the Heavens can be observed from the North Pole to about $31\frac{1}{2}°$ south of the celestial equator. But the south stars rise too little above the horizon to be examined with any success, even through a powerful telescope; for at this small height the lower strata of the atmosphere produces a tremulous motion in the image. I resolved in consequence that I would extend my survey only to 105° from the pole, or 15° south of the equator. In this space the lowest stars were still at a height of $16\frac{1}{2}°$ above the horizon in their meridian passage. I divided this space into 12 zones, according to their distance from the celestial pole, and I performed my reviews by zones. All the stars up to the eighth magnitude, and the most brilliant of the ninth which can be discovered with the finder of the instrument, were brought one after the other into the field of the telescope to discover which of them were double. As soon as a star was known to be double, its position was determined by the reading of the index of the two circles of the instrument, as well as by the clock regulated to sidereal time, and a short description of the star, according to its class and magnitude, was written in the register. When a magnifying power of 214, generally employed, made us only suspect that a star was double by showing itself under an elongated form, a stronger magnifying power of 600 times was employed to decide the point.

The number of stars thus passed in review were computed at 120,000. I have collected in a catalogue, which will be published, all the double stars thus found, including those which were already known. This catalogue includes 3063 double stars of the four first classes, of which 340 are found in Herschel's catalogues, and 440 in my catalogue of double stars, known before 1820.

The following table indicates the increase of our knowledge of the double stars of the four classes, and of each of them in particular.

Number of double Stars.	1st to 4th Class.	1st Class.	2d Class.	3d Class.	4th Class.
In the new catalogue,	3063	987	675	659	736
In the catalogue of Herschel,	340	76	76	82	106
In the catalogue of 1820,	441	96	112	111	122

For six stars of the new catalogue the class has not been indicated. The number of the double stars is thus *nine* times greater in this catalogue than in that of Herschel, and that of the stars of the first class *thirteen* times greater.

I have made a map of the double stars now known situated in the northern hemisphere, and as far as five degrees south of the equator, which will be published as an addition to the catalogue of stars, in order that we may be able to judge of the distribution of the double stars in the celestial vault. This map proves that we find double stars in all the regions of the heavens. But in general they are less numerous in those places where there are fewest stars; and hence it is that in the Great Bear, in one part of the Dragon, and in the *Canes Venaticæ*, which are the constellations farthest from the Milky Way, we find the least number of double stars.

From this region the number of double stars increases in general in proportion as we approach the Milky Way, that is to say, in proportion as the number of stars increase. There are, however, in the Milky Way itself, regions which are not richer in double stars than the Great Bear; such as that which crosses Cepheus; the honours of Frederick and Cassiopeia; those more to the south, and upon the borders of the Milky Way; the region situated upon the constellation Pegasus, and the anterior part of that of Andromeda. The regions where they are found in the greatest numbers are in Lyra, to the north of the Milky Way, in the Goose, the Fox, and the Arrow. We find also in Perseus, and to the north of the Milky Way, a great accumulation of double stars, while the Milky Way itself is not so well supplied as the constellations Aries, the Triangle, the Fly, and a part of that of Taurus, to the south. In short, the constellation of Orion, that region of the Heavens so astonishingly rich, to the south of the Milky Way, contains a surprising number of double stars, while the parts of the Milky Way itself which follow it, such as the Unicorn. &c. contain a very limited number. At a greater distance from the Milky Way to the north, in Gemini, and in the constellations of the Lynx and of the Telescope, in general deficient in bright stars, we find even more double stars than in the parts of the Milky Way situated to the south of these regions.

At the first glance of the above comparative table, we observe the superiority in the number of double stars of the first class, which may lead us to the following important conclusion. If these stars were only optically double, those in which the little star appears the most distant from the great one ought to be the most numerous, so that there ought to be more double stars of the fourth than of the first class. As the surface of circles whose radii are 4, 8, 16, 32 seconds, (which correspond, as we have seen, to the limits of distance of the four first classes of Herschel,) is proportional to the square of the numbers 1, 2, 4, 8, or in the ratio of the numbers 1, 4, 16, 64, it follows that the numbers of optical double stars of various classes is, according to the doctrine of probabilities, as the differences 1, 3, 12, 48, between these last numbers; whence it follows, that of 64 stars optically double there should be only one of the first class.

Let us suppose now that the 736 double stars of the first class observed were optically so, we ought to find from the preceding ratio

In the 1st	2d	3d class
16	47	184 stars optically double.

But our catalogue contains 987, 675, and 659 double stars of these three classes. We may then conclude with certainty that almost all the stars of the first class are physically double, likewise those of the second class, and a very great part of those of the third class. The ratio of the number of double stars found in the various classes thus supplies us with a criterion for knowing the stars which are physically double. It is evident from what we have said, that the determination of the parallax of the fixed stars, according to Herschel's method, could not, as was before supposed, be attempted with any hope of success; for this method being only possible for stars optically double, could never consequently be applied to double stars of the first or second class, but solely to those of the fourth, and beyond it. The bright double stars, that is to say, those where the two stars of the first to the seventh magnitude appear joined together, deserve particular consideration. The new catalogue contains 207, among which there are but 69 new ones, and this is not surprising, as preceding observers had principally turned their attention to these stars. Among the bright double stars, those of the first class are the most numerous, for there are 92 of that class, 33 of the second, 34 of the third, and 48 of the fourth. In the 69 new stars there are 49 of the first class, which shows the extraordinary power of our telescope; for Herschel examined a great many without finding out that they were double stars of that class. We easily perceive that all the double bright stars, even those of the fourth class, ought to be considered as physically double. I have obtained a confirmation of this fact in the following manner.

In the celestial maps of Harding, which may be considered as perfect, as far as regards stars of the seventh magnitude, we reckon 10229 stars of the first to the seventh magnitude, even to the distance of fifteen degrees south of the equator. If we apply to this number the calculation of probabilities, we shall obtain the following very remarkable result. It is, that we ought to find in this space but one pair of stars, thirty-two seconds distant from one another. If then it is possible that some one of the double bright stars of the third and fourth classes are in a manner optically double, all the double stars of the first class, and a great part of those of the last, ought to be considered physically double, or as forming a particular system of two stars joined together.

Since among 200,000 observed stars more than 3000 double ones have been found, we may say that there are nearly one in 40 double; but this ratio changes with the brightness of the stars. Flamsteed determined more than 100 years ago, in that part of the heavens where we made our survey, the position of 2374 stars, which, for the most part, were from the first to the sixth magnitude. Among these stars of Flamsteed, which have all been examined by Herschel, 169 of the four first classes have been found double, and *more recently* 63 others have been added. Thus among 2374 stars, from the first to the sixth magnitude, there are 230 stars double, that is to say, out of every *eleven* stars there is *one* double. The great catalogue of Piazzi contains in the part of the Heavens under our consideration 5762 stars. In subtracting those of Flamsteed there remain 3388 fainter in a great measure, among which 134 are double, which is at the rate of one in 25. As to the stars which are much fainter, and whose position has been lately determined, the proportion is nearly one double star in 42. We cannot account for such a variety of ratios on the hypothesis of stars optically double. This diversity gives us a new proof of our former assertions; and we can explain why the small stars appear so seldom double, from the difficulty of seeing at an immense distance the satellite star, which is often much more faint than the principal one.

It is remarkable that among the double stars newly discovered there are several whose proper motion is already known. I shall mention here only the bright star γ Ceti, composed of a star of the third magnitude, and one of the seventh; No 42 in Berenice's hair, composed of two stars of the sixth magnitude singularly close, and γ Coronæ, which, on account of the great proximity between the principal star of the fourth magnitude, and its companion of the seventh, is one of the most difficult to be seen. Our catalogue affords a great number of double stars of this kind, many of which had probably escaped preceding observers by the difficulty of distinguishing them. η Herculis, and γ Coronæ, may be considered in this respect as the best tests of the perfection of telescopes; and they may help us to compare the power of these instruments with that of the great telescope of Fraunhofer. I have examined with this telescope the double stars of Herschel, of which some, such as ζ Herculis and δ Cygni, had become single, according to his own observations, and of which others had no longer been found double by subsequent observers, because their instruments had not sufficient power. I have recognized that they were double, and I even saw the circular motion of the companions of the two stars mentioned above, which disproves what has been conjectured, that the companion of one of these stars had disappeared. The star τ Serpentarii is the only one seen double by Sir W. Herschel, which the great telescope of Fraunhofer has shown single. The small altitude of the star might have weakened the power of our telescope. I intend, however, to observe it often : for the time will certainly come when the companion will separate itself from the star, whose brightness hinders us from seeing it. It is owing also to the extraordinary power of our telescope that we are able to see many triple stars, which were before only known as double ones. Thus Sir W. Herschel has seen the star No 7, Tauri, as a double star of the fourth class, and all subsequent observers have also seen it thus, the principal star being of the sixth magnitude, and its companion of about the tenth. But our telescope has shown that the principal star is itself a double star of the first class, composed of two similar stars of the seventh magnitude. According to the observation of Sir William Herschel, also those made at Dorpat, and those of Mr Herschel Junior and Mr South, the star ψ Cassiopeiæ was considered as double. But our telescope has shown that the companion itself is composed of two stars nearly united of the ninth magnitude. All astronomers provided with good instruments have observed a trapezium of four stars of various brightness, which are found in the middle of the nebulæ of Orion. The two Herschels, and Schroeter in particular, have examined this curious object. However, our telescope has enabled us to see a fifth star, which has not been remarked by any of the preceding observers, although, since I have communicated this discovery to Mr Herschel Junior, he has also distinguished it with a reflecting telescope of 20 feet. Is this little star of the number of the changeable stars, or does it still exist ? These conjectures appear to me to be entitled to more consideration, as I had never seen this star in my first observations of the nebula of Orion. It was only on the 11th November 1826 that I discovered it, although I had examined this nebula several times during two years with Fraunhofer's telescope. Besides, this star appears now to be too brilliant to have escaped the penetration of the great Herschel and Schroeter, as well as the researches of Mr Herschel Junior, who is specially occupied with the nebula of Orion.

Our telescope has made us only suspect the doubleness of some stars, unfavourable states of the atmosphere frequently not allowing us to make use of the highest magnifying powers. Thus in the new catalogue the bright star Atlas in the Pleiades is indicated as wedge-shaped. A later observation made during the most favourable weather, and with the highest magnifying powers, has enabled us to discover clearly at the side of this star a companion of the eighth magnitude, which is at the distance of three quarters of a second. But it is very certain that an instrument still more perfect would show many more double stars than the great telescope of Fraunhofer itself can distinguish to be such.

Our catalogue contains fifty-two triple stars, in each of which the stars are less than thirty-two seconds from one another. Among these stars there are several, such as No. 11. of the Unicorn, ζ Cancri, and ξ Libræ (triple stars already recognized by Herschel,) where the three stars belong to the bright stars, which proves that they are physically triple stars of ternary systems. These systems, as well as those of quadruple and quintuple stars, which are not uncommon in the Heavens, while they give a little more extension to the scale of the mutual distances of the stars which compose them, serve as a gradual transition between these double stars and clusters of stars. In the case of the triple star ζ Cancri, the rotatory motion of the two little stars relative to the principal one is already proved by observation. The star ψ Cassiopeiæ furnishes us with the example of two little stars very near each other, situated near to a third of greater brightness. If there is here a real connection, so that the star be physically triple, the two little stars ought to turn first round their centre of gravity, and this centre round the bright star. I have already seen this phenomenon three times. The case where two double stars of the first class are so near one another that it is impossible to avoid thinking they are united is still more remarkable, and I have also seen this three times. A fourth case is where a double star of the first class is found at a distance of one minute of a degree from a third, and where the four stars are of equal brightness, and of the eighth magnitude. The pair No. 4 and 5 of Lyra supplies an example of a fifth case; it is that of two double stars of the first class, each of the fifth magnitude, situated at the distance of three minutes and a half. Who can doubt that we behold here a system where each pair circulate round their centre of gravity, and where the two pairs move round their own common centre of gravity. Our sun is decidedly a single fixed star. If it formed a double star with another star, this would, on account of its great proximity to the sun, be distinguished by its brightness from other fixed stars, even more so than Sirius itself, and its change of position in the heavens would characterize it still more surely. Let us suppose, for instance, that the time of its revolution was equal to that of the companion of the star *p* Serpentarii, we ought to observe in the star joined with our sun a proper motion of more than 7° in a year; and even if the times of its revolution were a hundred times longer, its proper motion ought to be fifty times greater than that of sixty-one Cygni, which is the most considerable that has been observed. Another question which may be started is, whether there exists between two stars of the first magnitude some mutual relation similar to that of double stars, and which we cannot discern on account of their great proximity to us. If we should find some surprising approximation between the stars of the first magnitude, such a relation would acquire some probability. But there is in the northern hemisphere 306 stars from the first to the fourth magnitude, and 317 in the southern hemisphere, viz.

	1st Mag.	2d,	3d,	4th,
In the northern hemisphere,	9 stars,	26	76	195
——southern ———	9 ——	26	101	181

The small number of stars of the third magnitude in the northern hemisphere is compensated by the greater number of stars of the fourth magnitude. A calculation founded upon these numbers, and compared with that which really exists, shows that there are not in the heavens two stars of the first magnitude so near one another that their nearness may not probably be considered as accidental. On the other hand, the magnitudes which follow the first present examples of the most remarkable proximities. Who does not know the three bright stars of the second magnitude in the belt of Orion, of which the two external ones are distant from the middle star, one by a degree and twenty-six minutes, and the other a degree and eighteen minutes? The calculations show that there are 1400 chances to one that their nearness is not accidental. The constellation of the southern cross is still more remarkable. We find there in a space of fifteen degrees square (which does not include the 2700th part of the celestial vault) one star of the first magnitude, two of the second, one of the third, and one of the fourth; and the probability that such a distribution is accidental is only that of 1 in 20,000. We have thus the best reasons for thinking that these stars depend upon one another.

These conjectures are confirmed when we consider the stars from the sixth to the seventh magnitude, relative to their distribution throughout the celestial vault.

From a calculation of probabilities, founded upon the number of the stars which are in the celestial Atlas of Harding, the case where two of them should be distant from one another from thirty-two seconds to one minute, ought to occur only one-and-a-half time, while fifteen instances of it are known. There ought to be but six or seven pairs of stars from the first to the seventh magnitude, where the two stars forming the pair are distant from one to two minutes; and there are already fifteen cases known. If we consider it for greater distances for stars of the sixth magnitude, we shall find that there ought to be but seven or eight pairs where the stars are distant from one another from two to five minutes; while there are eighteen cases known. Between five and ten minutes of distance, the calculation of probabilities gives twenty-seven to twenty-eight pairs; and we know thirty-six cases. We can find in the heavens still more pairs of stars, distant from each other ten and fifteen minutes, than the calculation gives, viz.

twenty-five instead of twenty-two. We may then, with much probability, consider a great number of pairs of stars, from the first to the sixth magnitude, where the two stars are distant from each other from one to fifteen minutes, as being systems of stars, of stars really double, visible to the naked eye, and which are consequently the most brilliant and the nearest to us. Such are, for example, the Nos. 16 and 17, and 1 ν and 2 ν Draconis, Dragon, Nos. 4 and 5 of Lyra, the two 1 α and 2 α Libræ, ζ Ursæ Majoris, and the well known star *Alcor*, &c. &c. A remarkable confirmation of this opinion may be drawn from the circumstance already observed by Bessel, that some of these pairs have a common proper motion, such as, for example, No. 36 Serpentarii and 30 Scorpii, and the two stars above-mentioned in the last of the Great Bear. But what is well worthy of remark, it frequently happens that sometimes one of the stars of these pairs, and sometimes both, are themselves double in the strictest meaning of the word.

We find also very frequently three stars near each other, which would not probably happen if they were distributed by chance. Among the 1386 stars between the first and fifth magnitude which are in the maps of Harding, the case that there are three in one circle of one degree diameter, ought not to take place more than a quarter of a time; that is, it ought not to occur at all. But it actually presents itself seven times, or twenty-five times oftener than would be probable if it were accidental. From what has now been said, therefore, we may hazard the conjecture that the stars, such as the three of δ Tauri, and the three of ψ Aquarii, which we can recognize with the naked eye, are stars physically, and not optically triple.

Art. XII.—*Notice of "The Third Series of Observations with a twenty-feet Reflecting Telescope, containing a Catalogue of 384 new Double and Multiple Stars, completing a first thousand of those Objects detected in sweeps with that Instrument.* By J. F. W. Herschel, Esq. F.R.S. and President of the Astronomical Society.

The valuable paper, the title of which is given above, was read before the Astronomical Society of London on the 11th January 1828. As it is so intimately connected with the preceding paper by Professor Struve, we have thought it right to place beside it the following abstract from the *Annals of Philosophy*, till we shall be enabled to publish a more copious analysis of it.

" This paper, as its title imports, is a continuation of the two papers previously communicated by the author on the same subject. The field of discovery in this department of astronomy, though narrowed by the great work recently published by Professor Struve, the author considers as not yet exhausted; since, on an average of the part of the heavens swept by him not above one in four of double stars, sufficiently remarkable to attract attention in sweeping, have been catalogued by the eminent astronomer last named; not to mention the vast number of interesting close double stars, below the ninth magnitude, which a minuter examination than the nature of his sweeps permits would no doubt produce. The double stars of this catalogue, he observes, are considerably more *select* than those of his two former ones; those whose distance exceeds 32″ being (except in particular cases) excluded, and the limit of distance being narrowed according to the faintness of the component stars.

" The author prefaces his catalogue with a comparison of the magnitudes habitually assigned to the stars by himself and Professor Struve; from which it appears that on the average his magnitudes have a denomination about one unit lower than those of that astronomer;—a star (for example) which M. Struve would call of the ninth magnitude, being, in Mr Herschel's nomenclature, of the tenth. The limit of vision in the Dorpat telescope, he presumes to lie about his average fourteenth magnitude, though such a determination must necessarily be liable to some latitude. This conclusion he deduces from a series of instances, in which small companions have been seen by him attached to large stars, within the limits of Professor Struve's fourth class, which have escaped the notice of the latter.

" The author then states the principle on which he estimates magnitudes below the sixth, which is that of continual bisection of the light; and he cites some experiments, by which it appears that the light of an average star of the first magnitude is at least 150 times that of the sixth. He then adduces a series of observations of a considerable number of the closer stars of M. Struve's catalogue, by which it appears that the Slough telescope easily defines with its ordinary sweeping power the generality of M. Struve's stars of the first class, and many of those marked by him as *vicinæ*, and even *pervicinæ*; but those which have the epithet *vicinissimæ*, he has not yet succeeded in separating with the highest power (240) usually applied,—which indeed was to be expected. In lieu of M. Struve's classification of double stars, which he considers as enlarging beyond due limits the number of those of the first class, he proposes the following system, which in fact very nearly approximates to that originally followed by Sir William Herschel.

Class I.	close - - - - -	0″ and below	1″
	not close - - -	1 and below	2
Class II.	- - - - - - -	2 and below	4
Class III.	- - - - - - -	4 and below	8
Class IV.	- - - - - - -	8 and below	16
Class V.	- - - - - - -	16 and below	32
Class VI.	- - - - - - -	32 and below	64

So that the limit of distance of stars of the *n*th class shall be $2^n \times 1''$.

"The author then subjoins a list of stars common to his two former catalogues, and to that of Professor Struve, 86 in number; after which he proceeds to describe some singular phenomena observed in the course of his examination of these objects, which explain certain discrepancies between the results of observations of their angles of position on different nights, and which tend to throw light on some obscure points in the theory of vision. He considers it as rendered very probable by some of the facts adduced, that time is required for light to make an impression on the retina, as well as for the impression made to wear off; and that this time is the less, the brighter the object; and explains by this principle a remarkable degree of unsteadiness and fluctuation observed in the limb of the planet Mars, while small stars in the field remained perfectly tranquil, as well as certain other curious phenomena.

"He then adds some observations on the contrasted colours so frequently observed in double stars, and regards them as (at least) in many cases referable to the laws of vision; in virtue of which, a strong light having an excess of the less refrangible rays, will cause a feebler one, in which no such excess exists, to appear of the complementary hue; instances of which, in artificial lights, are adduced. He notices especially the extremely intense red colour of a star of the eighth magnitude, R. A. $4^h\ 41^m$. N.P.D. 61° 47′ (1828.)

"These prefatory remarks are terminated by some observations of the fifth star in *trapezio nebulæ Orionis*, pointed out by M. Struve. The author adduces evidence, which he considers as satisfactory, that no such star existed in that situation on the 13th March 1826. It was observed, however, by M. Struve to be conspicuous on the 11th November of that year. It is now readily seen in the Slough telescope; and at the time of drawing up the present paper, it was so bright as not to be overlooked with the most ordinary degree of attention. He considers it, therefore, if not as a NEW STAR, at least as a variable one of very singular character.

"The catalogue which follows is arranged in all respects like the preceding ones published in the Memoirs of this Society, and is followed by a list of about 200 double stars, for the most part found in the same sweeps with the others; but which, occurring in M. Struve's catalogue, cannot now be regarded as new double stars. Their observed places, and estimated angles of position, distances, and magnitudes, are, however given, in order to afford ground of comparison between the two catalogues, of which comparison the results are stated."

ART. XIII.—*Description of Erinite, a New Mineral Species.* By WILLIAM HAIDINGER, Esq. F. R. S. E., &c. Communicated by the Author.

MINERALOGY is indebted to Count Bournon for the establishment as distinct species, of several of those minerals which contain arsenic acid and copper, some of which are found ex-

* Read at the Royal Society of Edinburgh, April 21, 1828.

clusively, others in more beautiful varieties than in any other country, in the rich mining districts of Cornwall.

Though not at first recognized as distinct species by Haüy, who endeavoured to refer all their different forms to the same type, four of them have been proved to be actually independent species, not only by the characters given by Count Bournon himself, but also by the subsequent labours of later mineralogists.

They all belong to the natural order of the malachites in the system of Professor Mohs, in which they are comprised in several genera, with the exception of one species classed in the order mica.

The new species, which it is the object of the present paper to describe, contains arsenic acid, and copper, and undoubtedly likewise belongs to the order Malachite, and is in particular remarkable for its resemblance to the common green carbonate of copper, or the hemiprismatic habroneme-malachite of Mohs.

Though not presenting determinable crystals, the appearance of the specimens in Mr Allan's cabinet, the only ones which I remember to have ever met with, are highly crystalline. The individuals are arranged in concentric coats with rough surfaces, produced by the termination of exceedingly small crystals, the layers often not firmly cohering, so that they may be easily separated from each other. These layers themselves are very compact; they show an uneven, or sometimes imperfect conchoidal fracture, and traces of cleavage. The cleavage probably takes place parallel to the broad faces of rectangular four-sided plates, into which the individual terminates. I have in several instances observed something like them by means of a compound microscope, but always very indistinctly. These plates form crest-like aggregations, similar to those of mesole. A circumstance which greatly increases the difficulty of observing the regular forms, is the complete absence of lustre, the surface of the concentric layers being quite dull, while there is only a slight degree of resinous lustre in the fracture.

The colour of erinite is a beautiful emerald green, slightly inclining to grass green. The streak, likewise green, is a little paler, and approaches to apple green. It is slightly translucent on the edges.

The substance of erinite is brittle; its hardness I found = 4.5...5.0 of the scale of Mohs; its specific gravity = 4.043.

According to the locality attached to the specimens in Mr Allan's cabinet, they are natives of the county of Limerick in Ireland. For the name of Erinite, which is here proposed for this mineral, the mineralogical public is indebted to Mr Allan. It unites, what is rarely the case with mineralogical names, the comparatively trite and prosaical allusion to the native country, with the poetical recollection of the characteristic verdure of the "*Emerald Isle.*"

Erinite is associated with two of the species containing arsenic acid, and copper, described by Count Bournon, the common arseniate of copper, (prismatic olive-malachite of Mohs,) and the dark-blue arseniate, both of them crystallized and disposed between the concentric layers of erinite.

Notice on the Composition of Erinite. By Dr Turner.

I had intended to add an analysis of erinite to the preceding account of its mineralogical characters; but being desirous to repeat one part of it before publication, I subjoin the following as an approximation.

Oxide of copper, -	59.44
Alumina, - -	1.77
Arsenic acid, - -	33.78
Water, - -	5.01
	100.00

Art. XIV.—*Analysis of the solid contents of two hot mineral Springs in India.* By Edward Turner, M.D. F.R.S.E. and Professor of Chemistry in the University of London.* Communicated by the Author.

The saline matter submitted to examination was presented to me for that purpose by Dr Brewster, (who received it from

* Read at the Royal Society of Edinburgh, March 17.

Mr Swinton,) and was sent in glass phials from India to this country by Mr P. Breton, who procured it by evaporating the water to dryness. The springs from which it was obtained are situated near Pinnarkoon and Loorgootha. The mineral water of Pinnarkoon, as it issues from the spring, has a temperature of 116° F., and one gallon of it contains twenty-two grains of solid matter; while that of Loorgootha raises the thermometer to 160°, and sometimes to 186°, F. and the saline contents of one gallon amount to twenty-five grains. Both springs are colourless and transparent, and their odour and taste slightly sulphurous. Their density varies little from that of common spring water, as may be expected from the small quantity of solid matter which they contain. Mr Breton, who noticed these characters, has also described the effects produced by chemical tests; but as his observations are not very conclusive as to the nature of the springs, it will be unnecessary to occupy the time of the Society by detailing them.

The solid contents of the spring near Pinnarkoon has a yellowish colour, an alkaline odour, taste, and reaction, and effervesces with acids. The gas which escapes during effervescence is carbonic acid, without any admixture of sulphuretted hydrogen; for the colour of white paper moistened with a solution of acetate of lead was not affected by it. On neutralizing the alkali with sulphuric acid, and allowing the hot concentrated solution to cool, prismatic crystals possessed of all the properties of sulphate of soda were procured, and among which muriate of platinum did not detect the presence of potash.

The solid matter when heated gives out a considerable quantity of water. It also becomes black, and emits an odour like that arising from the igneous decomposition of mixed animal and vegetable substances, the presence of ammonia being made obvious by turmeric paper. Carbonic acid is expelled at the same time; since after exposure to heat very slight effervescence was occasioned by the addition of an acid. The mass is fusible at a red heat, and when held in the flame of the blowpipe, communicates to it the rich yellow tint characteristic of soda.

The saline matter is in part soluble in water. The aqueous solution was highly alkaline from the presence of carbonate of soda, and had a pale yellow colour derived from the organic matter. On digesting the solution for a few minutes with carbonate of ammonia, so as to saturate the soda with carbonic acid, a gelatinous precipitate subsided, which had all the characters of pure silica. The alkaline solution, after being acidulated with nitric acid, yielded white precipitates with the nitrates of silver and baryta, and hence must have contained muriatic and sulphuric acid. I could not detect any nitric or hydriodic acid. The portion which was insoluble in water, equally resisted the action of muriatic acid, and proved on examination to be siliceous earth. Traces of iron and lime were separated from it by the acid.

The properties just enumerated demonstrate, that the solid contents of the hot spring of Pinnarkoon consist of silica, soda, chloride of sodium, sulphuric and carbonic acids, a small quantity of animal and vegetable matter, water, and traces of lime and iron. The relative proportion of these ingredients was ascertained in the following manner.

10.172 grains of the solid matter heated to redness, lost 2.112 grains or 20.76 per cent. The residue effervesced slightly with dilute sulphuric acid, and the loss in carbonic acid amounted to 2.57 per cent. Before exposure to heat 22.09 grains, when treated by dilute sulphuric acid, lost 1.72 grains, or 7.786 per cent. of carbonic acid. Consequently it follows, that the total loss in water, and a little organic matter, occasioned by heat, amounts to 15.544 per cent. The quantity of carbonic acid was ascertained by the method described to the society on a former occasion, and which admits of minute accuracy.

To discover the proportion of soda, 8.525 grains of the solid contents of the spring were dissolved in dilute sulphuric acid, the solution evaporated to dryness, and the residue exposed to a red heat. The sulphate of soda, separated from a trace of iron and siliceous matter, amounted to 6.72 grains; equivalent to 2.987 grains, or 35.05 per cent. of pure soda.

The quantity of silica was ascertained by acting upon the saline mass with muriatic acid, evaporating to dryness, and after digesting the silica in acidulated water, collecting it on a filter, and exposing it to a red heat. The pure siliceous earth amounted to 21.5 per cent. From the filtered solution a trace of iron was detected by ammonia, and a trace of lime by the oxalate of ammonia.

The muriatic and sulphuric acids were precipitated in the usual manner from a solution in acetic acid. The quantity of fused chloride of silver, procured from 8.775 grains of the saline mass, amounted to 4.082 grains, equivalent to 1.000 grain, or 11.47 per cent. of chlorine. This quantity of chlorine was united in the solid contents of the spring with 7.648 parts of sodium. The sulphate of baryta, after being heated to redness, weighed 2.783 grains, equivalent to 0.94 grains, or 10.74 per cent. of sulphuric acid. This quantity of acid must have been united with 8.593 parts of soda.

According to this analysis, 100 parts of the solid contents of the mineral spring at Pinnarkoon, contain,

Silica, - - -	21.50
Soda, - - -	24.84
Sodium, (united with chlorine,) -	7.648
Chlorine, (united with sodium,) -	11.470
Sulphuric acid, - - -	10.74
Carbonic acid, - - -	7.786
Water, with a little organic matter, -	15.544
Oxide of iron and lime, - -	Traces.
	99.528

Or, by adding the chlorine and the carbonic and sulphuric acids to their equivalent quantities of sodium and soda, the constituents are as follows:

Silica, - - -	21.50
Chloride of sodium, - -	19.118
Sulphate of soda, - - -	19.333
Carbonate of soda, - -	19.109
Pure soda, - - -	4.924
Water, with a little organic matter, -	15.544
Oxide of iron and lime, - -	Traces.
	99.528

The analysis does not account for the sulphurous smell and taste reported by Mr Breton. Perhaps the sulphuretted hydrogen, which, from the presence of pure soda, could not escape as gas, may have acted on the iron, and have subsided as sulphuret of iron prior to the water being evaporated. It is possible also that Mr Breton may have been deceived, especially as he is disposed to attribute the high temperature of the spring to the oxidation of metallic sulphurets. This is the more probable, as he states that the water did not yield a precipitate, or undergo any change with the nitrates of silver and bismuth.

The analysis of the solid contents of the hot spring near Loorgootha, agrees so closely with that just described, that it is unnecessary to state it. The distance of Pinnarkoon from Loorgootha is not mentioned by Mr Breton; but as the hot springs which flow there are so analogous, even in the proportion of their ingredients, their origin must doubtless be similar, if not identical.

The society will perceive from the preceding analysis, that the hot springs of Pinnarkoon and Loorgootha belong to that kind of mineral waters which contain siliceous earth, and of which the boiling springs of the Geyser and Rykum in Iceland have I believe hitherto afforded the only examples. According to the analysis of Dr Black, * one gallon of the Geyser water contains 62.85 grains, and an equal quantity of the Rykum water 49.61 grains of solid matter. The residue is thus composed.

	Geyser.	Rykum.
Soda, - -	5.56	3.0
Alumina, - -	2.80	0.29
Silica, - -	31.50	21.83
Muriate of soda, -	14.42	16.96
Sulphate of soda, -	8.57	7.53
	62.85	49.63

The siliceous springs of Iceland are hotter, richer in solid matter, and abound more in siliceous earth, and proportionally less in pure soda, than the hot springs of Pinnarkoon and Loorgootha. In all of them the silica doubtless owes its presence to the solvent powers of the soda. The carbonic acid reported in my analysis, in all probability did not exist in the original spring, but was absorbed from the atmosphere during the evaporation.

* *Philosophical Transactions of Edinburgh,* iii. 95.

ART. XV.—*Account of the Lizard of Siam, with Observations.* By Captain BURNEY, Envoy to Siam in 1826. Communicated by GEORGE SWINTON, Esq. F.R.S. and F.A.S. Edinburgh.

As two specimens of this remarkable animal has been recently sent to the Museum of the Royal Society of Edinburgh by George Swinton, Esq. and are now in that collection, it will be interesting to the naturalist to be put in possession even of the little information which has been obtained respecting it.

When Captain Burney was at the Court of Siam in 1826, he collected the information which could be procured relative to this lizard; and as Mr Finlayson, who acted as naturalist to the still more recent mission of Mr Crawford, neither seems to have seen nor heard of the animal, the observations of Captain Burney become of still more value.

M. La Loubere, in his *Historical Relation of Siam*, (p. 16, Lond. 1693,) gives the following account of the lizard :—

" But their history of animals must not easily be credited. They understand not bodies better than souls; and in all matters their inclination is to imagine wonders, and persuade themselves so much the more easily to believe them as they are incredible. What they report of a sort of lizard named *Toe-quay* proceeds from an ignorance and credulity very singular. They imagine that this animal, feeling his liver grow too big, makes the cry which has imposed on him the name of Toe-quay, to call another insect to its succour, and that this other insect, entering into his body at his mouth, eats the overplus of the liver, and after this repast retires out of the *Toe-quay's* body by the same way that he entered therein."

Remark by Captain Burney.—The name *Tut-ke* is *said* at Bangkok to be taken from *tap-ke*, " liver old," with which cry the animal gives notice to a description of snake, on the approach of which the animal vomits its liver, and the snake bites off a bit and relieves the *Tut-ke.*

The following account of the Toque is given by Turpin in his *History of Siam.*—" The toquè is also a large lizard, six or eight inches in length, and one and a half in breadth; its back is in square compartments, each of a different colour, as red, green, yellow, violet; its head is large, and enamelled with white and a dark brown. This animal, so beautiful to the eye, is very dangerous to touch; they kill it wherever they find it. Its claws are so piercing that it sticks them into glass. It walks along boards with its back downwards, to which it even fastens its eggs, which are flat on one side, and as large as the end of the thumb. Its ordure has this singular quality, that if any of it gets into one's food, it entirely takes away the voice, which lasts near a month. If any of its urine falls on the hand or skin of any person, it causes black spots, which can never be got out. When it bites it never lets go its hold, and its claws never come away without taking out the piece. It begins its cry by chirping, which continues increasing, and afterwards diminishes in the same proportion."

Remark by Captain Burney.—The Tuk-ke is certainly not beautiful to the eye, and the Siamese children kill it more for its loathsome appearance. We did not observe its claws stick into glass. This evil quality of its ordure or urine was not confirmed at Bangkok. The commencement of its cry much resembles the cackle of a hen, and it is followed by a clear and distinct sound of *tuk-ke*, heard at a distance of several hundred yards at night. The animal is considered very harmless, unless it fall on the hair, from which it cannot be extracted without difficulty. Almost every house at Bangkok is full of these animals, whose presence is rather encouraged, as they destroy rats. Mr Hunter at Bangkok heard a great noise at night in his bed-room, and discovered it to proceed from a *tuk-ke* having a rat as large as itself in its mouth, which animal it was gradually swallowing.

The *tuk-ke* is common at Rangoon, Taury, and Mergin, and I believe in Java. Whenever a Siamese hears the *tuk-ke's* cry, he strikes the floor, or wherever he is sitting, three times with his middle finger.

Tachard, in his *Seconde Voyage au Royaume de Siam*, Ed. Paris, 1689, p. 276, &c. gives an anatomical description of a tuk-ke, with two plates.

ART. XVI.—*Remarks on a Luminous Arch seen at Kendal, 27th December* 1827. By Mr SAMUEL MARSHALL. Communicated by the Author.

AT ten minutes past six in the evening, a luminous arch appeared across the heavens, stretching directly from the magnetic east and west, through the zenith, the eastern extremity being by far the most intense in light, and narrower than the western one. The eastern end appeared much more compact than the western, the latter having the appearance of streaks of light. The centre, which passed directly through Cassiopeia, had the appearance of flocci, and at least three times the breadth of the western end, and four times that of the eastern. About 20° degrees further north another arch of light appeared, quite distinct from the former, but much thinner. Its ends terminated in the extremities of the larger bow. The northern horizon exhibited the aurora by appearing like the sky when illuminated by the rising sun. Round the moon was a very distinct halo, and she had attained the altitude of about 50°. In the south were thick white clouds which concealed the southern horizon. After the appearance had continued about ten minutes, the larger bow began to move at the centre towards the south, and to increase in breadth, the extremities remaining stationary; and this continued till the part of the bow which had been in the zenith united with the clouds, the smaller bow advancing in the same degree. When the centre of the bow had moved about 20° towards the south, the halo entirely disappeared. The bow during the whole time seemed to have a motion from one extremity to the other, as though impelled by wind, from the west to the east. The wind at the surface of the earth was at the same time N.W. by N., the thermometer was 40°, the barometer 30.30, and had risen during the day from 30.07. The appearance lasted about half an hour, after which the sky was clear, except in the south. No streamers were visible, except from the eastern end, whence a few large ones moved towards the magnetic north, but rather sluggishly.

Art. XVII.—*Account of the Discoveries in Vegetable Physiology, particularly those respecting the motion of the Sap,* made by M. Dutrochet, Corresponding Member of the Academy of Sciences.

The important discoveries of M. Dutrochet may be justly considered as forming an era in the history of vegetable physiology. They have been published in two different works, one of which appeared at Paris in 1826, under the title of *L'Agent immediat du Mouvement vital devoilé dans sa Nature et dans son Mode d'Action chez les Vegetaux et chez les Animaux,* while the other appeared in the *Annales de Chimie, &c.* for August 1827, entitled *Nouvelles Observations sur l'Endosmose et l'Exosmose, et sur le Cause de ce double Phenomene.*

Of the discoveries contained in the first of these works we shall lay before our readers only a general account, particularly as an able review of it has already appeared in an English work; but of the second we shall give an entire translation.

M. Dutrochet has demonstrated that the sap of plants is transmitted through what he calls *tubes corpusculiferes,* the *lymphatic vessels* of De Candolle, and the *fausses tracheæ* of Mirbel. These vessels are situated in the wood, whether it is in the condition of alburnum or of old or hard wood (the *duramen* of our author.) These tubes do not exist in the bark, nor in the pith or medulla. They possess no valves, and have no lateral communication with each other.

That the cause of the motion of the sap resides in the roots, may be proved by making successive sections of the stem of a vine in spring. When it is cut near the earth, the part cut off ceases to bleed when the section is made, while the surface attached to the root bleeds freely; and this continues to be the case till we come to the radicles, at the extremities of which are the *spongioles* and *fibrils,* small conical bodies, in which the power which impels the sap resides. These spongioles communicate directly with the lymphatic tubes which pass up the stem. They consist of cellular tissue, the central parts of which are oblong cells, the elements of the lymphatic tubes through which the sap ascends. The cellular cortical part of the spongioles is transparent, and covered with minute corpuscles.

These organs possess the faculty of introducing forcibly into their cavity, and through their sides, the water which is in contact with their exterior surface; and they do this in such a manner as to expel from their cavity substances which it formerly contained. To this peculiar action, which will probably be found to be an electrical one, M. Dutrochet gives the name of *Endosmose*, or *impulse inward*, from the Greek words ἐνδον, *inward*, and ὠσμος, an *impulse*. This action, however, does not take place unless the fluid within the spongioles is specifically heavier than the water or fluid without. When the fluid within the cavity is specifically lighter than the fluid without, the inner fluid passes out with the same rapidity with which it would have entered in the other case. This action M. Dutrochet calls *Exosmose*, or *impulse outwards*, from the Greek words εξ, *out*, and ὠσμος, an *impulse*.

The following experiment is illustrative of these two actions: M. Dutrochet took the cœcum or blind gut of a young chicken, into which, when well cleaned, he put 196 grains of milk, which occupied one half of its cavity. Its mouth being firmly tied, it was placed in water. After 24 hours the cœcum had imbibed 73 grains of water; and at the end of 36 hours, 117 grains, which rendered it very turgid. The weight of the cœcum *now diminished;* and after 36 hours it had lost 54 grains of the imbibed water. The milky fluid had become putrid, and had become specifically lighter than the water without.

The turgidity which is the necessary consequence of *endosmose* causes the ascent of the sap. The cavity of the spongioles being extended by the imbibed water, the sides of the cavity react on the contained fluid, and force it upwards. This M. Dutrochet proved in the following manner:—

He took a glass tube 24 inches long, and about one-fifth of an English inch in diameter, and he fixed the open end in the cœcum of a chicken, filled with a solution of gum arabic. The cœcum being placed in rain water, and the glass tube held vertically, the fluid during 24 hours rose in the tube and reached the top, over which it flowed, which it continued to do till the third day, when it began to sink. On the fourth day the fluid in the cœcum was found to be putrid. The same results were obtained with the inflated bladder of the *Colutea arborescens*, or bladder senna, and also with the swimming-bladder of the carp.

M. Dutrochet likewise found, that when an alkaline solution was placed in the cœcum, *endosmose* took place, and *exosmose* when the fluid contents were acid. He now placed the negative wire of a galvanic battery in the cœcum containing water, and the positive wire in the water in which the cœcum was immersed. *Endosmose* took place, and the fluid rose in the tube and flowed over as before when fluids of different densities were employed. But when the wires were reversed, and the cœcum filled with water, *exosmose* took place, and the cœcum was emptied. Hence our author regards such membranes as minute Leyden phials, negatively electrified within, and positively without. This conclusion was countenanced by the following experiment. A cœcum, nearly filled with the white of an egg, was closed and plunged in water. Turgidity ensued, and in a few hours its inner surface was lined with coagulated albumen, which is one of the effects of galvanic action.

The upward flow of the sap, produced by the elasticity of the sides of the lymphatic vessels called into action by the turgidity of *endosmose*, is greatly aided by another operation which M. Dutrochet calls *adfluxion*.

The loss occasioned by the copious transpiration of water from the leaves of plants, is supplied by *endosmose* in the leaves, in virtue of which there is an adfluxion or motion of the sap from the lymphatic vessels to the leaves. A plant of Dogs' Mercury, for example, with four leaves only, continued fresh four days when placed in a vessel filled with quicksilver. In this experiment, "the plant," says M. Dutrochet, "lived at the expence of the liquids which the roots contained, and which were drawn up into the leaves by adfluxion only, for there could be no impulse communicated in the roots, as nothing entered into them from without."

When the sap is thus drawn to the leaves, it is changed by the action of light into a nutritious fluid, which is the proper juice of the plant, and which descends by the alburnum and liber until these parts are changed into hard wood and old bark.

This descent of the sap M. Dutrochet ascribes to a mutual interchange (through the operation of *endosmose*) of the fluid contents of the oblong cells, which give out through their sides the nutritive matter contained in them. This is dissolved by the first ascending sap in spring, and is carried up for the developement and formation of the fruit, and for the growth of the stem.

The sap of plants is likewise diffused laterally for the purpose of nutrition and developement. This is effected by *endosmose*, which produces the interchange in the fluids of the cells already mentioned.

From the facts now mentioned, and many others which we cannot even notice, M. Dutrochet draws the following conclusions.

1. That in vegetables there is no circulation of sap, but merely an ascending and a descending current, and a lateral diffusion of the sap.

2. That the sap ascends through cylindrical tubes passing through both the alburnum and the old wood.

3. That the juice elaborated in the leaves is conducted through a set of oblong closed cells existing chiefly in the bark.

4. That the lateral diffusion of the sap and the elaborated juice is effected through the organic membrane which forms the cellular tissue.

5. That these motions are the effects of distinct electrical currents, one, viz. *endosmose*, operating so as to introduce fluids into the cells and capillary organs of the plant, and the other, viz. *exosmose*, operating so as to abstract it from them.

6. By *endosmose* the sap rises to the tops of trees contrary to its natural gravity, and independent of any contractile power in the vessels which contain it; and,

7. That secretion in plants, and consequently nutrition, depend wholly on electrical agency.

We shall now proceed to the later memoir of M. Dutrochet, in which the preceding views are considerably extended, and more firmly established.

" When two fluids, says he, differing in density and in chemical properties are separated by a thin and permeable membrane, there are formed across this membrane two currents of opposite directions and of unequal force. It follows that the fluid accumulates in greater quantity at the side towards which the strongest current is directed. These two currents exist in the hollow organs which form organic textures, and it is there that I have described them under the names of *endosmose* and *exosmose*. My experiments have shown me that this phenomenon is not exclusively produced by organic membranes. Porous inorganic plates very thin produce them also. The extreme thinness of the permeable membrane is a necessary condition for producing the phenomenon, which does not show itself for example when the permeable membrane is four millimetres in thickness, but which takes place when the membrane is only one millimetre in thickness. In these two cases, however, the porous plates will have an equal capillary action, that is to say, they will be susceptible of transmitting by filtration an equal quantity of water in a given time. The proximity of the two heterogeneous fluids appears thus to be a necessary condition for producing the phenomenon, which does not depend upon capillarity alone, as a celebrated mathematician has maintained, and of whose theory I shall now give a summary account. * When two fluids of different densities, and whose heights are in the inverse ratio of their densities, are separated by a membrane whose capillary pores are permeable to these fluids, the pressures exerted upon the orifices of these pores are equal on every side; but the capillary force being unequal at the two ends of the pore, it follows that the fluid exposed to the strongest capillary action fills the whole pore. This filament of fluid is therefore acted upon by two opposing forces; 1st, the attractions of the fluid to which it belongs; 2d, the attraction of the other fluid situated at the opposite side. But this last attraction being greater than the first, it follows that the filament of fluid contained in the capillary pore will flow without stopping in the direction in which it is acted upon by the stronger attraction, and will increase also continually the fluid mass towards which it is drawn.

* On the effects which may be produced by the capillarity and affinity of heterogeneous substances, by M. Poisson, in the *Annales de Chimie, &c.* tom. xxxv. p. 98.

This effect continues to take place until the difference of pressures which the two fluids exert in the ratio of their height is equal to that of the attractions exerted by the two fluids upon the filament of the fluid contained in the capillary pore.

It follows from this mathematical theory, that there should exist but one single current across the membrane which separates the two heterogeneous fluids, and that this single current ought to be directed towards that of the two fluids which has the greatest force of attraction. But observation has shown that there exist across the separating membrane two currents, opposite and unequal in force. This fact alone is sufficient to weaken the theory of M. Poisson, and to show that it is to a different cause from that which he supposes, that we must attribute the phenomenon in question.

New proofs of this fact are furnished by the following observations.

If *Endosmose* and *Exosmose* are phenomena belonging to capillarity, there ought to exist a constant relation between the height to which different fluids will rise in the capillary tube, and the manner in which they comport themselves in relation to the endosmose and exosmose.

To make these views more intelligible, let us consider only the phenomenon of the accumulation of fluids which takes place on one of the sides of the separating membrane, and see if this accumulation always takes place on the side where the fluid is, whose ascending power in the capillary tubes is the least considerable, as the theory of M. Poisson supposes, and like that which actually takes place in many circumstances.

In general the more density a fluid has, the less does it rise in a capillary tube; but it is not the density here which causes the fluid to ascend less; we know that certain fluids of very small density ascend nevertheless very little in capillary tubes. It is thus that alcohol and ammonia, although less dense than water, ascend much less in capillary tubes than the last fluid. Thus the chemical properties of the fluid produce the same effect as excess of density. But I have remarked, that when pure water is placed in connection, by means of a separating organized membrane, with a fluid whose ascent in capillary tubes is less than that of the same pure water, we see the accumulation of fluid take place on the side where the fluid *ascends the least* in the capillary tubes. Thus we find here a constant relation between the phenomenon of the accumulation of fluids and the phenomenon of capillary attractions. Let us proceed to examine other fluids.

The height of the ascent of distilled water in a capillary tube being represented by - - 100

Olive oil rises in the same tube to -	67
Essential oil of lavender rises to -	58
Alcohol at 36° rises to - -	47

Olive oil being placed in connection by means of a separating organic membrane, with essential *oil of lavender*, we see the accumulation of fluid effected on the side where the olive oil is, that is to say on the side where we find the fluid which *ascends the most* in the capillary tubes. This action, which is very weak, requires, in order to become appreciable, a temperature not less than 59° Fahr.

If by the same means we place in connexion the essential *oil of lavender* with *alcohol*, we shall see the accumulation of fluid take place on the side of the essential oil, that is to say, on the side where the fluid *rises highest* in the capillary tube. This action is stronger than the preceding one. The essential *oil of turpentine* comports itself in these experiments like the essential *oil of lavender*, and I think it ought to be the same with other essential oils.

In these last experiments, we observe between the accumulation of fluid and the capillary action a new relation, and the inverse of that which has been noticed above. In the first experiments, indeed, the accumulation of fluid took place on the side where the *fluid ascended the least* in capillary tubes; while in the second experiments, the same accumulation of fluid took place, on the contrary, on the side where the fluid *ascended the most* in capillary tubes. Thus it is demonstrated, that the accumulation of fluids in these experiments is not in constant relation with the manner in which these same fluids comport themselves in reference to capillary attraction, and it follows that capillary action is not the cause of the phenomenon of accumulation. This fact, and that of the simultaneous existence of two inequal currents flowing in an inverse direction across the separating membrane, completely prove the impotence of the mathematical theory, by means of which M. Poisson believes that he has explained the phenomenon in question. It remains to be determined if the affinity which may exist between heterogeneous fluids is the cause of the phenomenon. This question is resolved by an experiment which I have mentioned in my work, and which I shall briefly relate here. If the albumen of an egg is put into a large tube of glass, and if pure water is cautiously poured from above, the two liquids will not mix together; we see distinctly the line of demarcation which separates them. But this line of demarcation never varies; there is no increase in the bulk of the albumen, whatever length of time the experiment lasts. This proves beyond contradiction that the albumen has no affinity to the water which covers it. But when these two substances are separated by a membrane, the water crosses it, to accumulate on the side of the albumen, with which it then mixes. It is, therefore, to some other cause than the reciprocal affinity of fluids to which we must attribute this phenomenon. My opinion is that it is caused by electricity, allowing, however, that this electricity does not manifest itself in the galvanometer, of which I have convinced myself by many trials. There are several ways to conceive the formation of this electricity. I have been induced to think that it may be caused by the approximation of the two heterogeneous fluids, which are but imperfectly separated by the permeable membrane which is interposed; but then it appears to me that the two fluids ought to have a different electricity, which the galvanometer does not show. It appears to me probable that this electricity is caused by the contact of the fluids with the separating membrane. We know from the experiments of M. Becquerel, that electricity is produced by the contact of fluids with solid bodies. Thus, in the present circumstances, the contact of the two different liquids with the two opposite sides of the separating membrane, produces two different degrees of electricity, which are consequently stronger on one side than on the other; it is most likely this double electrical action, which produces the two opposite and unequal currents in intensity which cross the separating membrane. It is certain that this phenomenon ceases to take place when the two opposite sides of the separating membrane are in immediate contact only with but one of the two different fluids, which is shown in the following experiment. A tube of glass furnished with a wide mouth, which was closed with a plate of baked pipe clay, about the twenty-fifth of an inch in thickness, was filled with a solution of gum arabic, and then plunged in water, above which the empty part of the tube rose vertically. The endosmose took place, and the gummy fluid rose gradually in the tube. Some hours afterwards the ascent of the fluid stopped and it soon began to descend. Having taken the apparatus out of the water, I perceived that the plate of pipe clay was coated on the outside with the gummy fluid driven from within outwards by the exosmose. I wiped the outer surface of this plate, and I replaced the apparatus in the water; immediately the endosmose showed itself by the rise of the fluid in the tube. Here the two opposite sides of the separating membrane having ceased to be in immediate contact with the different fluids, the phenomenon of endosmose ceased to take place. It appears, then, that it is in this double contact that the cause of the phenomenon is to be found.

The double phenomenon of endosmose and exosmose being produced by thin plates of inorganic bodies permeable to fluids, as it is with the organic membranes, it follows that this phenomenon is not exclusively an organic one, but that it is generally a phenomenon of general physics. This phenomenon, however, is found to belong exclusively to organized bodies, because it is only among them that we find different fluids separated by thin and permeable membranes. This disposition is never found in inorganic nature. Thus the double phenomenon of endosmose and exosmose is *by the fact* and not *by its nature* a phenomenon entirely physical. It is the point at which the physiology of living bodies is confounded with the physiology of inorganic bodies. The more we advance in the knowledge of physiology, the more reason we have for ceasing to believe that the phenomena of life are essentially different from physical phenomena; this opinion, which the authority of Bichat has above all others contributed to establish, is indubitably erroneous."

ART. XVIII.—*Account of the Earthquakes in the Antilles during the last six months of* 1827. * By M. MOREAU DE JONNES.

DURING the last six months of the year which has just expired, there was an extraordinary increase in the number of earthquakes in the Antilles. Besides that on the 3d of June, of which an account has been read to the academy, there has been nine from the end of July to the middle of last December.

As the precise date of these phenomena may help to throw some light upon the direction of the subterraneous commotions, and upon the rapidity of their propagation, it is necessary to indicate the exact epochs.

The first earthquake happened at Martinique in 1827, and took place on the 3d June, at two o'clock in the morning; the second on the 24th of July at forty-five minutes past five o'clock P. M. These two shocks were very violent. The third took place on Sunday the 5th of August, at thirty minutes past ten in the morning, when the greater part of the population were assembled in the churches, which increased the terror and the confusion. The disaster at the Caracas had happened in a similar manner, and the recollection of it contributed to augment their terror.

The fourth shock was felt on the 25th September, at thirty minutes past five in the morning; the sixth on the 2d of October, at four in the afternoon; the seventh on the 30th November, at forty-five minutes past two in the morning; the eighth on the 1st of December, at ten in the morning; the ninth on the same day, at fifteen minutes past five in the afternoon; and finally, the tenth on the 8th December, at twenty minutes past five in the morning.

The three last were formed of an undulatory motion from the earth, very weak and slow; but the earthquake on the 30th of November, before day break, was remarkably violent and prolonged. The lowest calculation of its duration was fifty

* This notice was read to the Academy of Sciences on the 4th February 1828.

seconds. It is said there have been no shocks of equal violence, and so much prolonged, for seventy years. No other accidents took place from its immediate effects, except overturning and rending several edifices; but the fright which it occasioned made people leave their houses with such a degree of precipitancy as to produce many misfortunes.

By a letter from Guadaloupe, we learn that this earthquake was felt in that island, a distance of thirty-five leagues to the N. W. of Martinique, with a violence not less great, but a quarter of an hour later, if it is possible to credit the rigorous exactness of the hours indicated by the correspondence of Fort Royal and that of Pointe à Pitre.

The prevailing opinion in the Antilles, that these phenomena are not unconnected with the state of the atmosphere, is supported by new proofs. It was remarked that the rain began to fall immediately after the earth had shaken; and this singular coincidence has been so often observed, that many people incline to think it is not to be attributed to chance.—*Revue Encyclopedique*, Fev. 1828.

Art. XIX.—*Account of a New Self-registering Thermometer.* By James King, Esq. Communicated by the Author.

I find the common maximum registering thermometer is particularly liable to be deranged, by the little moveable metallic register getting entangled among the mercury with very slight agitation, which renders it almost impossible to be transported a short distance safely, even with the utmost care. Its indications cannot be relied on at sea, as the motion of the ship is liable to move the index, and besides, a powerful magnet is requisite to arrange the instrument every time it is used. These remarks apply equally to Sykes's day and night register thermometer. The plan of a new register thermometer has consequently occurred to me, which I think sufficient to remedy these inconveniences. It may also have defects, which can only be discovered on trial; but it is out of my power to get one made in the colony. If the following description and accompanying drawing of it deserve a place in your valuable Journal, they are at your service.

Without noticing the utility of these instruments in facilitating various investigations of the natural philosopher, and in regulating numerous processes in the arts and manufactures, suffice it to remark their use and importance in the practice of the art of cultivation alone, as a recommendation to their more general use. In every civilized community where that art is encouraged, vegetables from distant parts are there transplanted, and intended to grow and flourish within a few yards of each other, which are not indigenous on account of the climate. Artificial arrangements must therefore be had recourse to, and as the inequality of temperature alone forms in a great measure the diversity of climate which is so manifest on the earth's surface, these arrangements in Britain, in the same and similar latitudes, consist in compensating for the deficiency and fluctuations of the natural temperature of the atmosphere. In the cultivation of those vegetables that are exposed to these fluctuations, a correct daily register of the changes of temperature must be of vast practical utility to the cultivator. As they point out the necessity, they may also suggest the means of counteracting their effects. For those plants, again, which are too delicate to reach maturity in the open air of a climate liable to great and sudden meteorological vicissitudes, recourse must be had to a covering of glass, and heat from fuel to produce an artificial climate, of a more elevated and uniform temperature, and more congenial to their nature and habits; hence the construction of hot-houses, green-houses, and the like. Register thermometers, under such circumstances, are also particularly useful, for they not only point out slight changes in the heat of the forcing-house to the person who may have the charge, which guide him to regulate it accordingly, but they also exhibit afterwards to the proprietor or overseer the extent of those changes, thus forming a most correct and strict check on the carelessness and inattention of his servants.

The following description of one I beg to propose, I hope will be understood. Of this thermometer the leg A, (Plate II. Fig. 6,) is the same as a common mercurial thermometer, with a scale graduated to any convenient range. The tube is turned at top, and continued downwards, to form the leg B, parallel to A, terminating in a point at C. Fig. 7, which is a section of part of the tube B, and the bulb H, on a larger scale, over which point C is joined a bulb H, for the sake of uniformity, equal as near as possible in form and capacity to the other bulb of the instrument. The point C is immersed among a little mercury contained by the bulb H, which it occupies up to the line D. The other leg and bulb A and G, as already mentioned, are supposed to be a properly adjusted thermometer filled with mercury. All the other space of the tube, which forms the legs A and B, is filled with very pure and colourless alcohol; and part of the remaining space in the bulb H is also filled with alcohol up to the dotted line E. The still remaining space in the bulb H is allowed to be filled with atmospheric air. The tube must be of as equal calibre as possible. A scale divided into parts equal to the degrees of the thermometer or leg A, is attached to the leg B, reckoning from the point C upwards, allowing the first division or two to be a little larger, in proportion as the tube is contracted in its dimensions at the extremity. If this instrument is hung up, and so arranged that the leg B is filled only with alcohol, by an increase of temperature, the mercury in the leg A will rise accordingly, and a proportional quantity of the alcohol in the tube will be pressed out of it at the point C; and on account of the superior specific gravity of the little mercury among which it is immersed, that part of the alcohol which may thus be pressed out of the tube at C will rise through and rest on the upper surface of the mercury in the bulb H. Should the temperature again be reduced, the mercury in the leg A will of course suffer a corresponding depression in the tube, and a quantity of mercury which is contained in the bulb H will consequently be pressed by the elastic force of the contained air, up to the leg B; and in proportion as the leg B is filled with mercury, say up ten divisions of the annexed scale, an equal number of degrees are to be added to the degrees of temperature at the time of observation, which will give the maximum temperature since the last observation or adjustment of the instrument.

To again adjust the thermometer, apply the warm hand to the bulb G, to cause the mercury in the leg A to rise, till the whole of the mercury be again expelled out of the leg B; then place the instrument in such an inclined position that the point C will cease to be immersed among the mercury; remove the hand, and allow the thermometer to remain in that position for a few minutes, till the mercury in A has descended as low as the temperature of the air at the time; hang it up, and it is again arranged for another observation. This thermometer may be made without the alcohol, and the space in the tube which it occupies may be entirely filled with atmospheric air; but the indications would not then be so correct, on account of the extreme elasticity of the inclosed air. A horizoutal position may, however, correct that objection. At first sight the fabrication of this instrument may appear difficult; but if the two legs are made and filled separately, then joined at F, its construction and adjustment will, I conceive, be sufficiently simple.

Another plan has also suggested itself to me, which I think more simple, and may answer the purpose equally well, which I will explain in a few words. The tube and bulb A, (Fig. 8,) is a common thermometer, with a scale graduated in the usual manner, and the top formed into a ball F, for the sake of uniformity. (Fig. 9) is the bulb D, and part of the tube B on a larger scale. The tube B and under ball are completely filled up to the point C, which is open; over which point is fixed the bulb D, which is partially filled with fluid, say up to the dotted line. For the scale of the tube B, number the degrees downwards from the point C, making it the zero of the scale; ascertain the space between each degree, in the same manner as is done in the case of a common thermometer; hang up this thermometer, and, should the temperature rise, a quantity of the fluid will be pressed out of the tube at the point C, and fall among the fluid in the bulb D. When the temperature again falls, the number of degrees which the fluid is deficient in the tube B, being added to the degrees of temperature indicated by the attached thermometer A, will give the extreme height of temperature the surrounding medium has been at since the last arrangement of the instrument. The manner of adjusting it is obvious, and its construction is so exceedingly simple, that it must suggest itself to the glass-blower, on the plan being distinctly explained to him.

New South Wales, Sydney, *August* 1, 1827.

ART. XX.—*Observations on the Climate and Geology of New South Wales.* By JAMES KING, Esq. In a Letter to the EDITOR.

SIR,

I ONLY arrived in this flourishing British colony a few months ago. The voyage thither was a truly disagreeable one, from the foolish, and I may say despotic, conduct of the skipper, and from the length of time we were tumbled and tossed on the restless bosom of the ocean, being not less than from the 25th September 1826, when we sailed from Leith Roads, to the 23d March 1827, which brought us to anchor in Port Jackson. During the voyage I wrote you from St Jago, one of the Cape De Verd Islands, (where we stopped a few days to water,) 15th November 1826, respecting the air thermometer which I sent to the Royal Society; and at the same time inclosed the description of an improved safety valve for Woolf's apparatus, which you have no doubt received some time ago, as Mr Clark, British Consul there, kindly undertook to forward my letter to London.

Nothing occurred during the tedious voyage worthy of remark, except the very temperate atmosphere we had on the equator, and while under the sun's vertical rays. Between the 18th degree of north latitude, and the 22d of south latitude, the thermometer ranged generally between 75° and 82°; but while we lay at anchor in the bay off the town of Portapraya in St Jago, it stood about 84°; and one day the thermometer was at 86°, which was the highest indication during the voyage; and what made it the more remarkable, the sun was within a few degrees of its most southern declination, and its meridian altitude at the time was consequently only 57°, St Jago being about 14° north of the equator. We had an agreeable south east trade wind, which wafted us over the tropics, the southern boundary of Capricorn. We crossed only a few degrees distant from the coast of Brazil. Although it was then midsummer there, the heat on board the ship was not above 82°. During the summer of 1826, at Warsaw it was 95°, and at St Petersburgh 96°.

Sea-sickness, and the unaccommodating temper of the skipper, prevented me from keeping a regular meteorological journal by way of amusement, having instruments with me for the purpose. In fact, these ignorant and intolerant shipmasters are always displeased at any person, except themselves, making observations at sea; yet although it be the veriest drudgery in science the keeping of such journals, I was nevertheless disappointed by not being able to do so.

I have had yet no opportunity of knowing from my own observation any thing of the geological structure of any part of New South Wales. Around Sydney, however, and for sixty miles at least on each side of it along the sea coast, appears to be of the coal formation. The rocks, which rise in many places to lofty precipices, are stratified saccharoidal sandstone, * and some other of the accompanying minerals peculiar to that formation. Mr Fraser, our indefatigable colonial botanist, has just returned from a voyage of observation on the west coast of New Holland, and he has brought here geological specimens from about Swan River, sufficient to exhibit the structure of that part of the country. They consist principally of granite, felspar, quartz, hornblende rock, primitive limestone, &c., with some stalactites and stalagmite, also a specimen of light spongy sandstone, apparently of very recent formation, resulting no doubt from water holding carbonate of lime in solution, having filtered through the loose siliceous bed on the sea-shore. Mr Fraser says, that most of the specimens were taken from rocks almost as low as the level of the sea, none of which contain any metallic ore so far as I can judge. Generally speaking, the mineralogy of this interesting portion of the earth's surface is utterly unknown. The temper of a mineralogist's hammer has ne-

* Within a mile of Sydney, and round Botany Bay, there are immense alluvial accumulations of this mineral in the disintegrated state of sand, eminently calculated to enter into the composition of the finest flint and plate glass, being pure silica, and superior to that procured at Lynn, which is commonly used by the best manufacturers in Britain. It may be valuable in course of years;—I will, therefore, send you a specimen of it, also a quantity to my friends Messrs Bailey and Company, who will give it a fair trial. The result they will communicate to you, which may be implicitly relied on, from their respectability and experience in making the best flint glass, at their works in the Canongate, Edinburgh.

ver been tried here, nor does the government seem to appreciate the value of such information. Some years ago, and during the administration of Sir Thomas Brisbane, specimens of muriate of soda were picked up in the country. Nothing has since been done to follow up the discovery, though nothing could be more obvious than its importance; and we continue to depend on irregular supplies of that useful mineral from England. I am informed that the present government has been too much employed making arrangements to pay attention to these subjects. In short, with the exception of Mr Busby, civil engineer, and Mr Berry of Shoalhaven, I have seen or heard of no one in the colony who would know greenstone from wacke, or basalt from bloodstone. Botany, though of very remote advantage to the country, appears to be particularly encouraged, and every facility is liberally afforded to its professors in extending their researches, which at most can only increase slowly the catalogue of plants, and exhibit the endless diversity of the vegetable creation, thereby gratifying the laudable curiosity of only a few individuals in Europe, but can never realize the practical utility and solid advantages to the colony or the mother country, which would probably result from a knowledge of its minerals.

This is a very fine agreeable climate, and, with the exception of catarrh, there are no epidemic diseases known; and those complaints which are common to children in Britain, such as measles, hooping-cough, small-pox, &c. have no existence in this climate. In summer the heat is very oppressive in the sun, particularly during the hot winds from the N. W., which do not occur above a few days in a season. They induce a sort of nervous or feverish excitement during the day, and a chilly feeling in the evening from the sea-breeze, which then always sets in. Nothing more disagreeable is the consequence. The native blacks are a wretched race of human beings, harmless and undesigning; have little or no ingenuity, much less than many of the lower animals. They lie and live among the bushes like the beasts of the field, and seldom inhabit the same spot above once. They erect no hut to repose in during the night; only collect a few branches of trees, which they fix in the ground, to shelter them on one side from the influence of the wind; on the other they kindle a fire. Mimosa gum, fern-roots, fish, snakes, opossums, bandecoots, and kangaroos, some of which they spear only with difficulty, form their common food. The very limited means of subsistence which the country naturally affords, necessitates them to travel over a great extent of surface in quest of food, which almost precludes the possibility of a permanent abode. There are, I believe, few countries in the world where there is such luxuriant vegetation, and so little and so few of its products suited for the food of animals, than in this; although with culture and the importation of useful plants, no part will excel it in the course of years in the fertility of the soil and the variety and usefulness of its productions. Insects are numerous, various, and troublesome, as is the case in all warm climates. Domestic dogs are a great pest in the town. Every house keeps from two to six, which bask in the hot sun during the day, and prowl and yell about the streets at night. I mention this only to remark, that I have never heard of a case of hydrophobia. Snakes, I am informed, are all poisonous, of which there are a variety of kinds, varying also in the intensity of their venom; the largest being not above fourteen feet long. Some of the smaller kinds are the most deadly. Quadrupeds are not numerous. The kangaroo (of which there are two or three kinds,) opossums, and bandecoots, are the most remarkable. There are native dogs, but few in number. They often destroy sheep, and resemble, in appearance and disposition, something between a fox and wolf. Birds are much more abundant, and vary in size from the emu (an animal about six feet high, being a sort of ostrich) to small chirping creatures little larger than the humming-birds in the West Indies,—black swans, cranes of various colours, white hawks, black and white cockatoos, and thousands of parrots of the most splendid plumage which fancy could suggest. Ducks and quails are also very common. Besides, birds that resemble our pigeon, pheasant, and turkey, are also got in numbers. There are also a number of birds peculiar to the country—one called laughing bird; another the coachman, from its whistle ending in a smack like a whip; another the bell-bird, from its voice being like the sound of a bell, and so on. Most of the small birds appear to me to live on insects. We have swallows all the season; they resemble exactly those in England; and bats too, measuring between the extremities of their outstretched wings from three to four feet. They are called here flying foxes. Fishes are all different from those in England. Between them notwithstanding the people here trace resemblances, and give many of them very improperly the same names. There are almost no shell-fish on the coast, with the exception of oysters, which grow and adhere to the rocks, and on such rocks only as are left uncovered by the water at low tide. Mussels also adhere to the stones that are always under water. Cockles are also plentiful in some places. Shells are so numerous that all the houses are built with the lime they produce. These shells are not just on the sea-beach, but lying in heaps and ridges ten and twenty feet above high water-mark; and even at these places the sandy beach is without a shell. They appear to be the shells of oysters and cockles. The town of Sydney covers about two square miles; but in many places the houses are not crowded. They are mostly in the form of cottages, with flower-plots in front, and garden ground behind. The freestone of which many of the houses are built is as beautiful as that from Craigleith, near Edinburgh, but softer. Brick is also in common use for building. The houses are covered with beefwood, split into oblong boards about the same dimensions as a slate. They are light, look well, and last about fifteen years. There is a great want of architectural skill and taste in almost the whole of the buildings; and many of them are barbarously ill planned with respect to conveniency. Labour is no doubt high, but it is just as ill directed. The numerous shrubs, and flowers, and fruits that grow before and round the houses, particularly the peaches, and lemon and orange trees, which nod their red and yellow fruit over the cottage tops, and twine about the verandas which keep off the heat of the sun, give the town in many places a particularly agreeable appearance. All the fruits and vegetables which are raised in the gardens and *under glass* at home grow and bear here in the open air, with the exception of *pine-apples*. Melons, peaches, grapes, &c. are in great abundance, but almost all of bad sorts. The harbour is the finest and safest in the world. A ship which only ten minutes before was tossing on the swelling and roaring ocean, is now in water as smooth as a mill-pond. This is the case on entering Port Jackson. After a few windings and turnings the ship in half an hour is at safe anchor in Sydney Cove, within ten or twenty yards of the houses on the rocky beach. Ships of 500 tons come and discharge alongside the pier, which is only about fifty feet long. Port Jackson is more an arm or inlet of the sea than a river, and is composed of a number of projecting points or heads between each. The most commodious and safe harbours are formed by nature. Botany Bay was too shallow water ever to be of importance for shipping; and the soil around it is very barren. There is scarcely as much grass as would feed a cow in a square mile; and such is the state of it for miles round. The soil is sand, covered with stunted shrubs. It was consequently abandoned, and the settlement formed on Port Jackson. The soil here is very little better; but the harbour was the inducement. At present there are three papers published here, one three times a-week, the other two twice a-week. A quarterly journal is just commenced. I fear it won't do for want of original matter. Two others are advertised, but the people who have taken them up are unfit for the task. We have trade with China here on paying ten per cent. duty. The cheapness of their manufactures is surprising. Tea is 1s., what sells at home for 6s. There is considerable trade with New Zealand for flax, &c. and with many other islands in the eastern seas.

A great many New Zealanders come over here. They are a stout race of men. The natives here are nearly all as different as any two individuals at home—some of them tatooed all over the face and body in the most minute and fanciful manner. They are formidable fellows as a body in their own country. They have some thousand stands of fire-arms among them of English manufacture. They exchange pork and potatoes for these articles. These are the potatoes and hogs Captain Cook left with them. Some of them recollect him. I am, &c.

James King.

New South Wales, Sydney,
August 1, 1827.

Art. XXI.—*Notice of the Diamond and Gold Mines of the Residency of the North-West Coast of Borneo.* *

The mines in the Residency of the north-west coast of Borneo are worked by the Daya, Malayu, and Chinese. The former proceed in the following manner: A shaft barely sufficient to permit the miner to turn round in, or at the utmost two feet in diameter, is sunk to the Arèng. This is from one to three feet in thickness, and is dug out to the extent of seven or eight feet from the sides of the shaft, under the upper strata, which sometimes is propped up; but the laziness or improvidence of the Daya is such, that this precaution is often forgotten, the upper strata fall in, and the miners miserably perish. These accidents most frequently occur when an adjacent shaft is sunk, which is thus done:—The Arèng in the first mine being expended, and the course of the vein ascertained, a new shaft is sunk in that direction at the distance of fifteen or sixteen feet from the preceding, to enable the miners when arrived at the Arèng to work back to their former mine, and the same process is repeated till the vein be exhausted. The Arèng is hoisted up in small baskets by bambus, on the ends of which part of a branch being left forms a small hook.

The search for the diamonds is conducted in an equally simple manner. Small dulans, circular trays slightly converging towards the centre, are nearly filled with Arèng, and the Daya, seating himself in the nearest stream, immerses the dulan, and works the Arèng by hand until the earthy particles begin to separate; the dulan is then brought to the surface, and a rotatory motion is given to it, until the water it contains, being saturated with earthy matter, is poured off, and this is continued till such time as the water comes away clean. The pebbles, &c. which remain in the centre then undergo a strict examination.

The Malayu proceed in nearly a similar manner; but the superior intelligence of the Chinese teaches them to use a more efficient process. The Chinese seldom sink a shaft, but avail

* From the Singapore Chronicle, Oct. 11th, 1827. Communicated by George Swinton, Esq.

themselves of those which have been sunk, and of the mines abandoned by the Daya or Malayu. A tank is formed, or a small stream dammed up; and a channel being cut in the direction of the vein, the sluices are opened, and the superior strata are entirely cleared away by the velocity of the stream, and the Arèng being discovered, the sluice is shut. The Arèng having been dug out, is washed by exposure to the repeated action of water conducted along wooden troughs fixed in an inclined plane, and not cleaned in the dulang, until the stony particles are nearly freed from extraneous matter.

The largest diamond known with certainty to have been found in these mines weighed thirty-six carats. It was long supposed that the Sultan of Matan possessed one weighing three hundred and sixty-seven, which it was said he was afraid to cut lest it should prove flawed; but gentlemen to whom it has been lately shown consider it not to be a true stone.

Formerly, if the labours of the miners were rewarded by success, which is very uncertain, stones under four carats were their property; all of that size and upwards were claimed by the Panambachan, then a tributary of Bantam, from the Sultan of which state the former Dutch company purchased this monopoly or royalty, for fifty thousand dollars. At present, by treaty with the Panambachan, all the stones must be deli-delivered to government at twenty per cent. below the market price, which is accertained by appraisement on the spot, the necessary advances being of course first made to the miners by government. The small stones are sold at Pontianak, and the large ones, for which there are no purchasers there, are disposed of at Batavia, and the profits equally divided between government and Panambachan. There is every reason to believe that in the first year and a half succeeding this arrangement, which was made in the middle of 1823, these amounted to about nineteen thousand guldens, three hundred and ninety carats having been delivered to the agents of government in the latter part of 1823, and nineteen hundred in 1824, the cost of which must have been thirty-three thousand guldens, and the proceeds fifty-two thousand. The existing regulations are no doubt as often evaded as that mentioned above must have been; and if such be the case, two thousand two hundred and ninety carats are less than the actual produce of the period in question. The number of persons employed during it is unknown, so that no idea can be formed of the profit of mining speculations. The deliveries of 1825 and 1826 were less than that of 1824, and will be still less this year, government not advancing to an equal extent, in consequence partly of an outstanding balance against the miners, and partly to the disinclination of the latter to receive copper money. Some natives are of opinion that the veins are not so productive as in former times; others, making due allowance for the decrease occasioned by the measures of government, say that they are not worked with equal zeal.

Gold is found in almost every part of the Residency, also in the Arèng strata, and takes many names, being invariably designated by the name of the place where it is procured. The gold of Sintang, Sangão, and Landak, are about nine touch; of Muntuhari about eight and a half; that of Mandor a shade below eight; these are places under Pontianak; that found at Măntrādu under Mompawa is about eight touch; and under Sambas gold of nine touch is found; at Sapan of eight and a half at Larak; of eight, at Siminis; * and of seven and a half at Salakão. The mines are worked in a similar manner to those already described, and the Arèng cleaned in the dulan, in the centre of which the gold, from its greater gravity, is colected. There are no data for ascertaining the amount produced (Go) or the number of persons employed. The price at the principal ports may be taken at about two dollars and ninety cents per touch; or say, twenty-six Spanish dollars for Sintang gold of nine touch. The Sultaun of Sambas has in his possession a lump weighing twelve and a half bung kals, and says he has seen some which weighed twenty-five.

Iron is principally procured from Jellè, in the interior of Matan, in sufficient quantities to form an article of export, when it is known by the name of Bissi Ikat, from the manner in which it is made up. Ten pieces, each piece about eight or nine inches long, one and a-half broad, and half an inch thick, form a small bundle, and five of these a large one, which weighs

* There is here some error in the original which we cannot correct.—Ed.

about nineteen or twenty catties, and sells at Matan for about three dollars. It is collected by the Daya, and is of superior quality, as tools made of it are not steeled, and is in great demand among the natives. It is imported advantageously at Pontianak both from Matan and from Banjermassin, at which place it is known by the name of Bissi Desa, or Country Iron.

The animal productions which add to the exports of this Residency are wax, bezoar stones, and deer horns, but very little birds nest is found. The wax is of good quality when collected by the Daya, who find the hives most commonly on the Katapan tree, but, passing through many hands before it is exported, it is then generally adulterated. The bezoar stones, or Batu Galiga, the Daya allege, are collected by them from the muscular parts of animals, particularly the porcupine (Landak,) and the various species of Simia; and they conceive that they are produced by wounds received from other animals, especially the wild hog and Simia. On the coast this account appears to be believed, although contrary to the received opinion that the bezoar is produced in the stomachs of certain ruminating animals.

No meteorological journal has been kept, * but to judge from personal feeling, the climate must be very warm; the dense forests and extensive marshes would warrant the inference that the Residency is unhealthy, but it is considered otherwise, with the exception of the diamond district. The prevalent diseases are diarrhœa, dysentery, remittent and intermittent fevers, dropsical, rheumatic, and bilious complaints, small-pox, and the lues venerea. While the cholera morbus raged it made dreadful ravages. Once at Pontianak the whole garrison were attacked, and the Resident, who fortunately escaped, was the only person to administer the usual remedies.

Art. XXII.—*On the Construction of large Achromatic Telescopes.* By A. Rogers, Esq. †

In this paper the author describes a new construction of an

* We anxiously hope that a meteorological journal will be established at this residency. Its proximity to the equator would render the observations of great importance.—Ed.

† Mr Rogers's paper was read before the Astronomical Society on the 11th of April.

achromatic telescope, the object of which is to render a small disc of flint-glass available to perform the office of compensation to a larger one of crown, and thus to render possible the construction of telescopes of much larger aperture than are now common, without hindrance from the difficulty at present experienced in procuring large discs of flint-glass. It is well known that in the ordinary construction of an achromatic object-glass, in which a single crown lens is compensated by a single one of flint, the two lenses admit of being separated only by an interval too small to afford any material advantage in diminishing the diameter of the flint lens, by placing it in a narrower part of the cone of rays, the actual amount of their difference in point of dispersive power being such as to render the correction of the chromatic aberration impossible, when their mutual distance exceeds a certain limit.

This inconvenience Mr Rogers proposes to obviate, and obtain the advantage in question, by employing as a correcting lens not a single lens of flint, but a compound one, consisting of a convex crown and concave flint, whose foci are such as to cause their combination to act as a plane glass on the mean refrangible rays. Then it is evident that by reason of the greater dispersive power of flint than of crown glass, this will act as a concave on the violet, and as a convex on the red rays; and *that* the more powerfully, according as the lenses separately have greater powers or curvatures. If, then, such a compound lens * be interposed between the object-glass of a telescope, supposed to be a single lens of plate or crown glass, and its focus, it will cause no alteration in the focus for mean rays, while it will lengthen the focus for violet, and shorten it for red rays. Now this is precisely what is wanted to produce an achromatic union of all the rays in the focus; and as nothing

* A compound lens of this description was proposed for the same purpose by Dr Brewster several years ago. The construction of the lens is mentioned both in the *Edinburgh Transactions* and the *Edinburgh Encyclopædia.* The application of it to achromatic telescopes he explained to an eminent individual now in a distant part of the world; but as he never published any account of this application, Mr Rogers has all the merit of an original invention. Dr B. constructed several chromatic lenses, as he called them, with oil of cassia, &c. and plate glass, and frequently used them for correcting the colour in the eye, and also in magnifying glasses.—Ed.

in this construction limits the powers of the individuals composing the correcting lenses, they may therefore be applied any where that convenience may dictate; and thus, theoretically speaking, a disc of flint-glass, however small, may be made to correct the colour of one of crown, however large.

But this construction possesses other and very remarkable advantages. For, first, when the correcting lens is approximately constructed on a calculation founded on its intended aperture, and on the refractive and dispersive indices of its materials, the final and complete destruction of colour may be effected, not by altering the lenses by grinding them anew, but by sliding the combination nearer to, or further from, the object-glass, as occasion may require, along the tube of the telescope by a screw motion, till the condition of achromaticity is satisfied in the best manner possible. And, secondly, the spherical aberration may in like manner be finally corrected by slightly separating the lenses of the correcting glass, whose surfaces should for this purpose be figured to curvatures, previously determined by calculation, to admit this mode of correction—a condition which the author finds to be always possible.

Mr Rogers explains his construction by reference to a diagram, and states the rule for the determination of the foci of the lenses of the correcting glass in a formula which may be thus interpreted:—"The focal length of either lens of the correcting lens is to that of the object-glass, in a ratio compound of the ratio of the square of the aperture of the correcting lens to that of the object-glass, and of the ratio of the differences of the dispersive index of crown and flint-glass, to the dispersive index of crown;"—for example, to correct the colour of a lens of crown or plate glass of nine inches aperture, and fourteen feet focal length (the dimensions of the celebrated telescope of Fraunhofer at Dorpat) by a disc of flint-glass three inches in diameter, the focus of either lens of the correcting lens will require to be about nine inches. To correct it by a four inch disc will require a focus of about sixteen inches for each.

The author then remarks, that it is not indispensable to make the correcting glass act as a plane lens. It is sufficient if it be so adjusted as to have a shorter focus for red rays than for violet. If, preserving this condition, it be made to act as a concave lens, the advantage procured by Mr Barlow's construction of reducing the length of the telescope with the same focal power is secured; and he considers, moreover, that by a proper adaption of the distances, foci, &c. of the lenses, we might hope to combine with all these advantages that of the destruction of the secondary spectrum, and thus obtain a perfect telescope.

ART. XXIII.—*Occasional Meteorological Remarks and Observations, during the years* 1826–27. By a Correspondent.

I PROPOSE to extract from my memoranda some meteorological particulars which I have observed during the last two years, both in Edinburgh or its vicinity, and on the Continent of Europe. Some of the incidents may, I hope, afford interesting matter of comparison to other meteorologists; and I shall merely allude to those which have already been circumstantially detailed by myself in former numbers of this *Journal.*

January 9, 1826.—Very hard frost; at 3 afternoon in the country, only $26\frac{1}{4}$; at 8 A. $23\frac{1}{2}$. January 15th.—A very singular and piercingly cold day. A strong fog prevailed, which throwing out moisture, congealed in beautiful icy pellicles on every object. It prevailed in the evening, obscuring the sky for far above the horizon. At 10 A. $15\frac{1}{2}°$, about 400 feet above the sea.*

January 21st.—I observed a singularly beautiful auroral phenomenon this evening, somewhat resembling the famous arch of the 19th March 1825, but in some respects more curious. Soon after $9\frac{1}{2}$ A., when observing Jupiter, I saw a faint arch pretty low over the N. E. I thought at first that it was the common stationary polar lights, but soon perceived that it moved. At 9^h 43′ it passed through Cassiopeia in the west, and through Leo, rising at 9^h 47′ through Castor and Pollux, and Auriga, appearing almost in the zenith; at 9^h 49′ through Procyon and the Pleiades; at 9^h 51′ through α and γ Orionis and Aries; at 9^h 55′ through Orion's belt; at 9^h 58′

* See a full account of this great cold in this *Journal* for October 1826.

through Sirius. At $10^h\ 11'$ well-defined, but narrow, through Lepus, and the lower part of Canis Major; at $10^h\ 16'$ faint, but still visible, through δ Canis Major, and part of Eridanus. Its course was almost S. W., *diametrically opposite* to the wind, which was tolerably strong. The moon was extremely bright, being fifteen days old, and southing at $10^h\ 23'$; and therefore diminished extremely the brightness of the arch, which passed over her disc at $9^h\ 49'$, at the time that it passed through Procyon. Notwithstanding this bright moonlight I could perceive *through the* auroral arch the two minute stars of the sixth and seventh magnitudes which form υ Cassiopeiæ, with my naked eye, which proves the extreme tenuity of the arch, unlike others of a similar kind which have been observed which sometimes obscure all below the second magnitude, as I think was the case with that of March 1825. These observations will render it easy to trace the course of the arch over the heavens, and its direction and velocity.

January 31st.—The barometer at Edinburgh was at its minimum, 29.06. Its mean height for the month was 29.794.

February 25th.—Heavy hail showers. This month was generally dull; and no severe frost occurred. The prevailing wind W. and S. W.

March 10th.—This extraordinary day had the common temperature of summer, as the following observations prove: 8^1 M., $56\frac{1}{2}°$; $12\frac{1}{2}$, $68°$; $1^h\ 10'$ A., 68.6; $1^h\ 30'\ 69\frac{1}{2}°$; $1^h\ 45'\ 70\frac{3}{4}$; $8\frac{1}{2}$ A. $59\frac{1}{3}$. The wind was excessively changeable through the day, scarcely ever blowing the same a few yards distance. Barometer $8\frac{1}{2}$ M. 30.04; $1^h\ 10'$ A. 30.07; $8\frac{1}{2}$ A. 30.02, at which it remained during the next day. The wind settled in the east and brought cold weather, as on the 11th we had $8\frac{1}{2}$ M. $48\frac{1}{2}°$; 4 A. $53°$; at midnight $44\frac{1}{2}°$. The wind varied from N. to S. by the E. points. Next day,

March 12th.—The barometer rose to a very considerable height at Edinburgh. By observation both at $8\frac{1}{2}$ A. and $10\frac{1}{4}$ A. it was 30.40; and next morning, the 13th, at $8\frac{1}{2}$ M. by a very careful admeasurement, it was 30.409.

March 28th.—At midnight the sky, which had been very cloudy, cleared from the north with amazing rapidity, and became perfectly bright. It would be curious to know at what time this sudden breaking up was observed in different places.

March 29th.—Before $8\frac{1}{2}$ A. a light auroral arch appeared near the zenith. It progressed towards the south, precisely like that of the 21st January. Wind this day N. W. At 9 there was a brilliant display of the aurora.

April 9th.—A fine rainbow about 5 A. About $8^h\ 25'$ A. a large slow falling star. In part of its course it formed a right angled triangle with Algol and Capella. I observed it move through an arch of 7° to 10°.

April 12th.—At 2^h 50 a loud peal of thunder, with others following.

April 17th.—At $8\frac{1}{2}$ A. I observed a remarkable halo round the moon of about 40° diameter, which continued all evening.

April 27th.—An uncommon day at this season. Snowing almost incessantly till about 3 A. Thermometer (in the country) at 9 M. 39°; 1 A. 42°; 9 A. 33°; 10 A. 32°.

April 29th.—About $9^h\ 35'$ A. a very brilliant and rapid falling star passed parallel to δ Gemini, and β Canis minor, over a considerable space. At $11^h\ 13'$, a very bright and rapid shooting star, with a short course, probably eclipsed Libræ, and proceeded obliquely downwards.

May 14th.—At $10^h\ 30'$ M. the unusual phenomenon of an aerial waterspout was observed in the neighbourhood of Edinburgh. A light dusky cloud of a funnel shape was seen in a north-westerly direction, clearly relieved from a darker cloud behind. It was evidently transfusing the contents of a very dense and dark black cloud into one immediately below, with which it formed the only connection. At this time the lower extremity of the waterspout was bent from the direction of the wind, being N. E.; the upper cloud was moving in a *contrary* direction. In a very few minutes it reached its greatest distinctness, and a manifest transfusion of the contents was taking place, the column presenting the appearance of smoke or steam, and the undulation at the edges was scarcely perceptible. The form it assumed at this period is shown at Plate II., Fig. 10, according to a sketch I made shortly after, the lower extremity being turned towards the west. The undulations at the edges gradually increasing in distinctness, the waterspout grew less elongated, and the bottom turned in a direction contrary to the wind, which below still remained in the same point. The cloud above had now become less dense, while the one below increased in blackness, and that quarter of the sky became more generally dark; it then became short, with a broad conical termination, nearly as represented at Fig. 11. During this change the currents descending on the east and ascending on the west side presented at the bottom the appearance of violent ebullition. The waterspout then merged into the cloud above, and in about twenty minutes after being first observed it wholly disappeared.

The weather had been dry and sultry (temp. 61°.3) and the air appeared highly electrified. The change which followed was very remarkable. Partial torrents of rain fell in the direction in which the phenomenon was observed; and it was remarked in the vicinity of the place where I noticed it, that such a fall of rain had seldom been seen, although *there* only a few drops fell. The shower appears to have moved from the N.W. as I observed a very curious effect upon the dusty roads, which were *extremely partially soaked* in that direction.

May 22d.—4 A. temperature of the solar rays, 94°.

June 4th.—At 7 A. I saw a portion of a solar halo on a parallel stationary cirrus near the horizon. The whitest part of the cirrus was so strongly brightened as almost to resemble a parhelion. It might be 20° south of the sun, (then setting), and only a small portion of the halo in that direction was perceptible. It showed the prismatic colours pretty distinctly, and disappeared in about half an hour.

June 24th, 25th, 26th.—On these days, especially the last, a very intense temperature occurred. See a copious account of my observations on the occasion in this *Journal* for October 1826.

July 17th.—The following occasional thermometrical and other observations were made in the course of this day. [See Table II., p. 142.]

July 31st.—During a very favourable voyage from London to Calais, several very interesting meteorological phenomena were observed. About $10\frac{1}{2}$ M. a most tremendous flash of lightning was seen near Greenwich, followed by thunder and rain. It was the brightest I ever witnessed in this country. At $5\frac{1}{2}$ A. having passed the north foreland, I observed on the horizon at the south foreland a very beautiful mirage, which was soon after visible at the former point. It was an uncommonly fine example, and the ships were most distinctly refracted twice in the atmosphere. In the evening the sheet lightning appeared with uncommon splendour, and at the same time a very brilliant meteor passed through the north-west, in size and colour exactly resembling Venus, which was not far off, in beautiful conjunction with Jupiter. I had occasion to notice the luminosity of the sea as being very different from any thing I have observed either on the west or east coast of Scotland. It reminded me instantaneously (and indeed it resembles nothing else that I am acquainted with) of the splendid light emitted in the burning of silver leaf by galvanism.

In *August* the weather continued unremittingly oppressive.

September 7th.—At Trent, during the evening, a most tremendous thunder-storm took place, attended with lightning of various colours, and of incredible brilliancy.

In the beginning of October the autumnal rains set in, which they do regularly at this period in Italy.

November 22d.—A tremendous thunder-storm occurred at Naples in the evening. See my paper on the Climate of Naples in this *Journal* for October 1827.

November 29th.—On the occasion of the eclipse of the sun this day, I made a variety of thermometrical experiments, which have been published in No. xv. of this *Journal*, p. 166.

The following register kept for one month will give an idea of the weather at Naples in November and December last.

Nov.	NAPLES.	Wind.	Therm.
14.	Showery and cloudy,	S. W.	10 M. 59
15.	Dull and showery,		10 M. 65
16.	Rainy day,		10 M. 56
17.	Fine day, and clear,	S. W.	10 M. 61
18.	Delightful day,	S. W.	10 M. 60
19.	Rain last night; fine forenoon; some torrents of rain afternoon, and then rather cloudy,	S.	10 M. 61 10 A. 59
20.	Very fine day,	Var.	10 M. 57
21.	Fine morning; heavy rain forenoon; very fine afternoon,	Var.	11 M. 56
22.	Very rainy forenoon; fine afternoon,	S.	10 M. 55
23.	Rainy and unpleasant day,	S.	11 M. 56

Nov.	NAPLES.	Wind.	Therm.
24.	Rainy and unpleasant day,	S.	10 M. 57
25.	Fine and clear day,	S.	10 M. 58
26.	Showery, damp, and hot. A regular sirocco. Hygrometer 3 A. $2\frac{1}{2}°$. (See this *Journal*, Oct. 1827.)	S.	10 M. 66
27.	Fine day,	W.	10 M. 60
28.	Rain morning and evening; fine day,	Var.	10 M. 59
29.	Perfectly serene and delightful day,	N.	2 A. 51
30.	Fine day,	Chiefly N.	10 M. 53
Dec.			
1.	Very fine day,		
2.	Do.		
3.	Very unpleasant day,		10 M. 54
4.	Rainy; thunder and lightning in the evening,		10 M. 52
5.	Bad day,	S.	10 M. 50
6.	Fine cold day,	E.	10 M. 46
7.	Unpleasant sirocco day,	S.	10 M. 64
8.	Very fine day,	S.E.	10 M. 61
9.	Do.	S.E.	10 M. 54
10.	Do.	S.E.	10 M. 52
11.	Most delightful day,	S.E.	10 M. 54 on the sea at Pozzuoli.
12.	Delightful but sharp day,		10 M. 52
13.	Dull day,		10 M. 51
14.	Do.	S.	2 A. 57
15.	Fine, but dull,		10 M. 61

These observations are exactly copied from my register. The height of the thermometer ought to be diminished about a degree.

The weather is not such as we should have expected from an Italian season; but we understood that it was unusually bad.

1827, January.—It may be not uninteresting to give a regular diary of the weather at Rome for the months of January and February, kept by myself with very good instruments. The observations were made, with very few exceptions, exactly at the hours marked at the head of the columns.

I have added two columns of thermometrical observations at 8 M. and 8 A., which I caused to be made near Edinburgh, which may be compared with those at Rome. The mean of 10 M. and A., and of 8 M. and A., both give nearly the mean of the twenty-four hours.

ROME, January 1827.								Near Edinburgh.	
Day Month.	Day Week.	Weather.	Wind.	Barometer. 10 M.	Barometer. 10 A.	Therm. 10 M.	Therm. 10 A.	Therm. 8 M.	Therm. 8 A.
1	Mo.	Very fine day,				43		47	34
2	Tu.	Rainy,				48	47.5	25	21
3	Wed.	Dull and damp,	Var.		29.860	53	48.5	18	17
4	Thu.	Dull & showery,	S.	29.674	29.492	51.5	53	25	23
5	Fri.	Rainy,	S.E.	29.590	29.646	46	45.5	23	34
6	Sat.	Very rainy,	Var.	29.624	29.650	41.5	44.5	42	43
7	Su.	Rainy morning & fair afternoon,	S.	29.700	29.808	50	41.5	47	51
8	Mo.	Most delightful,	W.	30.040	29.136	39	41.5	47	48
9	Tu.	Dull day,	N.W.	30.172	30.170	48.5	52	34	31
10	Wed.	Most delightful,	S.W.	30.124	30.122	52	40	37	34
11	Thu.	Very fine,	S.	30.110	30.074	43.5	53.5	34	29
12	Fri.	Fine day,	W.	29.970	29.968	55.5	50	31	32
13	Sat.	Showery, fine night,	N.E.	29.958	30.000	47	40	37	47
14	Su.	Very fine,	E.	30.068	30.100	42	39	42	30
15	Mo.	Fine, sometimes cloudy,	Var.	29.962	30.016	40.5	39	29	36
16	Tu.	Very fine,	Var.	30.224	30.164	40	32.5	47	36
17	Wed.	Fine day,	N.	29.924		46	44.5	34	34
18	Thu.	Very fine,	N.	29.920	29.940	36.5	26.5	35	36
19	Fri.	Very fine,	N.	29.950	29.990	29.5	29.5	38	36
20	Sat.	Very fine,	S.	29.940	29.950	27.5	28.5	38	33
21	Su.	Very fine,	S.	29.936	29.936	27	34	33	33
22	Mo.	Very rainy and damp,	S.	29.574	29.490	42.5	49	34	33
23	Tu.	Excessively rainy	Var.	29.408	29.550	50	45.5	31	30
24	Wed.	Fine day,	Var.	29.824	29.908	50	35	31	31
25	Thu.	Very rainy and unpleasant,	S.	29.958	29.968	49.5	46	34	32
26	Fri.	Dull and damp, sirocco,	S.	29.958	29 962	55.5	55	34	32
27	Sat.	Dull and damp. Strong sirocco,	S.	29.976	30.000	58.5	55	27	32
28	Su.	Dull; sirocco,	S.	30.000	30.020	51	47	41	47
29	Mo.	Fine day,	Var.	30.050		49.5		47	45
30	Tu.	Very dull; strong sirocco,	S.	29.970	29.910	56.5	53.5	44	44
31	Wed.	Very dull; torrents of rain afternoon.	S.	29.886	29.908	55.5	45.5	45	47
		Means,		29.9139	29.8792	4535	43.53	35.87	34.97

ROME, February 1827.								Near Edinburgh.	
Day Month.	Day Week.	Weather.	Wind.	Barometer, 10 M.	10 A.	Therm.		Therm. 8 M.	8 A.
1	Thu.	Very fine,	S.	29.840	29.906	45.5	40.5	41	37
2	Fri.	Rainy,	N.W.	29.886	29.854	50.5	48	34	34
3	Sat.	Changeable and showery,	N.E.	29.814	29.844	57	48	29	31
4	Su.	Fine settled,	Var.	29.960	30.164	57	46.5	35	34
5	Mo.	Most delightful,	N.	30.242	30.224	51	49	41	39
6	Tu.	Fine,	Var.	30.118	29.850	53	46.5	37	35
7	Wed.	Very fine,	N.	29.654	29.574	50	45.5	37	35
8	Thu.	Very bad,	Var. chiefly S.	29.626	29.806	50	46	35	39
9	Fri.	Fine day,		29.980	30.078	51	46.5	32	35
10	Sat.	Extremely bad,		30.070	30.100	51	46.5	39	34
11	Su.	Fine day,		30.074	30.016	50	48.5	35	35
12	Mo.	Very changeable,		29.790	29.800	52.5	45	34	32
13	Tu.	Fine day,		29.790	29.760	55.5	43	33	32
14	Wed.	Remarkably fine,	N.	29.856	29.916	41.5	41.5	32	32
15	Thu.	Extremely fine, very cold,	N.	29.878	29.896	41	87	29	27
16	Fri.	Very fine, cold,	W.	29.888	29.907	49	35.5	25	29
17	Sat.	Showery & cold,	Var.	29.900	29.958	47	43	25	29
18	Su.	Rainy,	N.W.	30.018	30.118	45.5	42.5	29	25
19	Mo.	Showery & dull, strong sirocco,	S.	30.108	30.110	52	48	29	25
20	Tu.	Damp and unpleasant,	S.	30.040	29.950	53	53	30	31
21	Wed.	Very changeable,	S.	29.918	29.816	56.5	52	29	31
22	Thu.	Fine day,	S.W.	29.790	29.666	56	53	29	30
23	Fri.	Delightful,	N.	29.626	29.786	54.5	40.5	22	33
24	Sat.	Delightful cold day,	Var.	29.916	29.962	42	42	35	37
25	Su.	Very fine,	N.	29.984	30.002	45	42.5	32	35
26	Mo.	Delightful,	N.	30.170	30.288	43	35.5	44	46
27	Tu.	Delightful,	N.	30.376	30.404	37.5	38.5	39	33
28	Wed.	Delightful,	W.	30.410	30.358	40.5	43.5	34	47
		Means,		29.9543	29.9683	49.25	44.55	32.96	33.71

January 15th.—A set of complete hourly observations made this day were formerly transmitted to Dr Brewster.—[See TABLE I., p. 140.]

Jan. 18th.—On this and some following days a very severe frost occurred, such as would have been considered so even in Britain, as the register, p. 135, shows. On this day, at $10\frac{1}{2}$ A., the thermometer was at 26.5, which was the minimum I observed.

February 21st.—This was a curious example of variable weather in such a climate as Rome is generally supposed to enjoy. After heavy rain through the night, the morning, though rather cloudy, was fair, and bore much appearance of a fine day. It grew worse till about noon (that period which here, as well as in our country, seems to decide *almost universally* the fate of the day,) when it commenced raining heavily; and the sky was so closely clouded that hopes of fine weather were generally given up. However, from some traces of cirro-cumuli in the S.W., to which point I hoped the wind might turn from the south (for all here depends upon the wind,) I ventured to predict a very fine afternoon, though it was at the time pouring in torrents. In about a quarter of an hour the rain stopped, and the sun broke out with greater brilliancy than I have seen for several days, which gave, I hoped, a promise of future steady weather; but though the sky appeared almost completely cleared, yet in less than an hour it was again raining, and then three or four times alternately raining and fair, but dull. In the evening it rained in torrents, till suddenly about eight, I think, the stars thought fit to shine out, and all was clear and serene. This is strange weather for the end of February in Italy, and yet it is what we have been accustomed to for weeks past.

March 2d.—This day's observations proved very remarkably the sensibility of the barometer to a change of wind in this country. At 8 and 9 in the morning the wind rather from the north but wavering; barometer 30.274, stationary. At 10½ M. the barometer down to 30.260; wind between W. and S., with strong sirocco and fog coming on. At 11 M. wind the same, and barometer farther down to 30.242. At 12, on looking at the barometer, I was surprised to find it up to 30.284, and suspected an error in the observation, but finding none, I examined the wind vane, and discovered that it had shifted to the north with a clearing sky. During the afternoon the wind wavered, and the evening proved cloudy and mild; barometer sinking rapidly; at midnight 30.174.

March 27th.—After sunset, I observed in the neighbourhood of Naples a very brilliant example of zodiacal light, stretching in the form of an inclined cone with curvilinear sides, exactly to Aldebaran, about half or three-quarters of an hour after the sun had sunk. About the beginning of the month I observed a similar phenomenon at Rome, when the apex stretched to the Pleiades.

June 23d.—Not far from Milan, a tremendous thunder storm occurred at midnight, accompanied with the most brilliant lightning I ever saw, which illuminated the landscape in the most splendid manner, as bright as noon-day; and when the momentary flash was over, left the eye in a state of excitation, which is hardly to be believed without experiencing it.

July 22d to 29th.—The weather was very oppressive at Paris, particularly from the total want of wind, which rendered it almost insupportable. One day, if I recollect right, M. Chevalier's thermometer on the Quai des Horloges stood at 84° Fahr.

Near Edinburgh, September 10th.—On the 8th, the wind, which has been long in the east, shifted to the S. W., yet the foggy weather continued. This is what I have frequently observed, that the fog and vapours which, during a course of easterly wind, have been accumulating in the west, return when the wind has returned to the S. W., for a day or so before the weather becomes fine and clear. At the same time the barometer, which had been kept up to the unusual height of above 30.1, (400 feet above the sea,) declined. The evening of the 8th looked stormy, and a tremendous morning succeeded. From 10 A. to $9\frac{1}{2}$ M., or less than twelve hours, the barometer fell .418. It was attended with a violent hurricane and rain. But about 1 P. M. (on the 9th) the mercury having begun to rise, the nimbi and dense cumuli cleared off to the east, while cirri and cirro-cumuli formed an arch over the sky, bringing symptoms of fine weather from the west; and the evening accordingly proved delightfully clear. About 11 P. M. I observed a very remarkable auroral phenomenon, which consisted of variously shooting threads of light, forming an arch round Ursa major, and at each extremity shooting downwards with peculiar beauty, although the moon shone at the time. From above the upper point of the arch, beautifully electrified *cirri*, rather of the comoid kind, played in long lambent flakes till they completely reached the zenith, impelled by a very violent wind, which blew nearly from the N. W. by N. That these clouds were not distant from the earth was evident by the excessive smartness of their motions as they spread over the sky, and as the strong gusts of wind seemed to impel them at the same moment as I felt them, and caused their flakes to play as the flame of alcohol does in a draught of air. That they were clouds highly electrified I have no doubt, and they obscured bright stars. The simply auroral part of the spectacle was a very brilliant exhibition. The most violent winds have prevailed yesterday and to-day, lowering the barometer to 29.090, at which it is now stationary, having fallen more than an inch since the 5th.

October 16th.—This day has been extremely bad; rain throughout, and wind in the morning. As yet no prospect of good weather; yet the state of the barometer has been $8\frac{1}{2}$ M., 29.150; 10 M., 29.214; 4 A., 29.304; 8 A., 29.382; 10 A. 29.386, a continued and rapid rise. This seemed surprising during such weather; but on looking out in the afternoon I found that the high S. W. wind of the morning, which prevailed yesterday, and caused the decline of the barometer, was gone; that the aerial currents were in a variable state; and that from some copious smoke at a distance, the upper strata were moving from the east. A considerable reduction of the high temperature which the southern gales had brought took place,—a coolness which must probably be the cause of the decided increase of pressure which our east winds generally occasion.

December 7th.—This afternoon it blew a perfect hurricane, of such violence as I have seldom witnessed. Its effect on the barometer was very remarkable; it had descended *seven-tenths* of an inch from 10 M. to 8 A., and at the latter hour the convex surface of the mercury heaved with great violence to the amount of at least .030 inch. On the 17th a similar phenomenon was observable with very high winds, and I observed that the sudden depressions took place *just before* the loudest gusts were heard. From the greater adhesion of the mercury to the glass, it was more distinct in a common than a boiled tube, as the spherical convexity is more protuberant in the former than the latter.

December 27, 1827.—This day the weather changed in a very remarkable manner. It has for many weeks been mild and windy, with frequent and often excessive rain. The barometer has risen almost an inch within three days, and this afternoon I observed the wind in the N. E. and calm, (W. and S. W. high winds had before prevailed) while the uniformly cloudy sky broke into a low clear arch in that direction in a very beautiful manner. The arch gradually but very slowly heightened, throwing the clouds to the S. E. in an extremely singular manner, and the night turned out perfectly clear and serene. Δ.

TABLE I.

Lat. 41° 54′ N.
Long. 12° 28′ E. of Greenwich.

ROME,
January 15, 1827.

Distance from the sea about 14 miles.
Level above the sea about 123 feet.

FORENOON.

Hour.	Temp. shade.	Hygrometer.	Rad.	Temp. Spring.	Barom.	Wind.	Force.	Rain.	Clouds.	Weather, and appearance of the sky.
1 M.	39½	4½	Sun not risen above the neighbouring houses.		30.070			0	Cumuli.	1. Very cloudy, but not threatening.
2	38½	3½			30.072	E.	Moderate.	0	Dense and dark cum.	2. Ditto.
3	41	3			30.066			0	Ditto.	3. Extremely cloudy.
4	39	1			30.040	SW.	Brisk.	0	Few and light cum.	4. Fine clearing sky; moon quite clear.
5	36½	0½			30.016			0	Few cirri.	5. But few floating cumuli.
6	37	1			30.000			0	Very few cumuli.	6. Still clearer; very fine.
7	36½	1½			29.968			0		7. Dull and cloudy.
8	38	3			29.950	N.	Almost imperceptible.	0	Different form of dense cirri, very few cirro-cumuli.	8. Extremely dull.
9	39½	2½		58	29.946	N.	Gentle.	0	Fine cirri of several sorts.	9. The southern half of the sky first divided by the zenith, thick, with dense cirri, while the north had fewer cirri more attenuated and lateral, with two traces of cirro-cumuli E. and W.
10	40½	2½			29.962	NE.	Very gentle.	0	Cirri.	10. Sky very clear, with bright dispersed comoid cirri, and some denser and lateral ones inclosed by an arch over the S.
11	45	3	91		29.950	N.		0	Cum. and cirro-cum.	11. Very fine and clear; a few cirro-cumuli chiefly S.
12	53¼	5¼	89		29.916	N.	Do.	0	Do. do.	12. Between 11 and 12 the cumuli from the N. spread over the sky, the S. side of which was spread with cirro-cumuli

1 A.	53½	4½	Sun generally obscured.		29.916	N.	Very gentle.	0	Cum. and cirro-cum.	1. More cloudy, but the sun bursting out, the cirro-cumuli predominate, and are in clear patches.
2	53	5			29.916	NNW.	Extremely gentle, but clouds move considerably.	0	Cumuli, and traces of cirro-cumuli.	2. Cloudy, but clearing, particularly in the N. where are traces of cirro-cumuli.
3	53½	4½			29.910	Do.		A few drops about 4.	Cumuli.	3. Fine clear sky, with large floating cumuli; sun generally obscured.
4	47½	1½			29.900			0	Cumuli and nimbi.	4. Excessively cloudy, and rain just commencing.
5	46	2		59	29.914	Do.	Gentle.	Short shower, not measured.	Do. do. and cumulo strati.	5. Dull and cloudy, clear north. Cumulo-strati.
6	45	3			29.936	NE.	Moderate.	0	Almost no clouds.	6. Fine clear and star-light; traces of cumuli-strati, in the west.
7	43	6			29.944	E.	Strong.	0	No clouds.	7. Fine and clear; no clouds; brisk wind.
8	41½	5			29.964	NE.	High wind.	0	A few light cumuli.	8. Very fine and clear; one or two flakes of white cumuli; moon rising.
9	39½	3½			29.990	NE.	Moderate.	0	No clouds.	9. Extremely fine and cloudless.
10	39	6			30.016	E.	Do.	0	Do.	10. Do. do.
11	39	5			30.058	E.	Strong.	0	Do.	11. Do. do.
12	37½	5½			30.060	E.	Moderate.	0	Do.	12. Do. do.
Sums		82¾	180	117	629.480					
Averages	42.6	3.45	90	58½	29.978					

Near Edinburgh. JULY 17, 1826. About 400 feet above the sea.

Hour.	Temp. shade.	Temp. spring.	Force radiat.	Hygrometer.	Rain.	Wind.	Clouds.	Weather.	Appearance of the Sky.	
3¼ M.	49½				0					
4	49				0		Long cirri, &c.	Beautiful morning.	Very clear; cirri pretty high to the N.	4 M.
5	50				0		Cirri and cumulo-strati.	Ditto.	Do.; cumulo strati N. and cirri round the zenith.	5 M.
6	52½				0			Ditto.		
7	55				0	W.	Do., and cumuli.	Ditto.	Clear; many streaky cirri.	7 M.
8	56¾	50		6	0	W.	Chiefly cumuli.	Very fine.	Much covered with cumuli; very few cirri.	8 M.
9	58¾		27	7	0	WNW	Do.	Ditto.	Do. do. less covered.	9 M.
10	59¾			8	0		Do.	Ditto.	Comoid cirri N. E.	10 M.
11	61¼			7	0					
12	63½			8½	0					
1 A.	63½			7½	0					
2	65½		15½	9½	0	W.	Cumuli.	Fine.	Sun obscured by cumuli in all directions.	2 A.
3	64¾		15	9	0	SW.	Do. Cirri N.	Ditto.	Cumuli all over; clear spaces.	3 A.
4	63¼	51	8	8	0	SW.	Cirro-cumuli and cirro-strati.	Very fine.	Almost covered with cirro-cumuli.	4 A.
5	62		11	9½	0	W.	Cirro-cumuli, and cirri and cumuli.	Ditto.	Few cirri and cumuli.	
6	61		17	7½	0	W.	Ditto.	Very fine indeed.	Belt of cum. across zen; cum. S., & cirri N.; beautiful sky.	5 A.
7	56⅔	51		6	0	W.	Cirri & dark cum.	Ditto.	Almost clear; cirro-cum. SE.	6 A.
8	55⅔			5	0	W.	Do. Cirro-cumuli and cirro-strati.	Ditto.	Immense varieties of fine cirri; some cirro strati N., and dense cumuli S. E.	7 A.
9	53½			4	0			Fine.	Great mixture of dense cumuli, cirro-strati, & cirri.	8 A.
10	55			5	0			Ditto.		
11	55½			5½	0		Cumuli.	Fine; a little cloudy.	Much cov[rd] with flocky cum.	11 A.
12	56⅓			3	0	WNW		Fine, but very cloudy.	Threatening towards WNW.	12 A.
Mean.	57°67	50.°7	12.°2	6.°8	0					

Art. XXIV.—*On Single Vision and the Union of the Optic Nerves.** By W. Twining, Esq.

The phenomenon of single vision with two eyes, each of which represents a picture of the object we look at, has received various explanations, and has been the subject of much inquiry. Dr Wollaston has lately promulgated an opinion on this subject, which I propose to bring before the Society, for the purpose of noticing some observations respecting the structure of the optic nerves and thalami in a healthy state,† as well as investigations of the changes produced by disease, which preclude us from admitting Dr Wollaston's premises, or adopting his conclusions.

Dr Wollaston believes, that the faculty of single vision with two eyes may be attributed to a semidecussation of the optic nerves; namely, that the contiguous half of each optic nerve, on reaching the *sella turcica*, and there uniting with its fellow, does cross and ultimately serve to furnish retina to the nasal side of the opposite eye; the retina of the temporal side of each eye being formed by the expansion of half of the corresponding nerve, while the retina on the nasal side of each eye is supplied by the expansion of half of the nerve from the opposite side. This semidecussation and distribution of the nerves, though not within the reach of anatomical demonstration, Dr Wollaston considers established by induction, from the symptoms of disease in some instances which he relates.

A case nearly similar to those published by Dr Wollaston, came under my care about four years ago. C. D. a lady about twenty years of age, and in perfect health, was thrown from her horse, while taking exercise in a riding-school. In falling, the left shoulder and left side of the head struck against the boarded

* From the *Transactions of the Medical and Physical Society of Calcutta*, Vol. ii. p. 151.

† "Vesalius, Valverda, Aquapendens, and Losselius, sometimes found the optic nerves separated through their whole course from the brain to the eyes; and yet persons whose optic nerves were so separated during life, saw objects single as other men do; which would have been impossible, if this single appearance had depended on the conjunction of those nerves." See Porterfield's 1st vol. on the Eye, &c. p. 194, of the Retina and Optic Nerve.

wall. The shock occasioned a momentary privation of consciousness, but of such short duration, that it amounted only to the slightest degree of stunning; from which she soon recovered, and again rode for half an hour. About an hour after the fall her sight became impaired, so that half of objects on her right, (that is, the left side of persons walking towards her) was not seen. On looking at a book, she read with difficulty, half of the page being dark; and she found that she could not comprehend what she read, from forgetting the first part of a sentence before she arrived at its conclusion. A dull heavy headach was felt, the pulse became slow and oppressed, countenance pale and void of expression, pupils dilated, and vomiting came on.

The slow and gradual accession of these symptoms, distinct from the first effects of concussion, and not immediately connected with alarm at the moment of the accident, was attributed to effusion slowly taking place from ruptured vessels, and appeared to indicate the necessity of active treatment. The patient was accordingly bled to lb.iss. and a general system of depletion was adopted in its fullest extent; at the same time every kind of excitement was avoided, and no food but tea, and a very small quantity of bread, allowed for several days.

In a few hours after the V. S. the whole of objects was perceived, but there was a confusion of sight, objects appearing irregular, and their outlines not well defined. This symptom, with dizziness and a dull headach, subsided gradually; and after several days continuance in the plan of treatment above stated, the patient recovered, and has never since experienced any similar affection of the sight. In this case, no experiment was made to ascertain whether only the half of objects would be seen, when one eye was closed.

We sometimes find, that injuries of the head, sympathetic affections of remote parts of the nervous system, and disorders of the stomach, as well as those disturbances of the nervous system dependent on distress of mind, intense thought, and severe application to business, produce suspension of the functions of some organs, and disordered action of others. It is difficult to assign a reason why affections of mind occasionally produce the same symptoms, as arose from concussion of the brain in the above instance; nor is it easy to ascertain how mental emotions sometimes suddenly cause those symptoms to cease.

The function of vision does not unfrequently suffer from all these causes; but surely we have not legitimate reason to conclude, that when hemiopsia, or half sight has been produced, the cause must be lesion of just half the optic nerve, or of the whole nerve on one side, between its origin and the union on the *sella turcica.* On the contrary, lesion, or disease of one nerve at the point just mentioned has not been attended with hemiopsia.

Many have attempted to show how single vision with two eyes is obtained, and also to explain the phenomena of hemiopsia, or half sight. It would be endless to advert to the opinions of all who have written on these subjects; among the most eminent we find Berkeley. The theory which his reasoning seems intended to support, ascribes single vision to the corrections which the impressions made on the retinas by visible objects habitually receive from the sense of touch; so that the mind was supposed to acquire by degrees the habit of knowing that objects were single, though the impression on the organs of sight were double.

The assistance and correction which the sense of sight receives from the touch, is supposed to be shown by the case of the boy born blind, and restored to sight by Cheselden's operation. The same case is adduced as a proof of the gradual manner in which the knowledge of the effects of light and shade, as indicative of the figures of objects, was slowly acquired, and by remembering the errors of sight which the touch corrected. This boy saw objects single at the first moment his sight was restored; consequently, (if the lens had never transmitted light prior to the operation,) this case is a proof that the faculty of single vision is not acquired by habit, but is an original function.

Smith and Reid maintained, that single vision arises from the two pictures of objects falling on corresponding points of the retinas. The former of those authors believed the faculty of single vision to be acquired by habit, the latter considered it an original power possessed independent of habit. Cheselden's case, just noticed, tends to decide this point. Smith says, "When the optic axes are parallel, or meet in a point, the two middle points of the retinas, or any points which are equally distant from them, and lie on the same sides of them, either towards the right hand, or left hand, or upwards or downwards, or in any oblique direction, are called corresponding points."

Wells objects to this, which, he observes, attributes the joint possession of one property, to places of the retinas at unequal distances from the centres of the optic nerves; and that a point of the retina which is *external* in one eye, has a correspondence of action and sensibility, with a point of the retina in the other eye, which is *internal*. For instance, if we look at an object with both eyes, which is removed some distance, say 25 degrees, either to the right or left of the place immediately in front of us, the pictures fall on that part of the retina lining the temporal side of one eye, and the nasal side of the other eye. Wells's theory, derived from consideration of visible direction and visible distance, does not appear to explain the difficulty.

The theory of single vision which Dr Wollaston has lately deduced, from the assumed semidecussation of the optic nerves, and his reasoning founded on cases of disease in man, together with the facts which comparative anatomy afford, completely meet the objection which Dr Wells has urged against the theory of corresponding points of the retinas above noticed: assigning, at the same time, a very plausible reason for that correspondence in the anatomical structure, arising from the semidecussation which he believes to exist.

Now the structure which Dr Wollaston imagines to exist in man, namely, the semidecussation of the optic nerves, and the formation of retina thence supposed to arise; so that the nasal side of the retina in each eye is formed by fibres arising from one thalamus; and the temporal side of the retina by fibres from the other thalamus; if admitted in the fullest extent that he requires, only accounts for double vision when there is disaccordance of the optic axes in a horizontal direction. But we find that non-accordance of the optic axes in a vertical direction will also produce double vision, which is not accounted for by the structure which Dr Wollaston imagines. Moreover, I think the cases and dissections presently to be stated, will be admitted as evidence that such structure does not exist in man.

A person might probably subject himself to be accused of adopting an indefinite idea, instead of adducing a demonstrable explanation of the interesting phenomenon under examination, were he to say, that the consent of action of the retinas and optic nerves, whereby we see objects single with two eyes, is dependent on sympathy. Nevertheless, the anatomy and physiology of the human body affords several examples, where in like manner we find sympathy, or coincidence of action even of distant parts, to arise from the structure, and depend on juxtaposition of nervous fibres at their origin. This is nowhere more beautifully shown than in the associated action of the internal, with several of the external or accessory muscles of respiration. The latter being chiefly supplied by the spinal accessory nerve of Willis, which, though it passes out of the skull with the eighth pair, does arise within the spinal canal, from those pairs of cervical nerves, which externally give off the phrenic nerve to supply the diaphragm.

The sentiments of Sir Isaac Newton, on the subject of single vision, entirely accord with the reasoning of Dr Wollaston; indeed, on some points there is almost a verbal accordance between these two authors. The following extract and annexed diagram, from Harris's posthumous treatise on optics, published in 1775, proves that the genuine spirit of philosophical analysis is the same in all ages; and shows how the inductive reasoning of great minds on the same points, leads them to similar conclusions.

"And so there are a vast multitude of these slender pipes, which flow from the brain, one-half through the right side nerve I L, Plate II. Fig. 14, till they come to the juncture G F, where they are each divided into two branches, the one passing by G T to the right side of the right eye *a b*, the other half shooting through the space E F, and passing by X to the right side of the left eye *e f*. And in like manner the other half, shooting through the left side nerve M K, divide themselves at F H, and their branches passing by E V to the right eye, and by H Y to the left, compose that half of the retina in both eyes, which is towards the left side *c d* and *g h*.

"Hence it appears,—

"1*st*, Why the two images of both eyes make but one image in the brain.

"2*d*, Why, when one eye is distorted, objects appear double.

"3*d*, Why, though one thing may appear in two places, yet two things cannot appear in one place.

"4*th*, Why, if one of the branches of the nerve beyond the juncture should be cut, that half of both eyes towards the wounded nerve would be blind, the other half remaining perfect."

This opinion of Sir Isaac Newton, though connected with a belief that the influence of the brain is communicated through the nerves by a most subtile nervous fluid, still mainly rests on the assumption of a semidecussation of the nervous fibres. I have only copied such parts of Sir Isaac Newton's explanation as immediately apply to the point in question; his reasoning and the diagram will be found at p. 108 of Harris's *Treatise on Optics*.

The following anatomical observations respecting the structure of the optic nerves and thalami, and the effects of disease on those parts, appear sufficiently to establish the fact, that no decussation or semidecussation of the optic nerves exist in the human subject.

Obs. 1.—Mrs Scot had a fungus of the left eye, for which the eye was extirpated. Several months afterwards the patient died; and on dissection, the left optic nerve was of inky blackness, and this dark colour extended backwards from the orbit far beyond the point where the nerves join. The diseased nerve within the cranium was as thick as the little finger, and the corresponding thalamus *nerv. optic.* was about a third larger than the opposite one, but of natural structure. The dark colour above-mentioned was confined to the left side. On the right side the nerve was of its natural size and colour, and was merely attached to the black diseased nerve of the opposite side by cellular shreds, where the nerves come in contact on the *sella turcica.*

This patient had never observed any affection of her eye until two years before the operation, when the morbid changes commenced; and in the course of four months she became gradually blind of the left eye.—See Burns's *Surgical Anatomy of the Head and Neck*, p. 349.

Obs. 2.—Morgagni states, that Hildanus had dissected a subject that had been blind of one eye, and found the corresponding optic nerve wasted, even beyond the usual union of the nerves on the *sella turcica*.

Obs. 3.—A man was afflicted with paralysis of the left side of the body: there was no perception of light with the left eye, and the lids of both eyes were closed. The man died, and on dissection, an ounce of coagulated blood was found in the right thalamus *nerv. optic.* extending into the lateral ventricle. Here we find an injury beyond the junction of the optic nerves, produces blindness of one eye, not half blindness of both eyes, which it might be expected to do, if the semidecussation of the optic nerves did exist.—See Sir E. Home's *Attempt to ascertain the Functions of different Parts of the Brain.*

Obs. 4.—A patient was affected with paralysis of the right side of the body. Dissection discovered erosion of the right thalamus *nerv. optic.* Hemiopsia not noticed in this case.—See M. Bayle *on paralytic Affections on same Side of the Body, with organic Lesions.*

Obs. 5.—A patient had hemiplegia of the right side, and lived four years after the first attack. On dissection after death, an effusion of blood was found in the right thalamus *nervi optici.* Hemiopsia was not observed in this case.

Rostan mentions in his work *Sur le Ramollissement du Cerveau*, that the disease, when deeply seated, most frequently affects the *corpora striata*, and *Thal. nerv. optic. of the right side.* He states that imperfections of sight or blindness are frequent symptoms in that disease, and sometimes one pupil is more dilated than the other. But he has not mentioned hemiopsia as a symptom.

Obs. 6.—Cæsalpinus says, " Repertus est aliquando in anatome, alter ex nervis visoriis attenuatus, alter plenus; visus autem erat imbecillis in oculo ad quem nervus extenuatus ferebatur, habuit enim vulnus in capite circa eandem partem: nervus autem extenuatus non ad oppositam partem procedebat, sed ad eandem reflectebatur. Visum hoc est Pisis, anno 1590. Unde omnes spectatores argumentum id certum existimaverunt, nervos visorios nequaquam se intersecare, sed coire et regredi ad eandem partem."

Obs. 7.—Vesalius thus relates the dissection of the brain and optic nerves of a woman, in L. iv. cap. 4, *de Corporis humani Fabrica*:—" Mulier nobis obtegit, cui dexter quoque oculus ab ineunte ætate emarcuerat, sinistro interim integerrimo. Mulieri dexter nervus toto progressu longe tenuior sinistro visebatur, non solum extra calvariæ cavitatem, verum in exortu quoque et in dextra congressûs nervorum sede. Ac præterquam quod dexter tenuis erat, durior quoque et rubicundior cernebatur, uti sane et in adolescente: sed dexter non admodum neque crassitie, neqne mollitie adhuc sinistro cedebat."

After looking with particular attention to such instances of diseased structure in the optic nerves and their thalami, as have been observed connected with impaired functions of the organs of vision, we may reasonably attempt farther to elucidate the subject under consideration, by referring to the most accurate researches relating to the structure of the human brain and optic nerves in a sound state.

The labours of anatomists have not as yet detected any decussation of fibres at the union of the optic nerves on the *sella turcica* in the human subject. Vicq.-d'Azyr observed, that when the human brain was hardened by immersion in alcohol, and the union of the optic nerves examined, the medullary fibres of the superior and inferior surfaces go direct to the eye of the same side; but the central part of this union of the optic nerves contains a mixed mass, the direction of whose fibres could not be ascertained. Wenzel observed the same structure of the outer side of the optic nerves at that part, while a smaller portion of the inner side of each nerve is inclined obliquely towards the opposite side; but it was impossible to demonstrate that any of the fibres crossed.—Vide Wenzel *de penitiori Structura Cerebri Hominis et Brutorum.* This precisely accords with the evidences from morbid anatomy, in observations 1st and 6th above stated.

Reil and Haller, who dissected and studied the structure of the brain with unremitting assiduity, have not been more fortunate in their demonstrations than the other authors above named.

It is worthy of notice, that dissections have shown some instances, wherein there was not any union of the optic nerves at the *sella turcica* in man; each optic nerve proceeding directly to the eye of the same side, and no peculiarity of vision resulted from such structure.

Obs. 8.—Morgagni, in Book i. Letter 13, Art. 7, mentions that Vesalius "had observed the optic nerves to remain separated through their whole course, in a man who had always very strong sight." He refers to Epist. Anat. 16. p. 14. Morgagni also states, that Aquapendente and Valverda had found the optic nerves in like manner not united; but that these two authors had not ascertained if any peculiarity or disorder of vision existed in those persons during life. Vesalius says,—"His ille accessit cujus nervos visorios illo de quo hic sermo est, congressu invicem non connasci, neque sese contingere, vidimus: sed dexter nonnihil ea sede, qua calvariam agressurus fuerat, sinistrorsum, et sinister nonnihil dextrorsum reflectebatur, quasi non coalitûs occasione nervi congrederentur, verum ut commode per suum foramen e calvaria prociderent: notissimum quum etiam hoc ductu progredientes, in oculi posterioris sedis medium non inserantur. Quam sedulo autem ac sollicitè ejus viri, cui in eum modum nervi dehiscebant, familiares, num illi omnia gemina perpetuo oculis obversarentur, interrogaverimus, neminem naturæ operum cognitione flagrantem ambigere sat scio; at nihil aliud rescissere licuit, quam ipsum de visu nunquam conquestum fuisse, visuque præstante semper valuisse, familiaresque de visorum duplicatione nihil unquam intellexisse."

Obs. 9.—Mr Cheselden relates the case of "a gentleman who had strabismus, with double vision, produced by a blow on the head. By degrees the most familiar objects came to appear single again; and in time all objects did so, without any amendment of the distortion." See note to p. 171 of Travers's *Synopsis of Diseases of the Eyes.* This fact shows, that points of the retinas, not originally endowed with the joint possession of the correspondence, supposed by Sir Isaac Newton and Dr Wollaston, to depend on peculiar distribution of the optic nerves in the retinas, may by habit acquire that correspondence. Therefore, independent of the evidence of the previous observations, we have reason to conclude that the structure assumed as the basis of their reasoning is not necessary to the function of single vision.

We must be careful how we attempt to employ the facts which comparative anatomy affords, in explanation of the phenomena of vision, as performed by the human subject; for it is reasonable to conclude, that the organ or instrument of sight is constructed to accord with the medium in which the animal lives, and that the nature and degree of vision in each animal has that particular modification which is best adapted to the animal's wants and habits of life. We know that double vision has occurred in man, when, by accident, an aperture has been formed in the iris, besides the natural pupil, so that in fact there were two pupils.* But we have as yet no satisfactory account of the functions of vision in a species of fish, (the *Cobitis Anableps*,) whose eye is furnished with two pupils. The cornea is opaque in the *mustyphlus*, the *Murena cæcilia*, and the *Gastrobranchus cæcus*. Both the cornea and aqueous humour are wanting in the Sepia, in which there is only a thin membrane over the lens. In Lawrence's work on comparative anatomy, we are referred to p. 341 of the *Biology of Treviranus*, who states, that the retina in the mole is formed by an expansion of a branch of the superior maxillary division of the fifth pair of nerves.† Magendie has observed, that, when birds are blind of one eye from the destruction of the cornea, the optic nerve of the blind eye is wasted, and this atrophia extends to the optic thalamus of the opposite side; but he did not find the same occurrence to take place in mammiferæ.

These and other varieties of structure, which comparative

* See a case of diplopia from double pupil by Ragellini, in the Act. Hafn. No. 1. A. 27.—Also a similar case from two accidental apertures in operating for artificial pupil, in p. 66 of Sir W. Adams's work on artificial pupil, published in 1814.—In page 231, of Saunders's *Treatise on the Eye*, (1816 edition) is a case of double vision, arising from two apertures in the opaque lens, in consequence of unequal absorption after the anterior operation for cataract.

† Magendie and Demoulins ascertained, that the mole has no nerve corresponding to the optic of other animals, and that there exists no *foramen opticum* in the sphenoid bone for transmission of such a nerve; authenticating fully the observation of Treviranus.

anatomy makes us acquainted with, so far from illustrating the mode in which sight is accomplished in man, would rather lead us to believe that vision is variously modified in different animals, wherever a different structure is provided by nature. Nor does the crossing without any union of the optic nerves in fishes and some lizards militate against this general conclusion. It is evident, from the position of the eyes of such fishes as are alluded to by Dr Wollaston, that they cannot see the same object with both eyes at one time.

The eyes are not the only organs of sense which, being double, do communicate a single impression to the sensorium. We have a parallel instance in the sense of hearing. The fact is, that we have no proof that there is any more correspondence between the pictures in the eye, and the sensations produced by them in the brain, than there is resemblance between the sounds of any given words of a language and the sentiments excited thereby in the sensorium. Nor does it appear necessary towards unity of perception of any given object, that the impression on the organs of sense should be single. Brown has observed, in his *Philosophy of the Human Mind*, that the two words *he conquered*, produced in the mind the same single idea or impression as the word *vicit*.

I think the aggregate of the foregoing paper will be admitted as sufficient proof that there is no decussation of the optic nerves on the *sella turcica* in man. If we wish to ascertain how single vision is accomplished with two eyes, we must seek other reasons for that phenomenon than those which have been assumed by Sir Isaac Newton and by Dr Wollaston. The facts above stated appear to me so demonstrative on this subject, that I am satisfied those authors, with such evidence, would not have adopted the conclusions they have published.

Art. XXV.—ZOOLOGICAL COLLECTIONS.

1. *Account of one of the Brood of Boa Constrictors.** In a Letter from David Scott, Esq. to George Swinton, Esq.

One of the young boas having died, I send him down to you in spirits. He was *two years* and *two months* old, during which time he increased in

* See this *Journal*, No. viii. p. 221, and No. xiii. p. 164.

length from eighteen inches to *five feet.* It is very surprising that they will not eat any thing of themselves, requiring it to be forced down their throats with a stick, and afterwards pressed forwards with the hands to some distance, in failure of which they throw it up. I kept the one I now send you upwards of three weeks without food, and still he would not swallow a frog, although repeatedly put into his mouth.

GOWAHUTTY, 10*th September* 1827.

2. *Notice of a shower of Insects which fell in a Snow Storm at Pokroff in Russia.* *

On the 17th October 1827, there fell in the district of Rjev, (in the government of Twer,) a heavy shower of snow in the space of about ten versts, which contained the village of Pokroff and its environs. It was accompanied in its fall by a prodigious quantity of worms of a black colour, ringed, and in length three-quarters of a verschok. The head of these insects was flat and shining, furnished with antennæ, and the hair in the form of whiskers, while its body from the head to about one-third of its length resembled a band of black velvet. They had on each side three feet, by means of which they appeared to crawl very fast upon the snow, and assembled in groups about the plants, and the holes in trees and buildings. Several having been exposed to the air in a vessel filled with snow, lived there till the 26th October, although in that interval the thermometer had fallen to 8° below zero. Some others which had been frozen continued equally long in life, for they were not found exactly encrusted with the ice, but they had formed round their bodies a space similar to the hollow of a tree. When they were plunged into water they swam about as if they had received no injury, but those which were carried into a warm place perished in a few minutes.—*Journal de St Petersbourg,* No. 141, Nov. 14, 1827.

3. *Account of a Battle of Ants.* By M. HANHART.

The author in this memoir describes a battle which he saw between two species of ants; one the *Formica rufa,* and the other a little black ant, which he does not name, (probably the *fofusca.*) In other respects there is nothing new on this subject, this kind of combat having been described in detail, and in a very interesting manner, by M. Huber, (*Recherches sur les mœurs des Fourmis,* 1810,) a work to which we refer, not being able here to enter into the requisite details.

M. Hanhart saw these insects approach in armies composed of their respective swarms, and advancing towards each other in the greatest order. The *Formica rufa* marched with one in front on a line from nine to twelve feet in length, flanked by several corps in square masses composed of from twenty to sixty individuals.

The second species, (little blacks,) forming an army much more numerous, marched to meet the enemy on a very extended line, and from one to

* Along with this interesting article we have been favoured with a few of the insects themselves.—ED.

three individuals abreast. They left a detachment at the foot of their hillock to defend it against any unlooked-for attack. The rest of the army marched to battle, with its right wing supported by a solid corps of several hundred individuals, and the left wing supported by a similar body of more than a thousand. These groups advanced in the greatest order, and without changing their positions. The two lateral corps took no part in the principal action. That of the right wing made a halt and formed an army of reserve; whilst the corps which marched in column on the left wing manœuvered so as to turn the hostile army, and advanced with a hurried march to the hillock of the *Formica rufa*, and took it by assault.

The two armies attacked each other and fought for a long time without breaking their lines. At length disorder appeared in various points, and the combat was maintained in detached groups; and after a bloody battle, which continued from three to four hours, the *Formica rufa* were put to flight, and forced to abandon their two hillocks and go off to establish themselves at some other point with the remains of their army.

The most interesting part of this exhibition, says M. Hanhart, was to see these insects reciprocally making prisoners, and transporting their own wounded to their hillocks. Their devotedness to the wounded was carried so far, that the *Formica rufa*, in conveying them to their nests, allowed themselves to be killed by the little blacks without any resistance, rather than abandon their precious charge.

From the observations of M. Huber, it is known that when an ant hillock is taken by the enemy, the vanquished are reduced to slavery, and employed in the interior labours of their habitation.—*Bull. Univ. Mai* 1826.

4. *Account of the Dog Trains of the North-West.* By Dr Lyman Foot.

Thinking it might be some amusement to you, to see the mode of travelling in the North-west, *Mrs Foot* has sketched a dog train which I enclose you. Three dogs will carry a man and his provisions. The traders travel all over the wilderness with them, over unbeaten snow, generally following the course of rivers.

As night approaches, the traveller seeks a thicket, to protect him as much as possible from the wind. He then digs an elliptical hole in the snow, with a snow shoe, at one end of which a fire is built. The bottom is covered with evergreen boughs, on which he spreads a blanket, and wraps himself up, with his feet to the fire. If the night is stormy, large evergreen boughs are placed across the hole, supported by the walls of snow on each side. Thus the traveller and his dogs sleep comfortably in the coldest weather.

The dogs are easily trained to turn, halt, and go by the word of command. The whip is only meant to crack at them, or give any one of them a severe whipping if he is obstinate. When the traveller wishes his dogs to turn to the left, he says " chuck" or " chuch," and cracks his little whip on the right side of his train; if to the right, he says " ge," and cracks it on the left side. When they wish them to start or quicken their gate, he says " march," or " avance," *(avancez ;)* when they wish to turn short about, they most commonly get out, or put one foot out, slew the train partly round, and say "vena isse," *(venez ici,)* or as the Canadians pronounce it, "vena issit," making a motion with the little whip at the same time. It is astonishing to see with what facility dogs are taught and managed. I own a train of dogs, one of which I broke myself. They are a great amusement to me in winter. I frequently ride over the river, and a mile or two round for amusement, and have, with three dogs, taken my wife and little boy a mile, to make calls on a genteel family, over the river, (a Mr Erwatingen,) who has resided here ten years, carrying on the fur trade.

As to the traveller's sleeping, you will hardly believe what I tell you. Those who travel with trains, think no more of sleeping in the woods, in the coldest nights, than you would of sleeping on your dining-room carpet. There is a little management necessary, however. They first endeavour to select a thicket: they next dig away the snow to the ground, with a snow shoe, which they always carry, and build a large fire. They then, (after boiling their chocolate, &c. &c.) cover a spot close to the fire, with some small boughs of evergreens, such as hemlock or spruce, and if it storms, raise a little covering of evergreens over them, a little resembling a rural cot. There, with two blankets, they will lie down by their fire, dogs and all, and sleep comfortably all night.—*Prof. Silliman's Journal.*

5. *Rare Insects.—Furia Infernalis and Meggar.*

There exists in Livonia, a very rare insect, which is not met with in more northern countries, and whose existence was for a long time considered doubtful. It is the *Furia Infernalis,* described by Linnæus in the *Noveaux Mémoires de l'Academie d'Upsal,* in Sweden.

This insect is so small that it is very difficult to distinguish it by the naked eye. In warm weather it descends from the atmosphere upon the inhabitants, and its sting produces a swelling, which, unless a proper remedy is applied, proves mortal.

During the hay harvest, other insects named *Meggar* occasion great injury both to men and beasts. They are of the size of a grain of sand. At sunset they appear in great numbers, descend in a perpendicular line, pierce the strongest linen, and cause an itching and pustules, which, if scratched, become dangerous. Cattle, which breathe these insects, are attacked with swellings in the throat, which destroy them, unless promptly relieved. They are cured by a fumigation from flax, which occasions a violent cough.

6. *Account of a shower of Herrings which fell in Ross-shire in Scotland.*

A remarkable, though not unprecedented occurrence, happened on Monday last in the neighbouring county of Ross. As Major Forbes Mackenzie of Fodderty, in Strathpfeffer, was traversing a field on his farm, he was not a little surprized to find a considerable portion of the ground covered with herring fry, of from three to four inches in length. The fish were fresh and entire, and had no appearance of being dropped by birds—a medium by which they must have been bruised and mutilated. The only rational conjecture that can be formed of the circumstance is, that the fish were transported thither in a waterspout—a phenomenon that has before occurred in this county, and which is by no means uncommon in tropical climates. The Frith of Dingwall lies at the distance of three miles from the place in question; but no obstruction occurs between the field and the sea, the whole is a level strath or plain, and waterspouts have been known to travel even farther than this. Major Mackenzie has forwarded a small quantity of the fish to the secretary of the Northern Institution.—*Inverness Courier*, April 1828.

7. *On the Cicadæ, or Locusts of the State of Ohio.* By Dr Hildreth.

Our insects are so numerous and so various, that it would take a volume to describe them alone. One of the most interesting and curious of this class is the Cicada. It nearly resembles the harvest-fly, but is smaller. They are said to appear only at stated periods, which some have fixed at seventeen, and others at fourteen years. I have one record of their appearing in this country the 14th of May 1812. I was then told it was seventeen years since they were last here, viz. in 1795. They gradually disappeared, and by the first of July were all gone. The month of May was cold and wet, and very unfavourable to the egress of the cicada from the earth. From the 24th of May to the 3d of June their numbers increased daily, at an astonishing rate. The cicada, or "*locust,*" as he is vulgarly called, when he first rises from the earth, is about an inch and a half in length, and one third of an inch in thickness. While making his way to the surface, he has the appearance of a large worm or grub. The hole which he makes is about the same diameter with his body, perpendicular, and seems to be made with equal ease through the hardest clay or softest mould. When they first rise from the earth, which is invariably in the night, they are white and soft. They then attach themselves to some bush, tree, or post, and wait until the action of the air has dried the shell with which they are enveloped: the shell then bursts on the back for about one third of its length, and through this opening the cicada creeps as from a prison. Their bodies are then very tender, and they can neither fly nor crawl to any considerable distance. In this state they remain until morning, their wings gradually unfolding; and as the day increases, they, by little and little, and frequent attempts, learn to fly for a few feet, so that by night they are able to fly for several rods. In their efforts to disengage themselves from their shell or envelope, I noticed that many of them lost their lives—either from a want of strength to burst away, or from the narrowness of the passage, occasioned by their coming to the surface of the ground too early; and the action of the air drying, burst their covering before their bodies were prepared for the changes In a diary which I kept at the time I find the following observations.

June 3.—Yesterday the cicadæ were seen making preparation to lay their eggs.

June 4.—The cicadæ begin to deposit their eggs in the tender branches of apple-trees; they appear to be very fond of young trees of this kind and of the forest-trees they seem to have a decided preference for the beech, on which they collect in vast multitudes; *and when any one passes near, they make a great noise, and screaming, with their air-bladders, or bagpipes. These bags are placed under, and rather behind the wings, in the axilla, something in the manner of using the bagpipes, with the bags under the arms—I could compare them to nothing else; and indeed I suspect the first inventor of the instrument borrowed his ideas from some insect of this kind. They play a variety of notes and sounds, one of which nearly imitates the scream of the tree-toad.*

June 12.—The cicadæ still very busy depositing their eggs in the tender branches—which branches die and fall off. The male only makes the singing noise from the bladder under his wings. The female has no wind instrument, but an instrument like a drill or punch, in the centre of her abdomen, with which she forms the holes to deposit her eggs—the same instrument also deposits an egg at the instant the hole is made. The punctures, or holes, are about an eighth of an inch apart, and in the heart or pith of the branch on its under side. One cicada will lay an immense number; by the appearance of one I opened to day each fly is furnished with at least one thousand eggs.

May 27. I find the following record.—"This day, and for two or three days past, the locust, or cicada is beginning to appear in vast quantities on the trees and bushes in the woods; they seem yet not to be fully grown, nor very active, but are easily caught. The hogs are very fond of them and devour all they can find, and indeed they seem to have commenced their attack on them, by rooting, before they left the ground. It is thirteen days since they first began to break from the earth, but did not leave their holes, in any great numbers, on account of the cold, till lately." The last of June, the cicadæ gradually disappeared. At this time the females were very weak and exhausted; and some which I examined appeared to have wasted away to mere skeletons, nothing remaining but their wings and an empty shell of a body. Since that time few or none have appeared in this county; but I have heard of their being seen in some of the neighbouring states, I believe east of the mountains.

While the cicadæ remained with us, I could not discover that they made use of any kind of food, although I examined them repeatedly and particularly for this purpose. All the injury they did to vegetation was in depositing their eggs; by this process they materially injured, and, in some instances nearly destroyed, young orchards of apple-trees. Many of them to this day will bear ample testimony to the truth of this remark, in their mutilated limbs and knotted branches.

In addition to the foregoing observations, I have learnt to a certainty, that it is seventeen years since the cicadæ were here before. Early in the spring of 1795, a clearing was commenced eight miles above this place, on the Muskingum, and an orchard put out on the piece, perhaps half an acre, that was cut over before the cicadæ appeared; the rest of the clearing was made the same season, after they had disappeared. When they again appeared in 1812, it was observed by Mr Wright, the occupant of the land, that not one cicada came out of the earth on that piece of ground where he had cut the trees before they appeared in 1795; but that on all the rest of the land, wherever there was a stump, or a tree had stood, the earth was full of holes made by the ascending cicadæ. These facts are in my mind a sufficient evidence that it is seventeen years between the laying of the egg, and the reappearance of the cicada. Through how many transformations they pass, is to me unknown; but from the length of time they lie in the earth, it is probable the changes are more than one. But that they do not travel far is evident, from their coming up immediately by, or under the spot, where the tree stood in which the eggs were deposited.—Prof. Silliman's *Journal*, No. xxii. p. 327.

Art. XXVI.—HISTORY OF MECHANICAL INVENTIONS AND OF PROCESSES AND MATERIALS USED IN THE FINE AND USEFUL ARTS.

The following important articles connected with the theory of the steam engine have been kindly communicated by W. J. Henwood, Esq. Member of the Zoological Society, and of the Royal Geological Society of Cornwall. They form the principal part of a small pamphlet just published for circulation among the practical men in the mining districts of Cornwall.

1. *Observations on the Performance of the Engine at Huel Towan recently erected by* Mr Samuel Grose.*

The various forms of steam boilers have been very ably described by Mr Taylor; from whose observations it appears that in some of those used in Cornwall, the heated air, after having passed through the cylindrical iron tube A, Plate II. Fig. 12, which is surrounded with water, and in which the fire place is situated, returns through the flue B, which passes horizontally underneath the boiler, to the end at which the fire is situated; here it divides, passing through CC into the flues DD, and through them is conveyed along the sides of the boiler, and thence escapes to the chimney. *a a* is the part of the boiler filled with water, and *b* is the reservoir of steam. It will be observed that the upper parts of DD approach very near to the surface of the water; and as the heated air is carried so many times round the boiler, it seems probable that but little heat is carried off to the stack. I am not aware that the side flues were ever before carried so near the water line, as above represented; but this is the manner in which they are now constructed at Huel Towan. There are very many instances in which the air passes from A to DD, thence to B, and thither to the chimney. The diameter of the cylinder of the engine, on the per-

* Since the following article was written, this engine has been found to consume fifty-four bushels of Swansea coal in 26 hours; and its average performance for the time was 87,2 millions of pounds, raised *one* foot high by the combustion of *one* bushel of coals.—Ed.

formance of which I intend making some observations, is 80 inches. The piston making a stroke of 10 feet approaches to within 3 inches of the cylinder cover. The air pump is 36 inches in diameter. The load of the engine is (forcing) viz. 273 feet of 11 inches in diameter

462 —— 16 ——————

55 —— 16.5 ——————

63 —— 12 ——————

It works without intermission, and in the month of January made 274,320 strokes, consuming 2034 bushels of Swansea coal. The packing of the piston may be supposed to be about six inches in depth; the area of the rubbing part is therefore 10,472 feet; but the friction on every foot of the surface of a piston is said (Farey on the steam engine,) to be about 288*lbs.*

the amount of this is consequently - -	3015,936 *lbs.*
The area of the rubbing part of the air pump is 3,927 feet, and estimating the friction at 144*lbs* per foot, -	565,488
The depth of the packing surrounding each of the forcing pistons may be estimated at 9 inches, and the circumference of the whole of them 14,5299 feet; the friction per foot being considered the same as for the air pump,	1569, 2256
The mean temperature of the column of water being estimated at 69°, its weight is about - -	59662,349
The whole load of the engine being - -	64812,9986 *lbs.*

Or 10,917 *lbs.* per square inch of the area of the piston, or equal to 22,216 inches of mercury. But the pressure of the steam in the boiler is about equal to a column of 71,15 inches of mercury; therefore, the steam from the boiler must occupy about .38224 of the length of the cylinder. Perhaps .35 may be nearer the truth, a small portion more being required to overcome the friction of the working parts; this gives 24.9 inches of mercury as the pressure of the steam contained in the cylinder at the termination of the working stroke.

The capacity of the cylinder is about, - this must at every stroke be completely filled.	349,07 *cubic feet;*
The space between the piston and cylinder cover, nozle, &c. 10 cubic feet to be, 65 filled every stroke, is about	6.5 ———

Therefore 355,57 cubic feet of steam of the pressure of 24.9 inches of mercury are to be expended at every stroke.

$\frac{355,57 \times 274320}{2034} = 47954,75$ cubic feet which reduced to the pressure of 30 inches of mercury 39802,4425 feet of steam; or 23,03382 cubic feet of water converted into vapour, of the atmospheric pressure, by the combustion of a bushel (84 lbs.) of coal, exclusive of that condensed in the case. The increased weight of the column of water in the pumps, arising from its compression, seems too little to be worthy of a separate investigation. The load on the air pump is at the commencement very little; but towards the termination of the stroke, its piston is subject to the pressure of the atmosphere. This is in the present case equal to about 15267 lbs. It seems probable, that the momentum of the machine, and matter in motion, overcomes a considerable portion of this; but it will draw very largely on our credulity, to imagine that no more steam is required to work the engine than if this adjunct were dispensed with. An addition to the quantity of steam necessary to the operation of the engine must certainly obtain; but as we have no precise information on the value of the inertia, we have no data for calculating the increase of quantity required. We are also much in the dark on the subject of the relative quantities of heat given out by elastic fluids in a known period of time, when raised to various degrees of temperature, and moving with different velocities. From such an investigation, we may reasonably expect much valuable information, as to the most economical application of heat, and the requisite motion of air, in the flues of steam boilers, which might be derived.*

2. *On the quantity of heat disengaged by the combustion of a bushel of coal.*

According to Dr Ure, one pound of coal will yield 5 cubic feet of gas; consequently a bushel (84 lbs.) will give 420 feet. Dr Henry considers that 2 measures of carburetted hydrogen, 2 measures of carbonic oxide, and 15 measures of hydrogen, constitute 19 measures of coal gas. Hence the constituents of a bushel of coal are: Carburetted hydrogen—

45, 16 cubic feet, weighing 3,2206885 *lbs.* carbonic oxide.
45, 16 ——————————— 3,2206885 *lbs.* hydrogen.
329,68 ——————————— 1,7237 *lbs.* carbon.
(75,9) say 75,5 *lbs.*

Mr Dalton ascertained that the combustion of 1 *lb.* of hydrogen extricated sufficient heat to melt 320 *lbs.* of ice.

1 *lb.* — carburetted hydrogen 85 ——
1 *lb.* — carbonic oxide 25 ——
1 *lb.* — charcoal 40 ——

and it is well known, that the heat required to convert ice into water of the same temperature, would have increased the temperature of an equal quantity of water, about 150°; consequently the heat extricated by the combustion of the

Hydrogen—	1,7237	× 320	× 150	= 82737,6
Carburetted hydrogen,	3,2206885	× 85	× 150	= 41063,178365
Carbonic oxide,	3,2206885	× 25	× 150	= 12077,581875
Carbonaceous matter,	75,5	× 40	× 150	= 453,000,

588878°,36024 representing the number of degrees which the combustion

* The preceding investigation proceeds on the assumption, that the steam in the cylinder is, when the steam valve closes, of the same density as that in the boiler; and in both the same as when the valve is opened; but this is incorrect. There is an increase of space, and the velocity of the piston increases. For the satisfaction of those who wish to extend my calculations, the contents of the reservoir of steam in the boilers, pipes, &c. is about 520 feet, the engine makes 7 stroke per minute, and I imagine the working stroke to be made in about a 100 or 1 4-6 second of time, the diameter of the steam valve being 8 inches.

of a bushel of coal would increase the temperature of a pound of water, provided it could be retained in the liquid state, and without increasing its capacity. But $\frac{588878^\circ,36}{960 \times 62,5} = 9,4813$ cubic feet of water converted into steam, by the combustion of one bushel of coal.* This is much below the result obtained by Mr Grose at Huel Towan. Mr Dalton's experiments, which we have assumed as data in the preceding calculation, were conducted in such a manner as to give the lowest possible results; the ignited matter under experiment being placed in contact with the vessel containing the ice, without the application of any contrivance to prevent the radiation or conduction of heat through the surrounding medium. The vessel itself was of tinned iron, and it is to be presumed its surface was bright or polished. Certainly the quantity of heat absorbed by it must have been very small in comparison with the whole given off by the combustible; bright metal being known to absorb a very small portion of the heat impinging against it. But one portion of the heated air must have been displaced by its successor, before it could possibly have parted with its superabundance to the vessel. Much of the difference between Mr Dalton's experiments and Mr Grose's results may thus be accounted for.

In Mr Watt's time, the evaporation was from 8 to 12 cubic feet of water with each bushel of coal; and since that period some highly important improvements have been made in the construction of steam boilers.

3. *On the Steam Case.*

The cylinders of steam engines are frequently surrounded with cases, containing steam of the same elasticity as that in the boiler. The water proceeding from the condensation which takes place in the case was for a considerable time allowed to pass off without further use;—but it has subsequently been the practice to return it to the boiler.

The object of the case was to prevent condensation taking place *within the cylinder*. But we shall see that the application of heat in this manner is by no means advantageous. As far as experiments hitherto published afford us a clue, we will endeavour to investigate it in the case of the engine at Huel Towan.

MM. De la Roche and Bérard found that the capacities of *equal volumes* of air under the pressures of 29.2 and 41.7 inches of mercury were nearly as 1 : 1,2396 differing from the ratio of the pressures or densities which is 1 : 1,358.

If we suppose the densities and capacities to be in this ratio to each other; then under a pressure of 24.9 inches of mercury .8983.

29,2	1,000
39,6	1,215
71,15	1,91

* I am aware of having omitted to notice the ammonia and tar, but the former as probably not decomposed, and the quantity of heat from the second greater than an equal weight of carbon would have given, is fully required to volatilize the other combustible substances, which assume the elastic state.

As air and steam out of contact with its generating water, follow the same ratio of expansion,—in the absence of experiments on the subject, it seems reasonable to suppose that their capacities vary as one another, and consequently that the capacity of the steam in the case—1,910, whilst that of the steam contained in the cylinder at the termination of the working stroke—.8983 for equal *volumes;* and for *equal weights* that of the former,—.02684 whilst that of the latter—.03607. It consequently requires that 3607 parts by weight of steam of a pressure equal to that of 71,15 inches of mercury be cooled; in order to heat 2684 parts of the pressure of 24,9 inches, the same interval of temperature.

From the law of Marriotte it follows that the elastic force of a given weight of any elastic fluid × the sphere of its action, will give the same quantity, whatever may be the temperature, pressure, or density; provided the *whole* quantity of heat in the mass suffer no increase or diminution; and hence friction and capacity disregarded, we obtain the same result, whether a given quantity of water and caloric, in the form of vapour, act on a surface of 8, or 80 inches in diameter.

In the use of a steam case it appears that a portion of steam is destroyed, in order to communicate to another portion a force so considerably less than what would have been obtained by adding their volumes together, as the difference between 2684 and 3607. The former representing the effect *produced* on the steam in the cylinder by the abstraction of heat from the case; and the latter what *would have been* the effect of the steam condensed in the case, had it been employed in the cylinder.

But the quantity of injection water will be augmented by the steam within the cylinder acquiring an increased quantity of heat after its admission there; the load of the air pump being of course proportionally greater; the surface exposed to the cooling influence being enlarged by the application of a case. Mr Woolf and Mr Grose usually employ steam cases, which, with the upper parts of the boilers, the steam pipes, cylinder cover, nozzles, &c. are surrounded and covered with from 10 to 14 inches in thickness, of ashes, saw dust, or powdered charcoal.

Before the application of which I was informed by Mr Hocking, engineer at the Consolidated Mines, the quantity of steam condensed in the case of a 90 inch cylinder, and working with steam of a pressure of about 70 inches of mercury gave 81,6 cubic feet of water in 24 hours.

Mr Sims has recently adopted a plan, which, if it can be so carefully managed by the engine-men as to avoid charring the packing of the piston, seems preferable to a steam case. It is making the flue, from the boiler to the chimney, around the cylinder. But it is doubtful whether the advantage obtained in the cylinder be not counterbalanced by the increased burden on the air pump.

4. *On the quantity of heat which passes to the chimney, in Engines working with high pressure steam.*

The subject of the economy of *high pressure* steam is one of the most difficult parts of the theory of steam engines, and at the same time one of the most interesting.

I have before observed, that the resistance being the same, the quantities of water and caloric are in ordinary cases equal, whatever be the dimensions of the piston. It is of course understood that I mean when acting against a vacuum. The loss of heat by the conducting power of the air, and by radiation, may be in a great measure prevented by the application of thick coatings of non-conducting matter. But there is yet another cause, which, although of importance, seems to have been hitherto overlooked;—at all events it has not been submitted to calculation. I allude to the larger quantity of heat which must of necessity pass to the chimney, when the steam is of great elastic force, than when only a little above the atmospheric pressure;—supposing it in both cases to pass off when at the same temperature as the steam in the boiler, below which point it is obvious it cannot be.*

In a former part of our investigation we have seen that the quantity of hydrogen from a bushel of coal is 1.7237 *lbs.* which by combustion yields

of aqueous vapour, - - -	14,5133 *lbs.*
The oxygen required for combustion being derived from the atmosphere, the quantity of azote with which it was mixed, and is also heated, is, - -	55,1584
75,5 *lbs.* of coke by combustion gives carbonic acid,	276,82
The azote mixed with the oxygen here combining,	805,28
3,2206885 *lbs* of carburetted hydrogen by combustion is converted into carbonic acid, - - -	8,8568933
———— aqueous vapour, - -	7,2465491
The azote mixed with the oxygen entering into combination is, - - - - -	51,529116
3,2206885 *lbs.* of carbonic oxide by combustion become carbonic acid, - - -	4,9610777
and bringing azote, - - -	6,9615568
The whole weight of aqueous vapour being,	21,759849 *lbs.*
———— carbonic acid, - -	290,637971
———— azote, - - -	918,929072

But assuming as data for our calculation the before-mentioned experiments of De la Roche and Berard, we obtain the following quantities representing the pressures and capacities:—

* Under *ordinary* circumstances, it seems probable that the air passing into the chimney is of a temperature much above that of the steam in the boiler. Mr Sims informs me that at one of the engines in Huel Vor Mine, the air in the chimney was 318°—The steam at that time was probably not above 270°, and the damper open about half way.

	In mercury.	Equal bulks.	Equal weights.
Aqueous vapour	29,84	1,	,033512
	38,2	1,175	,03076
	71,15	1,91	,02684
Azote,	29,84	,510204	,017098
	38,2	,59949	,0156934
	71,15	,9745	,013696
Carbonic acid,	29,84	,64	,021372
	38,2	,74948	,019622
	71,15	1,2181	,017120

But the result will be the same if we suppose the *capacity* to be *invariable,* and the *quantity of matter* to be *increased,* in the same proportion, as the capacity increases by enlargement of volume ; and in order to facilitate our calculations we will proceed on this assumption.

We then obtain for the weight of the vapour 27,16743, and this reduced to the standard of water as 1 : ,8474.	23,02168
For the weight of the azote, 1147,11225, which reduced as 1 : 2754, - - -	315,91471365
For the weight of the carbonic acid, 362,839644, which reduced as 1 : ,221, - - -	80,18756132
	419,12395497

Now, supposing it to be required to ascertain the quantity of heat going to the chimney when steam of 225° or about equal to 38,2 inches of mercury is employed, and when that of 265° or 71,15 inches is used, the air in both cases, to escape at the same temperature as that of the steam in the boiler.

Then 419,12395497 $\times$ 40—16764,958 1988 *lbs.* of water raised 1°, or 1 *lb.* of water raised 16764°,9581988 $\div$ 60000, $=$,2780826 of a cubic foot of water more converted into steam of 225° than of 265°, with a bushel of coal. It will be observed that for the quantities of heat extricated during combustion, I have here, as well as in my preceding observations, assumed those given by Mr Dalton.

5. On the increase of elasticity which obtains, when steam removed from contact with its generating water is heated.

According to Mr Ivory " the heat extricated from air when it undergoes a given condensation, is equal to $\frac{3}{8}$ of the diminution of temperature required to produce the same condensation, the pressure being constant."

Whence it seems to follow, that when a given expansion of volume obtains the quantity of heat absorbed is equal to $\frac{3}{8}$ of the increase of temperature required to produce that expansion. We shall suppose that a quantity of heat represented by 960° is required to convert a cubic inch of water into steam ; double the quantity of heat will of course vaporize 2 cubic inches of water, which will give about 3456 cubic inches of steam, of the pressure of 30 inches of mercury. Now 960° will convert one inch of water into vapour, of which the capacity is to that of water as ,8474 : 1, consequently the quantity of heat which will raise a given weight of *water* 960°, will raise the same weight of *steam* 1133°—and 824° + $\frac{3}{8}$ 824°= 1133° and as an increase of 1° of temperature will produce on the elastic fluids an expansion of $\frac{1}{480}$ of the initial volume; 824° will augment the volume 2965,248, or increase 1728 inches to 4693,248.

Hence it appears that a given quantity of heat, when applied to water in the usual manner, produces an effect represented by 3456,

And that when one-half of the same quantity is applied to water, and the other half to the steam generated by the first portion, the effect is represented by, 4693,248

giving to the second mode of application an advantage equal to about ,358 of the total efficiency of the heat, when wholly applied through the aqueous medium. On examination it will be observed that this result is lower than that obtained by Mr Gilbert.

It appears that were the amount of inertia to be overcome at the commencement of the stroke inconsiderable, the expansive mode of working could be carried to but very small extent; it being the necessity of a much greater force than that required to keep the load in motion, when once moving, that permits the steam entering the cylinder and acting on the piston, to acquire an elasticity greater than sufficient to continue the motion. Consequently, that, if the force of the steam in the boiler be not considerably greater than the load on the piston, motion cannot obtain. In fact, that the steam engine must of necessity have always worked expansively, although probably in the commencement of Mr Watt's career, in a less degree than it afterwards obtained. The advantage accruing therefrom belongs, therefore, in some degree to engines worked by steam of low elasticity. I believe the additional quantity of steam which is required, in order to supply the diminution of elasticity attendant on the increased capacity, by enlargement of volume, has never yet been taken into account.

This will be greater as the elastic force of the steam employed increases, and is certainly an additional argument to the many already adduced, against the use of high pressure steam. The amount of this drawback may be calculated without difficulty. But before we can arrive at a correct estimate of the quantity of steam required for an engine of given dimensions; it seems that the amount of inertia should be accurately ascertained; and as the dimensions of the shaft work, and the amount of friction vary so very much, it appears that an extensive series of experiments on this point are much to be desired. It has long been acknowledged by the most strenuous advocates of the economy of highly elastic steam, that the effect obtained has been considerably less than theory led them to expect.

6. *On the use of Steatite or Soapstone for diminishing Friction in Machinery.* By Mr E. Bailey, Boston.

This mineral has been long in use at the extensive manufactories at Lowell, in North America. For this purpose it is thoroughly pulverised, and then mixed with oil, tallow, or tar, whichever may be the best adapted to the use for which it is designed. It is of course important to procure that which is free from *grit;* and it can be purified in a good degree by mixing the powder with oil, and diluting it after it has stood a few minutes. The heavier particles will form a sediment to be rejected. It is used on all kinds of machinery where it is necessary to apply any unctuous substance to diminish friction; and it is said to be an excellent substitute for the usual compositions applied to carriage-wheels.

Some idea of the value of soapstone, in this use of it, may be formed from the following fact, communicated by D. Moody, Esq. the superintendant of the tar-works on the Mill-dam, near Boston:—Connected with the rolling-machine of that establishment there is a horizontal balance-wheel weighing *fourteen tons,* which runs on a step of five inches diameter, and makes from seventy-five to a hundred and twenty-five revolutions in a minute. About a hundred tons of iron are rolled in this machine in a month; yet the wheel has sometimes been used from three to five weeks without inconvenience, before the soapstone has been renewed. The superintendant thinks, however, that it ought to be more frequently applied.

This use of soapstone was discovered at Lowell by an accident, the circumstances of which it is not necessary now to repeat. It is sufficient to say, that it is regarded by those who have used it as an invaluable discovery. I have been assured that it has never been known to fail of producing the desired result, when applied to machinery which has begun to be heated, even in those cases where nothing else could be found which would answer the result.—*Prof. Silliman's Journal of Science,* No. xxvii. p. 192.

7. *Anemoscope for ascertaining the Direction of Slight Winds.* By Mr B. M. Foster.

This instrument consists of an octangular box, Plate II. Fig. 13, with a circular opening in each of the sides. Within the box pieces of blotting-paper are fastened which cover the openings. On the top of the box is a tin tube or socket having a cork, with a ring by which it may be suspended in the air from a tree. If preferred, the cork may be taken out, and the box may be placed in an inverted position on a pole, the upper end of which goes into the tin tube.

The method of using this instrument is to wet equally all the portions of blotting-paper which appear through the holes, and then place the instrument in its proper position. When it has been exposed a short time to the air, we must observe which portion of blotting-paper has dried most. "Thin slabs of slate or of stone, which easily give out moisture," says Mr Forster, "would be far preferable to using blotting-paper. This instrument is founded on the principle by which I have understood sailors ascertain the course of the air in a calm, which is, by wetting a finger, and holding it up in the air; then, by feeling which part becomes by evaporation cool, they judge from whence the current of air flows. It is obvious that when the sun shines erroneous conclusions may be made without due attention."—*London Journal of Arts.*

This instrument would be greatly improved if a thermometer which registered the lowest descent of the mercury, and having its bulb covered with wetted paper, were placed in each of the openings. By examining the state of the thermometer after a given time, we would be enabled to determine what had been the state of the winds during that time. In this way we would obtain, in the absence of the observer, a record of veering or changing winds, and would gather much information respecting what took place during a certain period. It would be easy to keep the bulbs of all the thermometers constantly wet. A greater number too might be used, and they might be so placed that one of them would not be affected by a wind blowing at any given inclination to the direction of the face on which it is placed.—Ed.

8. *Notice of a Pyrometer for measuring high Temperatures.* By James Prinsep, Esq. Benares.

After trying various plans for pyrometers, Mr Prinsep gave the preference to one founded on the following principles:—

1. That the fusing points of the pure metals are fixed and determinate.

2. That those of silver, gold, and platinum, comprehend a very extensive range of temperature; and

3. That between these three fixed points in the scale as many intermediate ones as may be required will be obtained, by alloying the three metals together in different proportions. When such a series of alloys has been once prepared, the heat of any furnace may be expressed by the alloy of least fusibility which it is capable of melting. The determinations afforded by a pyrometer of this kind will, independently of their precision, have the advantage of being identifiable at all times and in all countries. The smallness of the apparatus is an additional recommendation, nothing more being necessary than a little cupel, containing in separate cells the requisite number of pyrometric alloys, each of the size of a pin's head. The specimens melted in one experiment need only to be flattened under the hammer, in order to be again ready for use. For the purpose of concisely registering the results, the author employs a simple decimal method of notation, which at once expresses the nature of the alloy, and its correspondence with the scale of temperature. As the distance between the points of fusion of silver and gold is not considerable, the author divides the distance on the scale into ten degrees; obtaining measures of each by a successive addition of ten per cent. of gold to the silver, the fusion of which, when pure, marks the point of zero, while that of gold is reckoned at ten degrees. From the point of fusion of pure platina to that of pure gold, the author assumes 100 degrees, adding to the alloy which is to measure each in succession one per cent. of platina. The author then enters into a detailed account of the method he employed for insuring accuracy in the formation of the requisite series of alloys, and of various experiments undertaken to ascertain their fitness as measures of high temperatures. The remainder of the paper contains the recital of the author's attempts to determine, by means of an apparatus connected with an air thermometer, the

relation which the fusing point of pure silver bears to the ordinary thermometric scale. A full account of these proceedings, which was read before the Royal Society of London, will probably appear in the next volume of their *Transactions.*

9. *Method of making Ultramarine, discovered by* M. Tunel.

This most important discovery, which will give the greatest satisfaction to painters and all the lovers of the fine arts, was announced to the Academy of Sciences in February last. The fortunate discoverer of this process, which will very properly be kept secret for some time, was made by M. Tunel, inspector of gunpowder and saltpetre. It was by following the analysis of M. Clement Desormes that he succeeded in the direct formation of it, and what he obtains is actually finer and more brilliant than the natural colour. M. Tunel has already been able to supply the public with ultramarine at one guinea per ounce, the colour having hitherto been sold from two guineas to two pounds ten shillings per ounce. He expects, however, to be able to sell it at a more moderate price. *Le Globe, Fev.* 9, 1828.

Art. XXVII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Spots on the Sun.*—Towards the middle and end of May 1828, the sun appeared covered with a very unusual number of spots, *one* of them of extraordinary size. On the 23d, when I observed it with great care, it was nearly in the centre of its path across the sun's disc, when I estimated the penumbra at $\frac{5}{86}$ of the sun's diameter in breadth, which gives about 1′ 6″ for the angle which it subtended and near 31,000 miles for its absolute extension. The dark nucleus of the spot was not uniform and unbroken, when examined with a considerable power: it appeared, especially towards the edges, composed of smaller spots in a state of aggregation, and forming pretty nearly a square rounded off at the corners, of which form the penumbra closely partook, except that at one point it stretched out considerably to the west and included three minute spots in that direction; but this partial extension was not counted in the preceding measurements. Yet this formed only one of seven points on the sun's surface in which spots were distributed, in some places single spots, in others groups of three and upwards. In all, there were at least 22 or 23 spots visible on the disc,—a sight very rare and extremely interesting. Cloudy weather has generally prevented me from pursuing farther my observations. The weather was particularly warm during the continuance of these spots, as I also observed to be the case with the great spots of June 1826. See this *Journal,* Number x. p. 245.

June 6, 1828. Δ

2. *M. Damoiseau on Encke's periodical comet.*—M. Damoiseau has

made the following calculations with respect to Encke's comet. They show the variations which have occurred in its elements; and, what is particularly interesting, they mark the places in which its *return may be looked for in the present year.*

Passage of Perihelion.	Eccentricity.	Long. of Perihelion.	Long. of Node.	Inclination of Orbit.	Mean daily Motion.	Major Semiaxis.
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 5460	2.224360

	R. Asc.	Dec. N.	Dist. from earth.	Dist. from sun.	Inten 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	0.532
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

Connaissance des Tems pour l'an 1827, p. 223, 224.

OPTICS.

3. *Large Achromatic Telescope by Lerebours.*—In our last Number we mentioned the large telescope made by Lerebours, and on the authority of our correspondent in Paris we stated the object-glass to be *twenty-four* inches in diameter. We learn, however, by a subsequent letter, that its diameter is only *twelve inches* and one line, and its focal length twenty-two feet.

METEOROLOGY.

4. *Mean Temperature of Penzance, deduced from Twenty-one Years' Observation.*—The following are the results of the observations made by Edward C. Giddy, Esq.—

	Max.	Min.	Mean.	Rain. Inches.	Wet Days.	Dry Days.
1821	73°	26°	52°.5	46.0	186	179
1822	78	28	53 .0	41.9	172	193
1823	70	27	51 .0	57.5	196	169
1824	72	30	51 .5	51.5	225	141
1825	84	29	52 .0	39.0	161	204
1826	80	26	53 .5	32.2	114	251
1827	73	24	51 .5	44.9	188	177
	75½°	25°.1	52°.0	44.6	177	187

Mean temperature of Penzance, - - - 52°.

Do. according to Dr Brewster's formula for West of Europe, 52°2.

The preceding observations were made with a register thermometer.

Mr Giddy has published the results of twenty-one years' observation, from 1807 to 1827 inclusive; but as these were made only at 8^h A. M. and 2^h P. M. they want an evening observation, and give ordinates of the daily curve, from which it would have been impossible to deduce the mean temperature, had we not been enabled to supply the defect from the hourly observations made at Leith. Thus the mean temperature at Penzance at 8^h A. M. and 2^h P. M. is — 54°5. But by the hourly observations at Leith for 1824, 1825, and 1826, the mean of 8^h A. M. and 2^h P. M. exceeds the mean temperature of the twenty-four hours by 2°.03. Hence we obtain—

Mean tem. of Penzance for 21 years, at 8^h A. M. and 2^h P. M.	54°.5
Correction, - - - - - -	2.03
Mean temp. for 21 years corrected, - - -	52°.47

A result which differs very little from the mean of the maximum and minimum register thermometer.

The mean of all the observations together is 52°.23, agreeing in the most extraordinary manner with the result of Dr Brewster's formula.

5. *Dr Heineken on the Mean Temperature of Funchal, &c.* An elaborate Meteorological Register of the weather for 1826, kept by Dr Heineken at Funchal in 1820, has been published in the *Philosophical Magazine* for November and December 1827.

The observations for the temperature were made 89 feet above the sea, with a maximum thermometer by Newman, and minimum one by Dollond; and the mean deduced from them is 64°.3,—a result so low, that we are persuaded there is some error either in the instruments or in the observations. The annual mean temperature of Funchal, as given by Humboldt, is 72°.22, and the mean temperature of the coldest month is 64°.04, fully as high as the annual temperature given by Dr Heineken. Dr Brewster's General Formula gives the Mean Temperature of Funchal 68°.65, equal nearly to the mean of Humboldt's and Heineken's results, which is 68°26. Dr Heineken's maximum thermometer was hung in a room with the door and window always open, which ought to have given a higher temperature than if it had been placed in the open air.

6. *Water-spouts in the Indian Ocean.*—According to Mr Main, the water-spouts in the Straits of Malacca and Singapore arise from the convergency of the air and the clouds to the spaces left unoccupied by the heavy and impetuous rains which precede them. "These generated various and contrary currents of air, wheeling the clouds in violent commotion; partial tornadoes were consequently created; these, by their vertiginous course, affected the adjacent and surrounding vapours, drawing them into the vortices. The grosser parts of this whirling body of vapour naturally inclined to the centre of the tornado, and these coalescing, formed the aqueous column called a *water-spout.*

"The first appearance of this phenomenon is the lower end of the column impending from the base of a dark cloud, in the shape of an inverted cone, in a somewhat waved direction, descending gradually to the sea or earth. When it happens to descend on the former, a considerable body of air around the spout partakes of its motion, because the water is violently agitated therewith for a considerable time before the point of the cone reaches the surface; and during its approach, a cylindrical body of thick spray, greater in diameter than the spout, is seen raised from the waves, and appears to meet it in its descent, and when in collision the agitation is extreme. The contact continues for ten or twenty minutes, according to the size of the spout, and when exhausted, the lower end becomes broken, less depressed, and shrinking as it were upwards, disappears as it begun."

On one occasion Mr Main saw *five* water-spouts from the ship at the same instant, some of which were above the land and others above the sea, the nearest being about five miles distant. One of these, illuminated by the sun's rays, and viewed through a small telescope, gave distinct indication of being tubular.—*Ann. of Philosophy*, No. xiv. p. 114.

7. *Meteoric Stone which fell in India on the 27th February*, 1827.—This aerolite fell in the district of Azim Gerh, nearly five miles from a village called Mhow. It fell about three o'clock, in a perfectly clear and serene sky, and was accompanied with noises like the roaring of cannons. Four or five fragments were picked up four or five miles asunder; one broke a tree, and another wounded a man severely in the arm. The largest piece weighed three pounds. It is perfectly similar to that which fell near Allahabad in 1802, and near Mooradabad in 1808. The specific gravity was 3.5. The presence of chrome and nickel was ascertained.

8. *Meteoric Stones which fell near Belostok in Russia*.—On the 8th October 1827 a shower of stones fell from a large black cloud, accompanied with noises like that of the running fire of musketry. The fall took place between nine and ten in the morning. Only four stones were picked up; the largest weighed four pounds, and the smallest $\frac{3}{4}$ths of a pound. —*St Petersburgh Gazette.*

9. *Vibration of Glass Vessels indicative of approaching Storms.*—Professor Scott of Sandhurst College, observed in Shetland, that drinking glasses placed in an inverted position upon a shelf in a cupboard, on the ground floor of Belmont house, occasionally emitted sounds as if they were tapped with a knife, or raised up a little and then let fall on the shelf These sounds precēded wind, and when they occurred, boats and vessels were immediately secured. The strength of the sound is said to be proportional to the tempest that follows.

10. *On Terrestial Radiation.*—1. In a series of observations with register thermometers undertaken to investigate the terrestrial radiation, the following results were obtained as the means of minima for May last: Radiating thermometer freely exposed on a turf raised two feet from the ground, 39°46; Reg. therm. in a sheltered situation, 48°39. Difference, 8°93. Made in the neighbourhood of Edinburgh.

2. An unexceptionable opportunity was chosen on the 22d May to make the following observations on the solar radiation. The bulb of the thermometer was covered with black cloth.

Hour.	Sun.	Shade.	Hour.	Sun.	Shade.
$10^h 50'$	96°	51°	$12^h 0'$	103½°	50½°
11 0	100		12 10	103½	51
11 10	97½	51	12 20	99	50½
11 20	99½		12 30	102	50½
11 30	100		12 40	101½	50½
11 40	99½	51	12 50	101	
11 50	103	50½	1 0	102½	51

Maximum force of solar radiation 53°. Δ

AERONAUTICS.

11. *On the origin of Air Balloons.*—Mr G. Cumberland of Bristol, in a paper on the origin of air balloons, published in the last Number of the *Quarterly Journal of Science,* states it as "rather remarkable that so many books have been published on the subject of balloons, and so much money expended in useless experiments, to discover a method of guiding them with precision, while no one that he knew of has as yet pointed out *the origin* of the invention, which will be found copiously detailed, accompanied by a figure explanatory, in a folio volume, dedicated to Leopold I. by *Francesco Lana* a jesuit of Brescia, MDCLXX." As the sole object of Mr Cumberland's paper seems to be to make known the claim of Father Lana, we beg to inform him, that not only a *description* of Lana's Aeronautic vessel, but also *an Engraving* of it, was published nearly *twenty years* ago in the article AERONAUTICS, in the EDINBURGH ENCYCLOPÆDIA, vol. i. p. 165, and Plate III. fig. 1.

MAGNETISM.

12. *Professor Hansteen's Magnetic Journey to Siberia.*—In a letter which we have just received from Professor Hansteen he expresses his anxiety of carrying into effect our wishes of obtaining the mean temperature of places related to the Asiatic Pole of maximum cold. "From Tobolsk, says he, I shall descend the river Obi to Beresov, and perhaps to the Gulf of the Polar Ocean, where this river falls into the sea; and it will give me great pleasure during this excursion to the north, as well as during the whole journey, to make every sort of useful observation."

II. CHEMISTRY.

13. *Expansion of crystallized bodies by heat.* Professor Mitscherlich has published a paper on this subject in "Poggendorff's *Annalen der Physik u. Chemie,*" vol. x. p. 137, &c. The results of the observations of this celebrated chemist are the following: He has measured some crystallized minerals in the temperature of a room, and then in hot mercury.

The variation of the angles for 80° Reaum. was

For carbonate of lime,	- - -	8′ 34½″
bitter spar,	- - - -	4′ 6″
bitter spar from the Pfitsch-valley,	- -	3′ 29″
carbonate of iron,	- - -	2′ 22″

In the sulphate of lime the variation of the inclination of the faces f and f' Fig. 57 second volume of Moh's *Treatise on Mineralogy*, is $= 10' \, 50''$, of the faces l and $l' = 8' \, 25''$, of the edge ff to edge $ll = 7' \, 26''$. All three angles become more obtuse.

14. *Analysis of the Honeystone or Mellite.*—Dr Wöhler has found this mineral to consist of

Mellitic acid,	41.4
Alumina,	14.5
Water,	44.1
	100.0

Poggendorff's *Ann.* vii. 330.

15. *Analysis of some varieties of Serpentine.* By Mr Lychnell, in Stockholm.—(Poggendorff's *Annalen*, vol. xi. p. 213.) The analyzed varieties are the following: 1. Noble serpentine from Skyttmine, near Fahlun; 2. radiated picrolite from the Taberg; 3. yellow translucent serpentine from Sjömine, in Svärdsjö; 4. common serpentine from Sala; 5. green radiated serpentine from Massachusets; 6. marmalite from Hoboken, in North America; 7. pale yellow, and in thin splinters, transparent serpentine from Hvittis, in Finland; 8. yellow and translucent serpentine from Aven, in Norbergs parish; 9. a pale yellow translucent mineral, called serpentine from Aker.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Water,	11.68	12.86	11.29	12.33	11.42	13.80	12.15	12.93	7.33
Silica,	41.95	40.98	41.58	42.16	43.20	41.67	42.01	41.66	35.28
Magnesia,	40.64	33.44	42.41	42.26	40,09	41.25	38.14	40.64	35.35
Lime,	—	—	...	—	—	—	3.22	0.31	—
Alumina,	0.37	0.73	...	—	—	—	—	0.70	13.73
Protoxide of iron,	2.22	8.72	2.17	1.98	5.24	1.64	1.30	2.11	1.79
——— cerium,	—	—	—	—	—	—	2.24	1.25	—
——— manganese,	—	—	—	—	—	—	...	—	—
Carbonic acid and bitumen.	3.42	1.73	2.38	1.03	—	1.37	0.19	0.13	6.28
	100.28	98.46	99.83	99.66	99.95	99.73	99.25	99.73	99.76

The corresponding formulæ are the following: For the variet. 1 — 6:

$\mathrm{Mg\,Aq^2} + 2 \left\{\begin{matrix}\mathrm{Mg} \\ f\end{matrix}\right\} \mathrm{S^2}$; for the var. 7 and 8: $\mathrm{Mg\,Aq^2} + 2 \left\{\begin{matrix}\mathrm{Mg} \\ \mathrm{C} \\ \mathrm{ce} \\ f\end{matrix}\right\} \mathrm{S^2}$;

for the var. $9 : 2 \left(\begin{matrix} Mg \\ f \end{matrix}\right) S + \ddot{A}S + Aq, \dot{M}g\ \ddot{C}^2$.

16. *Analysis of Glauber Salt.*—From Muhlingen on the Reuss in Switzerland, according to Dr Frey of Aarau :

Dry sulphate of soda,	44.4425
Hydrochlorate of soda,	0.1004
Water,	55.4571

V. Leonhard's *Mineralogische Zeitschrift*, October 1827.

17. *Cadmium.*—Cadmium is found, according to Mr Kersten, in Freiberg, in a black variety of blende from the mine Alte Mordgrube, near Freiberg.

18. *Analysis of Mica, Chlorite, and Talc, with one Axis of Double Refraction.* By Professor Von Kobell.—Professor Von Kobell of Munich (Kastner's *Archiv.* vol. xii. p. 29, &c.) has published a paper on *mica, chlorite,* and *talc,* with one axis of double refraction. The composition No. 1, is that of a mica from Monroe, in New York, which occurs in tables of blackish-green colour, and with a specific grammer = 2.78; No. 2, of a greenish-black mica, with 2.92 sp. gr. from Karosulik, in Greenland; No. 3, of a chlorite, which occurs in six-sided pyramids, with the angle in the edges of the axis = 128°, and with 2.65 sp. gr. at Achmatof, in Siberia; No. 4, of a chlorite, with 2.85 sp. gr. from the Filler-valley, in Tyrol, are the following :—

	No. 1.	No. 2.	No. 3.	No. 4.
Silica,	40.00	41.00	31.25	26.51
Alumina,	16.16	16.88	18.72	21.81
Oxide of iron,	7.50	4.50	—	—
Magnesia,	21.54	18.86	32.08	22.83
Potassa,	10.83	8.76	—	—
Oxide of titanium,	0.20	—	—	—
Fluoric acid,	0.53	...	—	—
Water,	3.00	4.30	12.63	12.00
Protoxide of iron,	—	5.05	5.10	15.00
	99.76	99.35	99.78	98.15

The corresponding formula for the analysis No 1 is $\left.\begin{matrix} A \\ F \end{matrix}\right\} S + \left.\begin{matrix} M \\ K \end{matrix}\right\} S$; for the analysis No. 2, $\left.\begin{matrix} A \\ F \end{matrix}\right\} S + \left.\begin{matrix} M \\ K \\ f \end{matrix}\right\} S$; for the analysis No. 4, $\left.\begin{matrix} M \\ F \end{matrix}\right\} \begin{matrix} A^2 \\ S^2 \end{matrix}$ + 6 Aq.

19. *Professor Erdmann's New Chemical Journal.*—Professor Otto Linné Erdmann of Leipsic, has published since the beginning of this year, with the assistance of other chemists, a "*Journal of Technical and Economical Chemistry,*" in monthly numbers.

20. *On a new method of preparing Chromic Acid.* By M. Arnold Maus. (Poggendorff's *Annalen,* xi. 83.)—This method consists in decomposing a hot concentrated solution of the bichromate of potash by silicated

fluoric acid. The chromic acid, after being separated from the sparingly soluble fluo-silicate of potash by filtration, is evaporated to dryness in a platinum capsule, and then redissolved in the smallest possible quantity of water. By this means the last portions of fluo-silicate of potash are rendered insoluble, and the pure chromic acid is then separated by decantation. The acid must not be filtered in this concentrated state, as it then corrodes the paper like sulphuric acid, and is converted into the chromate of the green oxide of chromium. When it is wished to prepare a large quantity of chromic acid by this process, porcelain vessels may be safely employed in the first part of the operation, provided care is taken to add a quantity of silicated fluoric acid, not quite sufficient for precipitating the whole of the potash. When the evaporation has proceeded so far that the liquid may be conveniently contained in a vessel of platinum, the silicated fluoric acid is added in excess.

M. Maus recommends, that in preparing the silicated fluoric acid the usual materials should be placed in a capacious retort, the beak of which descends into a large receiver with a long neck, without any luting. At the bottom of the receiver is placed water for absorbing the fluo-silicic gas, and its sides and neck are likewise moistened. On issuing from the retort, the gas descends like a cloud upon the surface of the water beneath, where the greater part of it is dissolved; and any portions which escape are absorbed by the moisture on the sides of the vessel. By operating in this manner very little gas escapes into the air, and at the same time, as the beak of the retort does not touch the water, there is no chance of the aperture being closed by the separation of gelatinous silica.

21. *On the detection of potash by the blowpipe, by means of the oxide of Nickel.* By M. E. Harkort.—In the ninth volume of Poggendorff's *Annalen der Physik und Chemie*, M. E. Harkort of Freyberg has described a method of detecting the presence of potash in salts or minerals by means of the blowpipe, and Berzelius recommends the method as decisive. The remarks on the subject which Berzelius proposes introducing into the next edition of his Treatise on the use of the Blowpipe are the following: (*Poggendorff*, xi. 333.) "I have found Harkort's method of detecting potash to be wonderfully delicate. It is only necessary to dissolve oxide of nickel in glass of borax, and then to add a little saltpetre, felspar, or any substance containing potash, in order to procure immediately a very distinct blue glass, even when a small quantity of the alkali is present. The presence of soda does not prevent this appearance."

"Of the preparations of nickel, either the nitrate or oxalate may be employed. The latter is easily procured in a solid state, and on that account is preferable for many experiments; but the former is more convenient for detecting potash in solution. It is essential to employ a salt or oxide of nickel which is free from cobalt,—a fact easily ascertained, by the pure nickel forming not a bluish, but a brown glass with borax. The blue colour which the oxide of nickel forms with potash is different from that produced by cobalt, and has the same purplish tint as the ammoniacal solution of the oxide of nickel by candle-light.

22. *On Aluminium and some of its Compounds.*—By Dr Wöhler. (Poggendorff's *Annalen*, xi. 146.)—Some years ago, Professor Oersted succeeded in forming a volatile compound of chlorine and aluminium, by transmitting dry chlorine gas over a mixture of alumina and charcoal heated to redness. By acting on this chloride with an amalgame of potassium, he procured an amalgame of aluminium, from which, by the aid of heat, the mercury was expelled, and there remained a metallic mass of the colour and lustre of tin, and supposed to be aluminium. On repeating these experiments at the request of Professor Oersted, Dr Wöhler failed in procuring aluminium, the metallic mass which remained after the separation of the mercury proving to be potassium; but by another process of his own contrivance he was so fortunate as to procure aluminium in a pure state.

23. *Chloride of Aluminium.*—To prepare this compound, from which the aluminium is procured, Dr Wöhler precipitated the aluminous earth from a hot solution of alum by carbonate of potash in excess, washed the precipitate on a filter, and dried it. From the mode of preparation, the hydrate of alumina contained a little potash in combination, but its presence does not interfere with the success of the process. The hydrate was mixed with charcoal in powder, sugar, and oil, so as to form a thick paste, and was then heated in a covered crucible until all the organic matter was destroyed. By this means the alumina was brought into a state of intimate mixture with finely divided charcoal, and in this state was placed, while yet hot, in a tube of porcelain, which was fixed in a convenient furnace. After expelling the air within the apparatus by a current of dry chlorine, the tube was brought to a red heat. The formation of the chloride of aluminium then commenced, and continued, with disengagement of carbonic oxide gas, during an hour and a half, when the interior of the porcelain tube became impervious from the sublimed chloride of aluminium collected within it, so that the process was necessarily discontinued.

On taking down the apparatus a large quantity of the chloride was obtained, of a pale greenish-yellow tint, partially translucent, and of a highly crystalline lamellated texture, somewhat like talc; but no regular crystals could be detected. On exposure to the air it fumed slightly, emitted an odour of muriatic acid gas, and soon deliquesced, yielding a clear liquid. When thrown into water it is speedily dissolved with a hissing noise; and so much heat is evolved that the water, if in small quantity, is brought into a state of brisk ebullition. The solution is the common muriate of alumina, obviously formed at the expence of the water. According to Oersted it is volatile at a point little higher than 212°, and its point of liquefaction is nearly at the same degree.

Sulphuretted hydrogen has a remarkable action on the chloride of aluminium, forming with it a compound which contains sulphur, hydrogen, chlorine, and aluminium, though it is not known in what manner these elements are combined. The substance was procured by subliming the chloride of aluminium in a small retort, through which a rapid current of dry sulphuretted hydrogen gas was transmitted; and the excess of this gas was afterwards displaced by dry and pure hydrogen. At common temperatures the chloride of aluminium does not act on sulphuretted hydrogen but at the subliming point of the former the new compound is formed, and collects in the neck of the retort. It is found partly in very white, transparent, crystalline scales of a mother-of-pearl lustre, and partly as a white, fused, brittle mass. It absorbs moisture rapidly from the air, and at the same time emits a strong odour of sulphuretted hydrogen. Heated in a glass tube, it is sublimed, but also undergoes partial decomposition, emitting from thirty to forty times its volume of sulphuretted hydrogen gas. From this circumstance it is obvious that the compound contains hydrogen as well as sulphur.

When thrown into water it is decomposed with the same violence as the chloride of aluminium; but a large quantity of sulphuretted hydrogen is set free, and the solution is rendered turbid by separation of sulphur. By performing this experiment in a glass tube over mercury, it was found that no other gas but sulphuretted hydrogen is disengaged. By the action of pure ammonia in water, alumina is precipitated, and a solution of the muriate and hydrosulphuret of ammonia generated.

24. *Metallic Aluminium.*—The preparation of this metal depends on the decomposition of the chloride of aluminium by potassium, and on the property of aluminium of not being oxidized by the action of cold water. Potassium acts on the chloride of aluminium by aid of a moderate elevation of temperature; but the action is so violent, attended with disengagement of intense heat and light, that a small quantity of the materials is destructive to tubes of glass. Dr Wöhler succeeded in conducting the decomposition in a platinum crucible, retaining the cover in its place by a piece of wire. The heat emitted at the moment of the reduction was such that the crucible, though but gently heated externally, became suddenly red-hot from the caloric evolved during the change. The platinum is scarcely attacked during the process; but to prevent the possibility of error from this source, the reduction was effected in a crucible of porcelain. The potassium employed for the purpose should be quite free from carbon; and the largest quantity operated on at a time was about the size of ten peas. The heat was applied by means of a spirit-lamp, and continued until the decomposition was effected. The proportion of the materials should be carefully arranged. The potassium should be in such quantity as to prevent any of the chloride of aluminium from subliming during the decomposition, but at the same time not so great as to render the reduced mass alkaline. The matter contained in the crucible at the close of the operation is in general completely fused, and of a dark-gray colour. When *quite cold*, the crucible is put into a large glass full of water, in which the saline mass is dissolved, with slight disengagement of hydrogen, of an offensive odour; and a gray powder separates, which, on close inspection, especially in sunshine, is found to consist solely of minute scales of metal. After being well washed with *cold* water, it is pure aluminium. The solution is neutral, and contains a quantity of alumina, owing to a combination being formed between chloride of potassium and chloride of aluminium.

The aluminium, as thus formed, is a gray powder, very similar to the powder of platinum. It is generally in small scales or spangles of a metallic lustre, and on some occasions small, slightly coherent, spongy masses were observed, which in some places had a tin-white metallic lustre. The same appearance was rendered perfectly distinct by pressure on steel, or in an agate mortar. The metallic aspect is therefore complete, and in this respect aluminium differs from silicium. In its fused state it is a conductor of electricity, but it does not possess this property in the form of powder. Dr Wöhler remarks, that metallic iron in the form of fine powder is a non-conductor of electricity, and that, therefore, the conducting power of metals is connected with their form.

Aluminium requires for fusion a temperature above that at which cast-iron is liquefied. When heated to redness in the air, it takes fire and burns with vivid light, yielding aluminous earth, considerably hard, and of a white colour. Sprinkled in powder in the flame of a candle, brilliant sparks are emitted like those given off during the combustion of iron in oxygen gas. When heated to redness in a vessel of pure oxygen, it burns with an exceedingly vivid light, and emission of intense heat. The resulting alumina is partially vitrified, of a yellowish colour, and equal in hardness to the native crystallized aluminous earth, the corundum. It not only scratches glass but even cuts it. It was remarked that the inner surface of the glass in contact with the aluminium during its combustion was half melted and brown, an appearance which Dr Wöhler ascribes to the reduction of silicium. Heated to near redness in an atmosphere of chlorine it takes fire, and the chloride of aluminium is sublimed.

Aluminium is not oxidized by water at common temperatures, nor is its lustre tarnished by lying in water during its evaporation. On heating the water to near its boiling point, oxidation of the metals commences, with feeble disengagement of hydrogen gas, which continues even long after cooling, but at length wholly ceases. The oxidation, however, is very slow by this means, and even after continued ebullition the smallest particles of aluminium appear to have suffered scarcely any change.

Aluminium is not attacked by concentrated sulphuric or nitric acid at common temperatures. In the former, by the aid of heat, it is rapidly dissolved with disengagement of sulphurous acid gas. In dilute muriatic and sulphuric acid, it is dissolved with evolution of hydrogen gas. In order to prove that the aluminium was free from potassium, the solution in sulphuric acid was slowly evaporated, but no trace of alum appeared.

Aluminium is easily and completely dissolved even by a dilute solution of potash with disengagement of hydrogen. Even ammonia dissolves the metal with evolution of hydrogen gas; and it is remarkable what a large quantity of alumina is held in solution under these circumstances.

III. NATURAL HISTORY.

MINERALOGY.

25. *Datholite or Prismatic Dystome Spar.*—Mr Bauersachs, lecturer on mineralogy in the Royal Mining-School of Clausthal, in the Harz, has found this mineral in the Waschgrund Valley, near St Andreasberg, in

veins in the greenstone, which contains in other countries of the Harz mountain axinite, which through the boracic acid is allied to the datholite.

Professors Hausmann and Stromeyer of Gottingen have examined the datholite from Andreasberg. (*Gottinger gelehrte Anzeigen*, 1828, No. 9.) It occurs in beautiful aggregated crystals, like Figs. 67 and 68 of the second volume of Moh's *Treatise on Mineralogy*, from half an inch in diameter, and massive with granular composition. The surface of most of the faces is even, the lustre vitreous, the colour white, inclining to green and red. The crystals are translucent. The specific gravity found by Professor Stromeyer of this and a variety from Arendal, in Norway, is = 3.3541, and therefore they differ from other crystals. According to Stromeyer, the datholite from Andreasberg consists of

Lime,	35.67	Boracic acid,	21.26
Silica,	37.36	Water,	5.71

From Professor Hausmann's "*Treatise on Mineralogy*."—A second edition of this valuable work is in the press, and will appear in the course of this year. The first edition appeared in the year 1813.

26. *Protherite.*—According to Professor Breithaupt of Freiberg the *protherite* of the Count Razumoosky, in Petersburgh, (Férussac, *Bulletin des Sciences Natur.* 1827, No. 5, p. 42,) is a variety of the paratomous augite-spar or augite.

27. *Diatomous Schiller Spar.*—The *diatomous*, or common *schiller spar*, from the Baste, near Harzburgh, in the Harz mountain, a mineral little known, has been examined with great exactness by Dr Köhler of Cassel. (Poggendorff's *Annalen der Ph. u. Chem.* vol. xi. p. 192, &c.) The mineral has a cleavage in two directions, with different distinctness. The one of them called P being highly perfect, and easily obtained, has a great extension, while the other, M, appears only in slight traces. The inclination between M and P is 130°, measured with the common goniometer of Haüy. The perfect faces of cleavage P have an eminent metallic pearly lustre, the others, M, a silky glimmer, and are striated. The colour upon P is deep leek-green, and in the light, brass-yellow or bluish-green. The directions in which these change of colours appear are constant in connection with the crystalline structure. The German name schillerspath or schillerstein is derived from this property. In the fracture the mineral is dull, or a little glimmering; in thin laminæ translucent. The hardness is = 3.5. The spec. gr. = 2.652.

Dr Kohler has marked the analysis of the mineral 1, with carbonate of potassium, and 2, with fluoric acid. The results are the following:

	1.	2.
Silica,	43.900	42.608
Magnesia,	25.856	26.151
Protoxide of iron,	13.021	10.915
Protoxide of manganese,	0.535	0.571
Lime,	2.642	2.750
Water,	12.426	12.426

The corresponding formula is $M\ Aq^4 + 4 \left\{\begin{matrix} M \\ f \\ C \end{matrix}\right\} S^2$

Before the blowpipe it becomes pinchbeck-brown, and the glance metallic. The thin laminæ are attracted by the magnet.

Commonly the schiller spar is found alone, more rarely in regular composition with paratomous augite spar, like this mineral and the hemiprismatic augite spar in the smaragdite. It is imbedded in foliated masses in a serpentine like mineral, which contains, according to an analysis of Dr Kohler,

Silica,	42.364	Alumina,	2.176
Magnesia,	28.903	Protoxide of manganese,	0.853
Protoxide of iron, (with a little chrome)	13.268	Water,	12.071
Lime,	0.627		

These constituent parts correspond very well with that of the schiller spar; and therefore the opinion of Breithaupt, (see Hoffmann's *Handbuch der Mineralogie*, vol. ii. p. 264,) that the matrix of the mineral is a compact variety of schiller spar, or which we may call schiller stone, is correct.

Art. XXVIII.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE MARCH 10, 1828.

10. March 10. For certain Improvements in Machinery for Propelling Vessels, which Improvements are applicable to other purposes. To Paul Steenstrup, Esq, city of London.

11. March 19. For certain Improvements on Power Looms for the weaving of Silk, Cotton, Linen, Wool, Flax, and Hemp, and all Mixtures thereof. To John Harvey Sadler, county of Middlesex.

12. March 25. For Improvements in making Healds for Weaving purposes. To William Pownall, county of Lancaster.

13. March 25. For Improvement in the Manufacture of Buttons and in the Machinery or Apparatus for manufacturing the same. To Thomas Tyndall, county of Warwick.

14. March 25. For a New or Improved method or methods of propelling Vessels through or on the water by the aid of Steam or other Means or Power, and which may also be applied to other purposes. To John Lee Stevens of Plymouth.

15. April 3. For certain Improvements in Machinery for the Manufacture of Bobbin Net Lace. To John Levers of Nottingham.

16. May 6. For certain Improvements in making Iron or in the method or methods of Smelting and making of Iron. To Thomas Botfield, county of Salop.

17. May 19. For certain Improved Machinery for Breaking or Preparing Hemp, Flax, and other Fibrous Materials which he denominates "the Rural Mechanical Brake." To Count de la Parde, county of Middlesex.

18. May 19. For certain Improvements in the Construction and Fastening of made Masts. To Thomas Hillman, county of Middlesex.

19. May 19. For certain Improvements in Cutting Paper. To Edward Cowper, county of Surrey.

Art. XXIX.—CELESTIAL PHENOMENA,

From July 1st, to October 1st, 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.

JULY.

D.	H.	M.	S.	
1				♃ Stationary near λ ♍
3	18	1		☾ Last Quarter.
6				♀ Stationary.
7	20	12	22	☽ ☌ 1 δ ♉ ☽ 37′ N.
7	20	44	56	☽ ☌ 2 δ ♉ ☽ 44′ N.
11				☿ Stationary.
11	13	20		● New Moon.
13	7	41	21	☽ ☌ 1 α ♋ ☽ 47′ N.
13	8	59	14	☽ ☌ 2 α ♋ ☽ 24′ N.
13	12			☽ ☌ ♀
16	2			♄ ☌ ☉
16	9	32	40	Imm. I. Sat. ♃
16	18			♀ ☌ 2 α ♋
17	10	11	32	Em. III. Sat. ♃
18	4			♀ ☌ 1 α ♋
19	16	3		☽ First Quarter.
20	5	2	12	☽ ☌ λ ♍ ☽ 42′ N.
20	6			☽ ☌ ♃
22	11			☉ enters ♌
22	19	15		H ☍ ☉
24	6	30		☿ Inf. ☌ ☉
26	7	5	54	☽ ☌ β ♑ ☽ 19′ N.
26	10	19		○ Full Moon.
27	20			♀ Inf. ☌ ☉
28	7	15		♃ □ ☉

AUGUST.

D.	H.	M.	S.	
2	3	38		☾ Last Quarter.
3				☿ Stationary.
3				♂ Stationary.
4	1	49	35	☽ ☌ 1 δ ♉ ☽ 24′ N.
4	2	22	7	☽ ☌ 2 δ ♉ ☽ 32′ N.
6	8	50	47	Em. I. Sat. ♃
9	13	37	54	☽ ☌ 1 α ♋ ☽ 48′ N.
9	14	55	39	☽ ☌ 2 α ♋ ☽ 25′ N.
10	4	42		● New Moon.
12				☿ Greatest Elong.
13	1	50	13	☽ ☌ ν ♌ ☽ 50′ N.
16	15			♀ ☌ δ ♋
16	17			☽ ☌ ♃
18				☿ Stationary.
18	2	46		☽ First Quarter.
22	17	36		☉ enters ♍
22	17	48	56	☽ ☌ β ♑ ☽ 22′ N.
24	8	3	3	Em. I. Sat. ♃
24	17	28		○ Full Moon.
28	9	57	17	☽ ☌ ο ♓ ☽ 55′ N.
28	10			☿ ☌ α ♌
31	16	38		☾ Last Quarter.

SEPTEMBER.

D.	H.	M.	S.	
5	3			☽ ☌ ♀
5	20	1	10	☽ ☌ 1 α ♋ ☽ 44′ N.
5	21	18	54	☽ ☌ 2 α ♋ ☽ 21′ N.
6	3	15		☿ Sup. ☌ ☉
6	4			♂ ☌ σ ♐
7	11			☿ ☌ σ ♌
7	5	13	51	☽ ☌ π ♌ ☽ 4′ S.
8	20	33		● New Moon.
11	21			☿ ☌ β ♍
12	14			♂ ☌ τ ♐
13	6			☽ ☌ ♃
14	2	59	12	☽ ☌ 4 ζ ♎ ☽ 48′ N.
14	12	15	48	☽ ☌ θ ♎ ☽ 4′ S.
16	11	26		☽ First Quarter.
16	13			☿ ☌ ν ♍
17	0			♂ ☌ ψ ♐
18	3			♃ ☌ 2 α ♎
19	3	2	11	☽ ☌ β ♍ ☽ 28′ N.
22	14	20		☉ enters ♎
23	2	12		○ Full Moon.
27	9			♀ ☌ ξ ♌
27	17	50	40	☽ ☌ 2 δ ♉ ☽ 12′ N.
30	9	7		☾ Last Quarter.

Times of the Planets passing the Meridian.

JULY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	h.	′	h	′	h	′	h	′	h	′	h	′
1	1	46	2	18	11	57	7	28	0	53	13	30
7	1	31	1	54	11	24	7	3	0	32	13	5
13	1	6	1	25	10	53	6	39	0	4	12	40
19	0	31	0	50	10	22	6	16	23	47	12	14
25	23	44	0	12	9	54	5	54	23	26	11	49

AUGUST.

D.	h.	′	h	′	h	′	h	′	h	′	h	′
1	23	5	23	21	9	25	5	29	23	2	11	21
7	22	46	22	46	9	2	5	8	22	43	10	57
13	22	45	22	16	8	42	4	48	22	23	10	33
19	22	59	21	53	8	24	4	28	22	4	10	10
25	23	21	21	35	8	8	4	9	21	45	9	46

SEPTEMBER.

1	23	48	21	21	7	53	3	48	21	23	9	21
7	0	6	21	13		41	3	30	21	4	8	59
13	0	24	21	8		31	3	12	20	45	8	37
19	0	39	21	6	7	22	2	55	20	25	8	44
25	0	52	21	5	7	13	2	38	20	6	7	52

Declination of the Planets.

JULY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	°	′	°	′	°	′	°	′	°	′	°	′
1	18	30 N.	16	10N.	28	5 S.	11	55 S.	21	43N.	20	30 S.
7	16	24	14	51	28	28	11	58	21	36	20	33
13	14	56	13	47	28	44	12	2	21	28	20	36
19	14	28	13	2	28	52	12	9	21	21	20	39
25	15	5	12	41	28	54	12	18	21	13	20	42
					AUGUST.							
1	16	44	12	42	28	49	12	30	21	4	20	46
7	18	11	13	0	28	41	12	43	20	56	20	49
13	18	54	13	28	28	30	12	57	20	47	20	52
19	18	17	13	59	28	17	13	13	20	39	20	54
25	16	2	14	26	28	0	13	30	20	31	20	56
					SEPTEMBER.							
1	11	41	14	48	27	38	13	51	20	22	20	59
7	7	11	14	53	27	14	14	10	20	14	21	1
13	2	28	14	44	26	47	14	30	20	7	21	2
19	2	12 S.	14	18	26	14	14	50	20	0	21	3
25	6	39	13	35	25	37	15	11	19	54	21	4

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a celestial globe, and to determine their times of risings and settings.

ART. XXX.—*Summary of Meteorological Observations made at Kendal in December* 1827, *and in January, February, March, April, and May* 1828. By Mr SAMUEL MARSHALL. Communicated by the Author in a Letter to the EDITOR.

State of the Barometer, Thermometer, &c. in Kendal for December 1827.

		Inches.
	Barometer.	
Maximum on the 28th,	- - -	30.46
Minimum on the 1st,	- - -	28.57
Mean height,	- - -	29.47
	Thermometer.	
Maximum on the 5th,	- - -	54°
Minimum on the 30th,	- - -	24°
Mean Height,	- - - -	42.53°

Quantity of rain in inches 10.365.
Number of rainy days, 23.
Prevalent wind, south-west.

This has been by much the wettest month in the year. In four days, the 1st, 8th, 14th, and 18th, 4.455 inches of rain fell. During the greater part of the month we have had several atmospherical phenomena. Hail has often fallen in heavy showers. Lightning was frequent about the middle of the month; and on the 20th we had a very heavy thunder storm about noon. The Aurora Borealis appeared towards the latter part of the month, in the evenings; and on the evening of the 27th a luminous arch appeared in the heavens, stretching from the magnetic east through the zenith to the magnetic west. The barometer and thermometer have been very fluctuating, but we had no frost till the night of the 27th, which lasted about three days. The thermometer fell from 45° to 28° in the night of the 27th, after the occurrence of the luminous arch mentioned above, before the appearance of which the moon was encircled with a distinct halo.

January 1828.

Barometer.	Inches.
Maximum on the 28th,	30.17
Minimum on the 13th,	28.98
Mean height,	29.67
Thermometer.	
Maximum on the 19th and 20th,	50°
Minimum on the 11th,	23°
Mean height,	39.17

Quantity of rain, 6.192 inches.
Number of rainy days, 17.
Prevalent wind, south-west.

From the 5th to the 18th the weather was generally severe; the wind E. and N. E. acompanied with snow, sleet, &c. On the 11th we had a heavy fall of snow; wind N. E.; but it was quickly succeeded by a thaw, the wind remaining in the same quarter. On the 16th and 17th tremendous storms of wind, particularly in the nights. The rest of the month has been surprisingly mild for the season of the year, the nights and days since the 19th having been nearly of the same temperature, and the mean has been since that date 44.61°,—a degree of warmth very unusual in this month, and which is promoting vegetation to a surprising degree.

February.

Barometer.	Inches.
Maximum on the 3d,	30.18
Minimum on the 21st,	28.89
Mean height,	29.57
Thermometer.	
Maximum on the 28th,	54°
Minimum on the 12th and 16th,	23°
Mean height,	38.93°

Quantity of rain, 4.625 inches.
Number of rainy days, 15.
Prevalent wind, south-west.

In different parts of this month we have had great variations of temperature; some parts being extremely mild for the season of the year, which is evident from the forwardness of vegetation, the fields looking green, and the early trees having burst into leaf. Rain fell almost incessantly the first nine days of this month. Several days of stormy weather succeeded, and the snow on the 14th had fallen ten inches deep, and was so much drifted as to impede the progress of travellers. A gentle thaw succeeded, and the last ten days of the month were extremely mild, the thermometer on the 28th being at 54°. On the 16th there fell 1.277 inch of rain. The barometer has been generally low.

March.

Barometer.	Inches.
Maximum on the 15th,	30.12
Minimum on the 21st,	28.75
Mean height,	29.69
Thermometer.	
Maximum on the 1st,	56°
Minimum on the 7th,	25°
Mean height,	42.09°

Quantity of rain, 2.440 inches.
Number of rainy days, 18.
Prevalent wind, west.

Though we have had eighteen days in this month on which rain has fallen, the quantity for the month is but trifling. On some of these days the quantity has been very small. The barometer has experienced considerable fluctuations; and the temperature for this month has proved, like its two predecessors, higher than usual at this season. The prevalent winds towards the middle of the month were generally W. and S. W. and since the 24th, have been generally N. and E. On the night of the 18th, the wind was high, and was the first which this season indicated the prevalence of the equinoctial gales.

April.

Barometer.	Inches.
Maximum on the 30th,	30.14
Minimum on the 10th,	29.08
Mean height,	29.54
Thermometer.	
Maximum on the 28th and 30th,	58°
Minimum on the 3d,	28°
Mean height,	45.45°

Quantity of rain, 4.012 inches.
Number of rainy days, 21.
Prevalent wind, west.

Since the 4th of the month, we have had but five days on which rain has not fallen, and yet the quantity is not very considerable, when it is recollected that but 4.012 inches have fallen in twenty-one days, or 190 inch each day on an average for that time, the greatest quantity on any one day was 472 inch, except on the 28th, when 1.032 inch was taken. The winds from the N. E. have prevailed since about the middle of the month, with some variations. The most prevalent through the month has been west. The barometer has attained but a low elevation, and though the average temperature is considerable, the air has at times been cold, as is always the case when the wind is in the E. and N. E. There was a little snow on the 6th, which disappeared in the course of the day; and a hail shower on the evening of the 24th. The swallow was seen this season for the first time by the writer on the 13th.

May.

Barometer.	Inches.
Maximum on the 1st,	30.17
Minimum on the 25th,	29.29
Mean height,	29.69
Thermometer.	
Maximum on the 28th,	68°
Minimum on the 1st,	35°
Mean height,	53.12°

Quantity of rain, 1.961 inch.
Number of rainy days, 10.
Prevalent wind, west.

Though the prevalent wind is stated as west, it must be understood with this limitation, as applying to the day-time. From the beginning to the latter part of the month, in whatever direction the wind blew during the day, in the evenings and mornings it was almost uniformly N. E. and E. and it is probable that this was the prevailing wind through the nights. The dryness of these winds is proverbial, and their effects on delicate constitutions well-known. On the evening of the 27th we had an appalling thunder storm. This did not cool the air, which had previously been sultry, so much as might have been expected, nor was the barometer affected during its continuance. Indications of a change in the weather on the 23d and 24th. Among these were whirls of dust, and a remarkable one occurred on the evening of the 23d by the side of the river Kent, and in the town. The dust of the road was raised in a dense column, which was estimated by different observers to be from 50 to 100 yards in height, and at least 5 yards in diameter. The top of the column being the broadest part, it appeared like an inverted cone. It was raised by a gyratory motion in the air, whilst round the column no agitation was perceptible, though several persons who were passing at the time stood within a few feet distance. After continuing about two minutes, it crossed the river, and then proceeded about 200 yards in an easterly direction, raising and dispersing the dust which it met with on the ground. In a few minutes after the same appearance was repeated, though not in so distinct a column, and originating within a few yards of the former. The latter whirlwind passing over a coal wharf, raised the coal dust in a dense black column to the height of about 40 feet.

ART. XXXI.—*Abstract of the Register of the Thermometer, Barometer, and Rain-gage for the years 1826 and 1827, kept at Canaan Cottage.* By ALEXANDER ADIE, Esq. F. R. S. Edin. Communicated by the Author.

ABSTRACT OF REGISTER FOR 1826.

Months.	Thermometer.		Register Ther.		Barometer.		Rain.
	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	
January,	1065	34.35	1029	33.19	923.525	29.787	.55
February,	1192	42.58	1169	41.75	824.06	29.431	1.77
March,	1277.5	41.21	1497	41.84	921.72	29.732	1.33
April,	1382	46.07	1403	46.77	889.37	29.646	1.52
May,	1562.5	50.4	1605.5	51.79	927.54	29.920	1.25
June,	1895.5	63.18	1838.5	61.28	901.93	30.064	.30
July,	1927.5	62.18	1921.5	61.98	921.555	29.726	2.31
August,	1871.5	60.37	1890.5	60.98	920 25	29.686	1.83
September,	1633	54.43	1639	54.63	891.185	29.706	1.01
October,	1529	49.32	1547.5	49.90	916.24	29.556	1.38
November,	1175	39.16	1162.5	38.75	887.49	29.583	.76
December,	1302	42	1273	41.06	915.96	29.546	1.26
Annual Sum,	17812.5		17776		10840.825		15.27
Annual Mean,		48.801		48.701		29.701	

Greatest degree of heat, June 24th and 26th, 87°
——————— cold, January 16th, - 10°
Greatest range of thermometer, - - 77°
Highest barometer, March 12th, - - 30.46
Lowest ditto, November 24th, - 28.48
Greatest range of ditto, - - - 1.98

ABSTRACT OF REGISTER FOR 1827.

Months.	Thermometer.		Register Ther.		Barometer.		Rain.
	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	
January,	1120.5	36.15	1098	35.42	914.64	29.504	3.33
February,	970.5	34.66	951.5	33.98	836.80	29.886	1.58
March,	1237.5	39.92	1242	40.06	905.94	29.223	4.84
April,	1356	45.20	1351.5	45.05	891.13	29.704	2.74
May,	1571.5	50.69	1574	50.77	914.085	29.487	1.28
June,	1671	55.7	1684.5	56.15	889.14	29.638	1.62
July,	1842	59.42	1812	58.45	923.71	29.797	2.27
August,	1742	56.20	1712.5	55.24	925.78	29.865	4.89
September,	1666.5	55.55	1649.5	54.98	891.74	29.724	1.15
October,	1574	50.77	1554	50.13	915.98	29.547	4.97
November,	1306.5	43.55	1284	42.80	889.685	29.656	1.02
December,	1333.5	43.02	1309.5	42.24	909.075	29.328	2.90
Annual Sum,	17391.5		17223		10807.705		32.59
Annual Mean,		47.647		47.186		29.61	

Greatest degree of heat, July 16th, - 77°
——————— of cold, January 3d, - 14
Greatest range of thermometer, - - 63
Highest barometer, February 9th, - 30.43
Lowest ditto, March 6th, - - 28.28
Greatest range of ditto, - - 2.15

ART. XXXII.—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 1828.

D. of Week.	Day of Month.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
S.	1	50	43	46.5	42	54	48	30.00	29.92	
S.	2	46	46	46	36	54	45	29.93	29.84	
M	3	50	42	46	38	51	44.5	29.73	29.72	
T.	4	47	38	42.5	37	51	44	29.58	29.38	
W.	5	36	28	32	31	38	34.5	29.55	29.71	
T.	6	34	31	32.5	26	37	31.5	29.85	29.86	
F.	7	41	49	45	29	47	38	29.66	29.55	
S.	8	51	49	50	47	55	51	29.71	29.77	
S.	9	51	50	50.5	47	55	51	29.70	29.61	
M.	10	48	41	44.5	39	52	45.5	29.81	29.82	
T.	11	48	45	46.5	39	52	45.5	29.90	29.82	
W.	12	48	49	48.5	39	51	45	29.67	29.64	
T.	13	55	50	52.5	48	58	53	29.68	29.82	
F.	14	54	45	49.5	47	57	52	29.93	30.07	
S.	15	50	49	49.5	42	57	49.5	29.97	29.96	.15
S.	16	50	50	50	43	54	48.5	29.94	29.83	.10
M.	17	51	43	47	43	58	50.5	29.78	29.82	.09
T.	18	48	45	46.5	38	52	45	29.76	28.70	
W.	19	46	38	42	42	50	46	28.92	29.05	
T.	20	44	35	39.5	37	49	43	28.75	29.82	.55
F.	21	44	34	39	32	46	39	28.48	28.62	
S.	22	40	36	38	30	43	36.5	28.67	28.82	.11
S.	23	40	35	37.5	30	48	39	29.12	29.39	
M.	24	41	38	39.5	31	44	37.5	29.56	29.66	
T.	25	42	34	38	31	47	39	29.66	29.67	
W.	26	41	34	37.5	30	45	37.5	29.95	29.58	.02
T.	27	40	35	37.5	30	43	36.5	29.47	29.50	.11
F.	28	39	36	37.5	32	41	36.5	29.46	29.60	.02
S.	29	42	36	39	31	44	37.5	29.67	29.75	
S.	30	44	41	42.5	28	48	38	29.82	29.94	.05
M.	31	44	39	41.5	31	48	41	30.05	30.08	
	Sum,	1405	1264	1334.5	1129	1529	1329	917.73	918.50	1.18
	Mean,	45.32	40.77	43.05	36.42	49.32	42.87	29.604	29.622	

APRIL 1828.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	49	38	43.5	34	51	42.5	29.88	29.91	
W.	2	45	36	40.5	32	46	39	29.93	30.05	
T.	3	42	36	39	32	48	40	29.89	29.78	
F.	4	41	38	39.5	32	47	39.5	29.78	29.56	
S.	5	42	34	38	37	49	43	29.46	29.37	.04
S.	6	38	34	36	32	47	39.5	29.38	29.25	
M.	7	40	34	37	26	55	40.5	29.25	29.20	
T.	8	42	40	41	27	49	38	29.05	29.16	
W.	9	47	42	44.5	38	49	43.5	29.14	28.95	
T.	10	50	43	46.5	38	55	46.5	28.98	29.10	.16
F.	11	52	45	48.5	40	54	47	29.23	29.18	
S.	12	52	49	50.5	41	61	51	29.28	29.26	.10
S.	13	48	45	46.5	44	61	52.5	29.02	29.08	
M.	14	50	45	47.5	41	56	48.5	29.34	29.46	
T.	15	53	47	50	37	56	46.5	29.35	29.05	.13
W.	16	53	41	47	41	57	49	29.16	29.05	
T.	17	44	41	42.5	37	57	47	29.23	29.37	.05
F.	18	43	43	43	39	47	43	29.42	29.56	
S.	19	43	43	43	42	46	44	29.71	29.85	
S.	20	44	40	42	42	47	44.5	29.95	29.92	.38
M.	21	44	38	41	37	49	43	29.84	29.62	.37
T.	22	43	41	42	37	43	40	29.46	29.44	
W.	23	49	44	46.5	41	53	47	29.42	29.40	
T.	24	48	40	44	40	55	47.5	29.35	29.34	.12
F.	25	50	41	45.5	37	53	45	29.29	29.23	.07
S.	26	50	44	47	37	55	46	29.50	29.79	
S.	27	53	52	52.5	38	42	40	29.84	29.68	
M.	28	61	52	56.5	49	64	56.5	29.77	29.98	
T.	29	61	43	52	50	65	57.5	29.78	30.00	
W.	30	52	44	48	37	62	49.5	30.12	30.13	
	Sum,	1429	1253	1341	1135	1579	1357	884.78	884.72	1.42
	Mean,	47.63	41.77	44.70	37.83	52.63	45.23	29.493	29.491	

MAY 1828.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	55	45	50	39	62	50.5	30.05	30.08	
F.	2	57	51	54	41	64	52.5	30.05	29.88	
S.	3	59	50	54.5	42	63	52.5	29.79	29.61	
S.	4	54	48	51	48	60	54	29.49	29.47	.30
M.	5	49	45	47	44	52	48	29.43	29.50	.30
T.	6	49	44	46.5	43	54	48.5	29.66	29.74	.02
W.	7	46	41	43.5	42	50	46	29.81	29.85	
T.	8	55	43	49	36	62	49	29.78	29.77	
F.	9	56	49	52.5	36	62	49	29.82	29.85	
S.	10	55	50	52.5	47	59	53	29.79	29.65	.10
S.	11	57	45	51	48	63	55.5	29.60	29.86	
M.	12	57	48	52.5	41	61	51	29.99	29.99	
T.	13	57	44	50.5	45	61	53	30.00	29.97	
W.	14	55	47	51	41	62	51.5	29.95	29.93	
T.	15	60	46	53	38	66	52	29.92	29.89	
F.	16	54	46	50	42	62	52	29.83	29.86	.05
S.	17	52	46	49	44	58	51	29.82	29.81	
S	18	58	42	50	39	63	51	29.77	29.79	
M.	19	52	45	48.5	36	56	46	29.78	29.75	
T.	20	48	46	47	38	53	45.5	29.70	29.57	
W.	21	50	45	47.5	46	50	48	29.50	29.50	
T.	22	49	46	47.5	43	53	48	29.50	29.48	
F.	23	56	47	51.5	41	59	50	29.42	29.39	
S.	24	48	46	47	41	51	46	29.38	29.15	.59
S.	25	56	54	55	45	61	53	29.19	29.42	
M.	26	64	53	58.5	49	65	57	29.52	29.44	.24
T.	27	56	49	52.5	49	60	54.5	29.34	29.39	.03
W.	28	58	53	55.5	47	60	53.5	29.32	29.28	.15
T.	29	57	51	54	49	60	54.5	29.30	29.45	
F.	30	60	54	57	48	62	55	29.58	29.40	
S.	31	64	55	59.5	49	65	57	29.38	29.45	.07
		1703	1474	1588.5	1337	1839	1588	919.54	919.17	1.85
		54.94	47.55	51.24	43.13	59.32	51.22	29.661	29.651	

THE

EDINBURGH

JOURNAL OF SCIENCE.

Art. I.—*Physical Notices of the Bay of Naples.* Communicated by the Author in a Letter to the Editor.

No. I.—*On Mount Vesuvius.*

"——— fractas ubi Vesbius egerit iras
"Æmula Trinacriis volvens incendia flammis."

Stat. Syl. IV. 4.

Sir,

In the series of papers, of which the following forms the first, I propose to illustrate in a general way the interesting phenomena of the Bay of Naples,—a region pregnant with interest to the naturalist in every branch of his study,—a region, the features of which are treasured up in the memory of the geologist as one of the most varied and important that he can ever hope to inspect among volcanic districts,—recorded too by the historian, sung by the poet, and moralized upon by the philosopher as he sits under the grief-dispelling shades of the verdant Pausilipo. No distinct and exclusive account of the Bay of Naples has, as far as I know, been published in English. Hamilton's *Campi Phlegræi* extend to other quarters, and are rather meagre and unsatisfactory in their details, besides that their high price makes them generally inaccessible. The *Topographia Fisica della Campania* of Breislak, published in Italian and French, is by far the best work on the subject with which I am acquainted, and I largely borrow from its pages. As my wish is to attempt a concise description of the subject before us, in our native language, and in separate essays of moderate length, neither a mere compilation from the writings of others, nor the crude ideas only which the residence of six or seven weeks in the vicinity could furnish, I hope to make my work not uninteresting to the general reader, nor unworthy of the attention of those who may hereafter visit this famous, but not overpraised part of Italy. As the most conspicuous and important object in the Bay, I commence with Vesuvius, of which, however, from a regard to the limits of the paper, my account must form a very imperfect sketch. —I remain, Sir, your most obedient servant,

Δ

August 9th, 1828.

In the following observations on Vesuvius, my wish is to avoid the unnecessary prolixity in historical and speculative details in which my predecessors have indulged, and to confine myself chiefly to the topograpical and scientific description, which a repeated survey of the locality, and a perusal of the principal works on the subject, may enable me to combine.

Vesuvius, I have always geologically considered as standing near the border of a great plain, owing its existence to the same causes which produced the volcano, bounded on the S. W. by the sea, and on the other sides by the Apennines, at the distance sometimes of near twenty miles from the sea. Though almost all this plain owes its origin to subterranean heat, those agencies are more distinctly marked in the vicinity of the burning mountain, which acts as the funnel or chimney of the whole, and, as Humboldt says of the Peak of Teneriffe, is a safety valve for the country round, though, as we shall see hereafter, not always an efficient one for the vicinity of Naples.

But my space is limited, and my subject so extensive that I must hasten to an outline of the topography of the volcano. It is divided into two distinct parts, the Monte Somma and Vesuvius, properly so called. The former is a ridge forming the segment of a circle; it is precipitous in the interior, but its exterior surface slopes gently to the country below. It is entirely composed of lava and tufaceous substances, and has been supposed, and with good reason, to be part of the wall of the original crater of the mountain previous to the tremendous explosion of A. D. 79, the first recorded in history, and which is imagined to have carried away the side of the mountain next the sea, and to have left a flat space for the erection of a new summit by subterranean action. The abrupt wall of the Monte Somma lays open to us its internal constitution, and shows that it is chiefly composed of lavas abounding in leucite, and traversed by veins or dikes in various directions, which have much puzzled geologists; but appear to me sufficiently easily accounted for by the supposition, that the pre-existent horizontal strata of lava were upheaved by internal action, while this part of the mountain remained the crater, into a dome-like shape, as the inclination of the strata actually proves; but that, when the subterranean force ceased, the mass being pressed downwards when nearly cool, it was traversed by cracks or fissures diminishing in size from the bottom to the top, as shown in the diagram, till by a new eruption they were filled with a different kind of lava, forming the dikes now observable. Similar dikes occur in the Lipari Islands; and in trap rocks they are very abundant. The height of the ridge of Monte Somma is 3703 feet above the sea. At the foot of the interior precipice, between it and the modern volcano, is the Atrio del Cavallo, a valley forming a segment of a circle round the base of the cone, and which has derived its name from travellers leaving their horses and mules there when they prepare to ascend to the top on foot. Its surface varies at different times, according to the condition of the lava with which it is covered. At present it is extremely rugged and desolate, as I have endeavoured to describe in my account of an excursion up the mountains in this *Journal*, (No. xiii. Art. 2.) being covered with the lavas of 1822, and some older ones still perfectly sterile, with the exception of a few lichens which grow in their cavities. At one part, near the foot of the hill on which the hermitage is built, the lava of 1819 assumes the form of coils of ropes, which is the natural consequence of a slaggy lava rolling slowly onward in waves, and which is not peculiar to this volcano, as I have seen a specimen quite similar from the Peak of Teneriffe. Sir W. Hamilton, in his *Campi Phlegræi*, has given a correct representation of this curious formation, which is called "Lava Corde."

Close to this a tabular variety occurs, which appears to have been caused by the fracture of a great cake of lava a few inches thick by another stream passing under it, which dividing it into small angular plates has cemented them together, and placed them at every possible inclination and direction. The coulée of 1822, though in great part *amorphous*, in the fullest sense of the word, has in one place a peculiar construction. The plain of the Atrio del Cavallo being covered at the commencement of the eruption by a great bed of cinders, (a shower of which fell so extensively as to lie finger-deep in Naples,) the lava which succeeded seems to have had a sort of repulsion to that perfectly dry and impalpable powder, as when water is thrown upon dry sand, and formed itself into blisters over it in dome-like concavities, from the interior of which spicular portions of the lava stretch towards the bed of ashes below in a very curious manner.

This valley follows the curvilinear form of the Monte Somma, and is terminated at the eastern end by a slope down to the plain. At the opposite one it is divided into two ravines by the mountain of tufa on which the hermitage of Saint Salvador stands, (raised by the eruption of A. D. 79, not 1779, as by a typographical error was printed in my former paper,) the southern branch skirts the cone, and extends as far as the lava of 1794, and that part of 1822 which devastated Torre del Greco, the other forms, after a short distance, the defile called the "Fossa Grande," a hollow washed out by the winter torrents, and famous for the ejected masses and fine minerals it contains, to which I shall presently allude. Between the hermitage and the cone was the crater in which an unhappy Frenchman plunged himself in 1820 in a fit of despair. Three days he remained with the monks, and twice essayed to bring his "courage to the sticking place;" but the third time he accomplished his dreadful purpose. The spot still retains the name of "il cratere del Francese."

Combining the actual appearances with historical relation, which we have not leisure to do here, there can be little doubt, that previous to the year 79, when Herculaneum and Pompei were overwhelmed, the Atrio del Cavallo was the centre of the volcanic action, and the Monte Somma, in part at least, formed the wall of the crater. It is generally alleged that the remaining portion of that ridge was actually the form of a segment of the original crater; yet even though we admit with Visconti (who it is said measured it *) that the present crater coincides with the centre of that circular segment, yet I cannot enter into the adoption of so *very enormous* a crater as this would imply,—certainly many miles in diameter. It seems to me more probable that a part only of the Somma was the wall of the existing crater; but that by the tremendous (perhaps unequalled) force of the eruption of 79, a longitudinal rent was made, and a whole side of the hill thrown towards the sea, where its debris formed the plain on which the new cone rose. If we suppose a disposition of the volcanic agency to work towards the sea, or a smaller resisting force to oppose it on that side, the circular direction of the crack will be easily explained, as well as the subsequent change in position of the crater.

Some observations on that part of the mountain properly called Vesuvius must next be made. Like all the higher portions of volcanos, it is a cone covered on the exterior with ashes, liable to change its height and form by different eruptions, and having on its summit a deep chasm or crater of great size in proportion to its height. The measurements of the absolute altitude of the different parts of the mountain at successive periods are of great interest, and, much as I wished to have added some new facts on the subject myself, I am glad to find that this problem has excited the attention of naturalists during a series of years of some duration.† The imperfections of barometrical measurement a century ago render the first determinations very uncertain. The Abbé Nollet in 1749 made it 3120 French feet, which probably approached the truth, while three years after, Padre della Torre gave only 1677. In 1772 Saussure found the height 3659 French feet; and af-

* Daubeny *on Volcanos.* From the largest maps of the mountain I have seen, I should not suspect this to be the case.

† I had prepared and boiled a barometer for the express purpose of measuring Vesuvius, but, being broke by an accident, I was compelled to relinquish it. It was therefore with peculiar pleasure that I saw the observations of the Earl of Minto, in the Number of this *Journal* for July 1827, which formed a most valuable addition to my paper.

terwards Shuckburgh took the point whence the lava of 1776 had flowed at 3692 = 3935 English. This lava formed a hill in the middle of the crater and disappeared in 1779. In July 1805, Gay-Lussac found the highest point of the summit 606 toises = 3757 English feet above the sea, and Humboldt a month after took the hill in the centre of the crater 542 toises. A mean of Humboldt and Gay-Lussac gives the base of the cone 370 toises and the hermitage 300. In 1817 the highest summit must have been (according to the Earl of Minto *) 3963 feet high. In February 1822 the summit was raised 202 feet, giving the extreme altitude 4165 feet. Salvatore the Vesuvian guide informed me, that before October 1822 its height was 4250 feet, (an estimation which it seems differed less than 100 feet from the truth), and that at the eruption of that period, more than 800 feet of the summit, including of course the cone lately formed, were carried away, so that the height may not be estimated at much above 3400 feet about the present time. The change of form will be made apparent by the diagrams in Plate III.

A represents the mountain as it was seen from Naples before 1822; B its form, December 1826. The consequence of this change was evidently the enlargement of the crater; for the mountain is so completely a *crust* in its upper part that the edge of the summit can hardly be said to be level for a yard in breadth between the exterior and interior slope. A few words on the modifications of the crater will find a proper place here. Before the first recorded eruption (that of A. D. 79,) Strabo, lib. v. informs us that the summit was a level plain covered with ashes and rocks, exhibiting marks of igneous action with many caverns and grottos between. In 1631, after a repose of 492 years, Bracini informs us that the crater was 5000 paces round and 1000 deep. In the bottom was a plain where cattle grazed, and the banks were clothed with abundant forests, in which wild boars took shelter; and numerous caverns of great size were found in the centre. The sloping path down was about three miles long. Three little lakes also existed there, the water of one of which he describes

* See this *Journal*, No. xiii. p. 72.

as warm, another salt, and a third bitter.* This curious description represents exactly the condition of the extinct volcano of Astroni near Naples, which at a future time I shall notice. In 1755 the bottom of the crater was so high that the great plain in the centre of it was only 23 feet (French) lower than the edge, and in the centre rose another cone 80 or 90 feet in height, having its own small crater through which its size was increased. This in fact is the constant mode of operation of the volcano, that the bottom of the crater is raised by the matter ejected from below, and when fairly emptied by some great eruption takes a long time to regain its former level, and have the means, even though the internal agency was there, of giving vent to a stream of lava. In looking forward to the future operations of the volcano, it is important to consider what stage of this regular course of phenomena it is in at present. Before 1822 (as I observed in my former paper) the crater was only 5600 feet, or little more than a mile in circumference; but in that year the mountain having disgorged with a fury unequalled in the memory of man, the matter collected in its bowels carried off the summit, and truncating the cone at a far lower point than before, left the present yawning chasm of three and one-third miles round and 2000 feet deep from the extreme part of the existing summit. Now this approaches much to the character of the crater before 1631, which, from its enormous size and the exhausted efforts of the mountain in producing it, remained quiescent near 500 years. *Cæteris paribus*, we should be disposed to expect that a considerable time will elapse before another great eruption; not a period, however, any thing like the one just mentioned; for *then* the volcanic agency seems to have been almost extinct, whereas now it is remarkably active, as the repeatedly frequent paroxysms of the last few years indicate, especially since there was one took place on the 22d of March this very year (1828), but which, I presume, cannot be a very considerable one. It is a very remarkable circumstance, that the crater of Vesuvius as it stood when I saw it (1826–7) was probably the largest in existence. "It might be laid down

* Hamilton's *Campi Phlegræi*, folio, vol. i. p. 62, and Breislak, *Campanie*, Tom. i. p. 186.

as a very general fact in geology" says the able author of the article *Physical Geography* in the *Edinburgh Encyclopædia* *, "that the most elevated volcanic mountains have the smallest craters at their summits, had it not been ascertained by Humboldt that the crater of the colossal volcanos of Cotopaxi and Ruen Pichincha are nearly a mile in diameter." Vesuvius now exceeds even these. Etna, which is about 11,000 feet high, had a crater estimated by Sir William Hamilton † in 1769 at only 2½ miles in circumference, three quarters of a mile smaller than Vesuvius, which is but 3400 feet high. The peak of Teneriffe, which is above 12,000 feet in height, has a crater only 300 by 200 feet, and 100 deep ‡.

In the proportion which the cone of ashes bears to the total altitude, Vesuvius is also remarkable, as the following comparison made by the indefatigable Humboldt § proves.

	Total height, Toises.	Cone covered with ashes.	Proportion of cone.
Vesuvius,	606	200	$\frac{1}{3}$
Peak of Teneriffe,	1904	84	$\frac{1}{22}$
Pichincha,	2490	240	$\frac{1}{10}$

The mean slopes of volcanic cones, according to the same author, are from 32° to 40°, and the steepest parts either of Vesuvius, Teneriffe, Pichincha, or Jorullo, from 40° to 42°. I have been at some pains to estimate the existing slope of Vesuvius by the comparison and careful measurement of a great number of eye sketches of Vesuvius made by different persons, so as to eliminate as much as possible the errors of such a vague observation, though the eye is not liable, as far as I know, to any particular misjudgment in taking *profile* views, such as it experiences in looking *down* a rapid descent. From a mean of a considerable number of angles thus taken for the northern acclivity, and by several observers, in the close of 1826 or the following spring, I deduce $41\frac{2}{3}$° as a probable mean, from which the extreme differences are not so considerable as we might have expected. This represents nearly the angle of ascent by the usual path from the hermitage of St Salvador, and the line whose angular elevation is measured ex-

* Vol. xvi. p. 487.

† Daubeny *on Volcanos*, p. 25.

‡ *Campi Phlegræi*, i. 47.

§ *Pers. Nar.* i. 207.

tends from nearly the highest summit of the mountain to where the cone merges into the Atrio del Cavallo, a well marked point, and the slope is very uniform. On the southern side again, the slope begins more abruptly, and may be estimated at the uppermost part above 46°,—a steeper slope than Humboldt admits in any case; nor would I for a moment wish to place the result of such an imperfect estimate against the penetration and experience of that great traveller. It only continues steep for a short distance, and then sweeps gently down to the sea-shore, a distance of four Italian miles. See the section in Plate III.

Having now discussed as far as I can at present attempt the general external features of the volcano, let us take a short survey of some other geological features and the peculiarities of one or two important localities of the mountain Had I thought myself equal to the task, I should have been glad to have entered more minutely here into the topography of Vesuvius, and given a map illustrative of the changes it has produced by its phenomena, especially streams of lava during authentic record; but as the subject is so vast that I could throw little light upon it, although I have been at the summit of the volcano three times and inspected various portions, and as I propose in future papers to discuss the phenomena of the buried cities, the formation of tufas, and some analogous subjects, I shall confine my remarks at present within narrower bounds.

From what has already been said, it is obvious that the volcanic agency is liable to change its place and manner of acting, and that it *has* occurred to such a degree as to change the point of ejection from the Monte Somma to the modern cone. We have now to observe the methods of eruption, which often change from year to year. It is a mistake to imagine that lava always flows from the crater of a burning mountain; it is only in particular circumstances that it can do so. The lava of 1760 flowed from four small craters still existing at the base of the cone on the south side. One of the hillocks raised on this occasion is 238 Neapolitan palms, about 200 feet high. In a similar manner the stream of 1822 was ejected on the opposite side of the mountain, and flooded the Atrio del Cavallo with its fiery torrent, which was of vast extent, laying waste many vineyards, and carrying away some few dwelling-houses. We have already noticed the appearance of this lava, which is perfectly sterile and untractable. In its course it covered several older lavas, and greatly contributed, as do all successive eruptions, to extend the elevated plain from which the cone rises. The lava of 1794 was likewise ejected at the base of the cone, on the western side, and a considerable distance from the mouth of 1822, at a spot named *La Pedamentina.* It opened in a narrow crack, being 2375 feet (French) in length, and only one-tenth of that number in width. It remains to this moment a vast track of sterile matter, as black and undecomposed as if but freshly ejected.* It took various directions, and spread its devastation far and wide, but nowhere so remarkably as at the town of Torre del Greco, through the very streets of which it rolled its dreadful tide; and though now we see houses rising on the mass which buried the pre-existent ones, the absolute effects of the lava are so perfectly unaltered, that the effect seems recent. The shattered houses and chapels, partly engulfed in the obdurate mass, still raise their melancholy fragments, with their empty and unlatticed windows, to the eye of the spectator; and when you mark the course of the flood through the rich vineyards which clothe the side of Vesuvius, there you find but a few inches betwixt luxuriance and desolation. The lapse of above thirty years has done nothing to soften down the horrible contrast. After observing its passage through the town, we see it enter the sea; and the condition of the lava in this remarkable situation demands a few words. The breadth of the stream here is no less than 1127 French feet, and it enters 362 under the water. Breislak,† from whom these measurements are taken, affirms that this event produced no remarkable phenomenon. "We should have expected," says he, "that the sudden cooling occasioned by the sea would have produced basaltic columns in this lava; but it is consolidated without taking any regular form; and perhaps this effect is to be ascribed to the abundant scoria with which it is united." Now, notwithstand-

* The Hon. H. G. Bennet, in his Account of the Island of Teneriffe, incorrectly states, that the lava of 1794 at Vesuvius flowed to the sea, a distance of eighteen miles, in six hours, whereas in reality it flowed only 12961 French feet, less than three miles, for which it required from six in the evening to four next morning, or ten hours.

† *Campanie,* tom. i. p. 203.

ing the high character of this naturalist as an observer, and the considerable advancement of science at the time in which he wrote, I suspect he has here fallen into two, if not three, material errors; 1*st*, that the lava is actually columnar. I should hardly venture to place my opinion against that of Breislak, were it not that the discrepancy may be explained by the fact, that extensive excavations have been made in the lava for a building stone, by which means its internal structure is displayed in a way which Breislak could not have seen. 2*d*, He expects to find crystalliform lava *on account* of the sudden cooling of the lava below water,—an idea which is entirely exploded by the more recent discoveries of Dr Hutton and Dr Hope, who have demonstratively proved that crystalliform lavas or basalts can *only* be produced by very slow cooling; and hence, 3*d*, Huttonians have undertaken to prove that lava cools slowest under water, (in order to reconcile theory with facts, such as the one before us,) a position which Dr Daubeny* has ingeniously defended, but which I cannot even touch upon here; nor can I decidedly give my opinion on his explanation, which, to say the least, appears somewhat paradoxical. I shall conclude with saying, that I have not the smallest doubt of the columnar arrangement of the lava where it approaches the sea; and I am convinced that excellent cabinet prismatic specimens might be procured from these quarries.

The structure of the Atrio del Cavallo has already been alluded to. There can be little doubt that it is composed to a great depth of successive layers of lavas, volcanic conglomerate, and strata of ashes. It is nearly flat, and its breadth between the base of the cone and that of the Somma was, according to the accurate measurements of Della Torre† in the last century, 2220 French feet, which cannot have greatly varied to the present time. We have the means of examining its structure best at the western end. There the hill named Cantaroni, on which the hermitage stands, is entirely composed of volcanic tufa, which, as we know it was raised from below, evidently indicates the nature of the subsoil of this valley. In fact, it would not require a word to illustrate so obvious a circumstance, as that the whole body of the volcano has been

* *Descriptions of Volcanos*, p. 400.

† *Storia del Vesuvio.* 4to, Napoli, 1755, p. 5.

raised by the operation of subterranean heat, had not the historiographer of Vesuvius in his work just quoted undertaken to uphold that the strata of lavas, &c. merely cover the original strata of the mountain no ways volcanic. Della Torre actually goes so far as to assert that the Monte Somma is in its aboriginal condition, and exhibits no marks of the agency of fire or of liquefaction, (*Storia*, &c. p. 6 and 23,)—an extraordinary assertion, which both Sir William Hamilton and Breislak have taken great pains to disprove, and have satisfactorily shown that the volcanic action has produced the strata on every side as far down as man has penetrated; and indeed, what mean ideas must we have formed of the depth of the seat of igneous fires, if we suppose them confined within the narrow limits of one division of a mountain of no great size,—a mountain which has probably, within the memory of man, disgorged a far greater mass than that of its own composition, and which, by its visible connection with the physical state of remote portions of the globe, must for ever set aside such paltry schemes of philosophizing.

To the south of Monte Cantaroni, we have the lava of 1767, which stretches to the Fossa Grande; to the north that of 1785, which flows into a valley presently dividing itself into two, the Rio Cupa and the Fossa di Faraonte. The Fossa Grande exhibits numerous sections of the strata, which are entirely composed of a soft tufa liable to be washed away by the rains, which constantly bring out the old ejected masses thrown from the Monte Somma, and imbedded in the mass, frequently containing the finest Vesuvian minerals. The bottom and sides of this ravine (for such is the meaning of the word "Fossa" in this neighbourhood) are thickly planted with the fine vines which cover a great part of volcano wherever the lava is disintegrated, and yield, perhaps, the best of the Italian wines,—the Lachryma Christi.

At the beginning of this essay I have placed a section of Mount Vesuvius in its state 1826-7, which I have compiled with great labour from every source which could afford me information, and the details of actual measurement, as well as from an immense number of drawings and engravings from the middle of the last century to the present time. I have done it in imitation of Humboldt's section of the American volcano Jorullo, but have made the horizontal and perpendicular scales the same, which alone can give a true idea of a mountain. I have already mentioned that the crater is $3\frac{1}{2}$ miles round; but I soon saw that in the line of this section (N.N.E. to S.S.W.) I could not give it the diameter of a mile. In fact, the crater is oval, having its longer axis nearly N.W and S.E. so that our section is nearly in the shorter diameter; and after a comparison of a great many recent drawings from the neighbourhood of Naples, I adopted $\frac{4}{7}$ths of the perpendicular height for the diameter of the crater, as seen in the line of section. In Plate III. A represents the Monte Somma, B the Atrio del Cavallo, C the highest point of Vesuvius, D the crater, E a flat space nearly level with the Atrio del Cavallo, F the Camaldolese convent of St Angelo on a hill of tufa, evidently raised by a volcanic explosion beyond the memory of man, G the Mediterranean Sea.

It is now time to turn our attention to a short consideration of the mineral productions of Mount Vesuvius, which are so numerous, so singular, and so important, as to have excited especial attention when the wonders of the kingdom of nature began to be accurately explored, and presented a glittering though laborious harvest to many of those who may be termed the fathers of modern science. At the present period the wonder seems to be, that these mineral treasures, explored but feebly half a century ago, have not excited the spirit of investigation they deserve under the hands of philosophers of this age; and that the works which describe them, though honourable to the time in which they were written, are so exceedingly confused and imperfect in the present state of knowledge, as to throw almost as much darkness as light on the subject they meant to elucidate. The great volcanos in the two Sicilies have each had their own lithologist, Etna in Dolomieu, the Lipari Isles in Spallanzani, Vesuvius in Giœni. All these works are quite antiquated on the science of which they treat. From thirty to fifty years have elapsed since they were composed; and they are now ill fitted to aid the student of nature in his researches. Perplexity, endless subdivision, confusion of epithets, and ill-defined characters, abound in the mineralogical works of that period; and although at the present time Messrs Monticelli and Covelli are publishing their

"*Prodromo della Mineralogia Vesuviana*" (a work which I have not been fortunate enough to see,) it displays, I understand, too fully that imperfect knowledge, that separation from the literature of modern Europe and the progress of modern science, too prevalent, alas! in Italy,—the land of Roman greatness,—the land of the Medici,—and the golden age of Leo the Tenth.

The reduplications of names to the same mineral, where there is not a well established correspondence of scientific men in different quarters, must perpetually occur, especially in Vesuvius, where species not hitherto noticed are daily brought to light, and after receiving some high sounding name are found to have been long known in the far northern schools of Great Britain, Germany, and Sweden. * The rage for multiplying species too exceeds all bounds, and the slightest, perhaps fortuitous distinction is considered a sufficient ground for giving a new appellation to the mineral. Where this chaos of unmeaning language is to end seems doubtful. As things go on at present, the terminology of the science must become so perplexed as to intimidate the boldest student. These digressive remarks may perhaps have led to the idea that I am going to attempt the reform of the Vesuvian mineralogy; but far other is the case. They are rather intended as an apology for being able to do so little where more might have been expected, and infinitely more is yet to be looked for. Brevity I must principally attempt, and that the little I say may be intelligible and satisfactory to the well informed reader. Although, contrary to the synthetical method, it will be far best to commence with the compound rocks of Vesuvius, and then to descend to the simple minerals.

I. Lava.—This rock is for the most part an intimate compound of two simple minerals, augite and felspar, although some other species occasionally occupy a large share of the composition. On the general forms and massive grouping of the Vesuvian lavas I have already made some remarks, but in their minuter characters they do not differ less widely. The lavas are for the most part either compact, cellular, or decomposed. The *compact* kind is generally porphyritic,

* See this *Journal*, No. xiv. p. 326.

having imbedded crystals, but sometimes it is nearly homogeneous, and highly crystalline. In this condition it much resembles the rocks of basalt so well known in this country, and which may give those who have not visited active volcanos an excellent idea of this, one of their most remarkable products. Of this kind, as nearly as I recollect, is the lava quarried for the pavement of the streets of Naples and the road to Portici, which is a splendid causeway. Some approach very nearly to the characters of the couleé of ancient lava at Capo di Bove, near Rome, which Daubeny considers as an intimate union of augite and leucite. The specimens in my possession are amazingly compact, and resemble perfectly some varieties of basalt, as I have noticed in my paper on the materials used by the Romans, in the last Number of this *Journal.* * Another variety of the compact lava, and very common, has a grayish ground, with imbedded black crystals of augite. That of 1822 is dark and compact, though sometimes scoriaceous. The true *partridge-eyed* lavas belong principally to the extinct part of Vesuvius,—the Monte Somma. They owe their name to the beautiful crystals of whitish leucite, bordering on pink, thickly studded on a dark ground. It must not, however, be confounded with another variety of lava from which the fine specimens of this beautiful zeolite are taken, which is so porous in its structure as hardly to be considered a compact lava. Its colour is dirty brown, and it is very tough. The lavas of the Somma are generally far the most crystalline, and well suited for polishing. The variety is very considerable, owing to the different parts of that compound formation. The dikes already alluded to are quite different from the general mass of the strata, though I cannot speak as to their generic difference. Breislak enumerates no less than twenty-two varieties of the lava of the Somma, but his descriptions are too undefined to give us very precise ideas on the subject. We must not suppose that the *partridge-eyed* lavas are peculiar to the ancient eruptions, and this part of the mountain in particular. I have very pretty specimens of this kind, with a basis reddened by iron from the lava of 1760, which flowed from the very opposite side of the volcano.

* No. xvii. p. 38, &c.

The *cellular* lava, properly so called, is, as far as I know, nearly of one description in every situation, and it is widely distributed through the volcanic regions of the globe. In composition it probably does not differ from the compact species, but owes its name to the cavities distributed through its mass, which render it extremely light, and balls of it are often discharged from the crater along with the sand or ashes. In this condition it is frequently found in the ruins of Pompei. Its characters seem to indicate that it forms the upper portions of the streams of lava where the air-bubbles, disengaged by pressure from the lower part, are collected and prevented from escaping by the rapid cooling of the cells containing them when near the open air. In structure the cellular lava precisely resembles some of our amygdaloidal trap rocks, where the zeolites have been removed by the weather from the cavities. Not unfrequently this lava is coated with a green salt of copper. I have an example of this from the "Cratere del Francese."

The *decomposed* lavas have very different characters from the two preceding kinds. Their appearance is so dissimilar, that an uninformed observer would find it difficult to recognize the hard basaltic mass of fresh lava in the soft clayey bed which it forms when decomposed. The action is in two ways, either by the simple weathering of the ingredients, or when this agent is assisted by the gaseous emanations with which volcanic countries abound. The chemical and other details we cannot pursue; but in the works of Breislak * and Dr Daubeny † they will be found considered. The general fact, however, is sufficiently simple, that those rocks in which felspar predominates are reduced in proportion to its constituent quantity to clay-stone, and the potash with which many of these rocks abound makes the soil thus produced extremely fertile. In the crater of Mount Vesuvius, as well as at the Solfatara, the decomposed lavas are very extensive, and generally pure white. As they are accidentally mixed with more or less sulphur and red orpiment, the shades of colour are beautifully and infinitely varied. See my remarks on Ve-

* *Campanie,* tom. ii. 96.

† *Volcanos,* p. 167 and 376.

suvius in this *Journal*, No. xiii. p. 13. The beds in the crater are of great size and thickness, from the many causes which combine to produce the reduction of the indurated material, the general high temperature and its great alternations, the perpetual moisture and the acidified gases, all contributed; but on the sides of the mountain these causes operate with far less force, and the decomposition of the lavas is proportionally slower. The time, however, is dependent upon the quantity of felspar in the lava, for if silex predominates it is not reduced in many centuries. The following is a notice of the state of the lavas in 1823. "Lava of 1551. Fossa di Gaetano. Heaths grow, and vines begin to be planted. 1737. Little decomposed; moss grows. 1760. More decomposed than the last, but unfit for vegetation. 1771. Gray; moss; no heath. 1785 Fossa di Sventurato. Hard and rough. 1794. Fossa di Cucazzello. More decomposed, especially the scoria near the crater. Moss and heath, but no trees. 1805. Fossa del Noce. White; no moss. 1810. Gray and rough, with some moss. 1822 Colour black; very rough and irregular; no moss. Many of the above lavas are more forward than that of Ischia, which flowed in 1302."* I took some pains to examine a few of the lavas last year, and found that of 1822 still perfectly sterile; and from its tremendously untractable appearance, it will probably long remain so. I have in my possession characteristic specimens of the lavas of 1777 and 1819, with the actual lichens. The former has them pretty long, (about three-eighths of an inch) and bushy. The latter exhibits only minute stalks in the crevices of the rock, and thinly scattered. Much more might be added regarding the decomposition of lava; but we must hasten to notice some other productions of the volcano.†

* Daubeny, p. 204, Note.

† This paper would be still more imperfect than I feel entitled to make it, were I not to notice the dates of the eruptions of the volcano. I shall merely give the years, and prefix an asterisk to the most tremendous. The following list which I have compiled is, I believe, more complete than any hitherto published. * A. D. 79, under Titus, the first recorded.

* It destroyed Herculaneum and Pompei, which were much injured by an earthquake which preceded it in 63. This interesting subject I shall resume in another paper.

II. Volcanic Conglomerate or Breccia. A rock composed of the various simple volcanic rocks in the state of fragments and united by a basis. It is occasionally agreeable in its appearance.

III. Tufa. This substance is best known as the work of extinct volcanos, but is a frequent production of Vesuvius even at the present day. It may be considered as a hardened mud of the same description as buried Herculaneum. I have a piece produced by the eruption of 1822, which has taken the complete impression of the leaf of a tree. I propose to resume the subject of tufa in two future Numbers of these "notices;" on the phenomena of the buried cities, and on the tufas of the Bay of Naples.

IV. Volcanic ashes, or more properly sand, is one of the most abundant productions of Vesuvius. A shower of it generally precedes great eruptions; and from the subtile division of its parts it is capable of being sustained long in the air, and carried even to Egypt and Syria in A. D. 79, to Constantinople in 472 and 1631, and all over Calabria in 1139 and 1794. In 79 it buried Pompei to the depth of many yards; and in 1822 the excavated parts of that wonderful city were again covered with the sand to the depth of several feet, and it lay finger deep in Naples. When chemically examined it was found (what is very remarkable) to contain a minute quantity of gold. The last portion that fell, such as I gathered it in the Atrio del Cavallo, is an almost impalpable powder.

From the extremely minute quantities of Obsidian or volcanic glass and Pumice afforded by this volcano, I prefer considering them as simple minerals rather than rocks. On the former class of substances we must now pass a few hasty remarks, which must be confined within very small compass.

Following, then, the system of Mohs, and stopping only at

203, under Severus. 472, 512, 685, 993, * 1036. Probably the first time that lava was ejected. 1049, 1138, 1139, 1306, 1500. (Monte Nuovo appeared in 1538,) * 1631, 1660, 1682, * 1694, 1701, 1704, 1712, 1717. Lava continued to flow for eleven years, 1730, 1751, 1754, 1759, 1765, 1766, * 1769, 1776, 1777, 1778, * 1794, 1802, 1803, 1804, 1806, 1809, 1810, 1812, 1816, 1817, 1818, 1819, 1820, * 1822, February and October. 1828, March 22. Forty-five eruptions have been above enumerated, and sometimes for years together Vesuvius has continued slight eruptions.

the more important individuals, we find several genera of the order Salt among the productions of Vesuvius. We have the volcanic *sal ammoniac*, and the curious mineral placed in the Appendix of Mohs,* *Mascagnine*, or sulphate of ammonia, which is formed in mealy efflorescences. Pure *marine salt*, or muriate of soda, is found in beautiful concretions in the crater. It is probable that *sulphate of alumina* and *vitriol* also occur, which are met with in the Solfatara of Pozzuoli. In the genus Limestone, one of the most interesting minerals we have is the compact marble found among the ejected masses of Monte Somma and of Vesuvius. They are brilliantly white, compact, and phosphorescent when placed on burning coals. A great many varieties are mentioned, and none is more remarkable than the blue kind, which is used for imitating the sky in the Mosaic work of Naples. One curious specimen I have of 1822, in which the parts are sometimes so homogeneous and crystalline as to be semitransparent. How this beautiful limestone should be produced by the volcano out of a country calcareous indeed, but excessively coarse and impure, is extremely surprising; and many have attempted to account for it by the influence of *heat under pressure*,—an opinion which, as facts stand, seems very probable. In a specimen bequeathed by Dr Thompson to the University of Edinburgh, there said to be coarse limestone, observed actually passing into fine marble. Sir William Hamilton has given a drawing of a piece much more unaccountable, where the marble is actually seen formed round a nucleus or lava. Surely there must have been some misapprehension here. These limestones are among the most interesting productions of Vesuvius, and they contain many of the simple minerals whose names we can do little more than mention. Coralloidal *Arragonite* occurs in lava on Vesuvius in beautiful scopiform concretions. My specimen is from the "Torre di Bassano," between Castelamare and Torre del Greco. Under the genus *Baryte* we have the *Witherite*, which occurs in beautiful silky dendritic concretions in the fissures of the limestone above described. It is called Barolite at Vesuvius. Under the order Malachite, the genus *Acatamite* exists in Vesuvius in the fis-

* Mohs' *Mineralogy*, by Haidinger, vol. iii. p. 125.

sures of lavas, covering them with a peculiar green crust. It is most abundant in the lavas of 1804 and 1805. My specimen is from that of 1820, at the cratere del Francese; it is a muriate of copper. *Mica* is an abundant production of Vesuvius, and varies considerably in its appearance. Sometimes it is black and thickly slaty, like that in the lava of the extinct volcano of Albano; at other times bright-greenish, with a silvery lustre. Its form is the six-sided prism, or in tables.

Among the zeolites, by far the most famous is the *leucite*, known also under the name of the white garnet of Vesuvius. This remarkable and beautiful mineral has twenty-four trapezoidal faces when fully crystallized. Its specific gravity, according to Brisson, is 2.4684; its hardness 5.5 — 6.0. They are very seldom transparent, generally translucent, and of a grayish white colour. They vary greatly in size. The largest known is in the Edinburgh Museum, from Thompson's collection, and measures 1.64 inches along the greater axis, and 1.23 the smaller. Sometimes they are so small as to require a lens for their inspection. They abound amazingly in some lavas, as I have already remarked. When much injured by heat, as often happens, they are called *leocita cotta*, or baked leucite. It is found in greatest perfection in a rather vesicular lava of no great hardness, but tough, in that part of the mountain named La Ria Cupa di Sobotionella. It contains potash in remarkable quantity. The following are the results* of four analyses; the first three by Klaproth, the last by Vauquelin.

	I.	II.	III.	IV.
Silica,	53.750	54.50	54	56
Alumina,	24.625	23.50	23	20
Potassa,	20.350	19.50	22	20
Lime,	0	0	0	2

Though not confined to Vesuvius, this mineral seems peculiar to Italy, at least as far as authentic information goes. I have before me specimens from its three principal localities, Vesuvius, the lava at Capo di Bove near Rome, and the extinct volcanic formations near Radicofani in Tuscany. Of the

* Taken from Breislak's *Campanie,* vol. ii. p. 4, and Allan's *Mineralogical Analyses.*

other zeolites, the *cubizite* or analcime, and the *mesotype*, occur in the lavas of Monte Somma.

The genus *Felspar* is amazingly varied in Mount Vesuvius, and many varieties are peculiar to it. I must merely confine myself to mentioning their names, as far as the latest discoveries have separated them. The rhomboidal felspar or *nepheline* is nearly limited to cavities in the granular limestone of Monte Somma, as are the *Meionite* and *Sommite*. *Albite* is a species of felspar which appears to be known under two other names, Cleavelandite and Christianite. See this *Journal*, No. xiv. p. 326. The last name is the one given by Messrs Covelli and Monticelli in honour of Prince Christian of Denmark. *Icespar* is an abundant production of Vesuvius, and *anorthite* is peculiar to it. See the Appendix to *Mohs' Mineralogy*. The genus *Augite* occurs in great abundance, and in very various forms which it would be tedious, were I competent, to particularize. One beautiful *white* variety is found in the Fossa Grande. I must, however, pause to observe that beautiful and well characterized specimens of *hornblende* are found in Vesuvius; although Humboldt, in his Account of the Canary Islands, says, " Hornblende is extremely rare at Teneriffe; and I *never found it in the lavas of Vesuvius*. Those of Etna alone contain it in abundance." I have several Vesuvian specimens in my possession. *Tremolite* not only occurs in the calcareous rocks of the Somma, but also in lava. My specimen is from that of 1809; it is highly crystalline and splendent. *Epidote* or *pistacite* is the next important mineral of the genus augite which occurs in Vesuvius. It is green and crystallized upon the limestone in rhomboidal prisms. There is, however, another variety of epidote, the *scorza* of some mineralogists, the *scorsalito* of the Neapolitans, which is arenaceous epidote. All the specimens in my possession are of the eruption of 1822; the colour pale reddish-brown, and the surface uneven and shining from minute crystals. Examined with the microscope, they have a beautiful appearance, and are found intermixed with Breislakite,—a mineral whose characters are quite undetermined,—which occurs in acicular crystals of a red colour. Of the genus *azure spar* the *lazulite* or *lapis lazuli* has been discovered among the ejected minerals of Vesuvius. It is mixed with rocks and volcanic materials, but its proper appearance is not altered. Breislak says, that the iron pyrites are never seen in the lazulite of Vesuvius. His remarks are, however, chiefly applied to the substance I was next going to name, which, though much allied in appearance to this mineral, has not yet been referred to its place in the physiographic system; I mean the *Haüyne.* This beautiful blue mineral is found in great perfection at Vesuvius, which is one of its few localities.* Its colour may, I think, be most correctly stated at smalt-blue. In this it differs from the fine azure-blue of the lazulite.

Of the order *Gem,* we have several important genera. The *spinel ruby* has been ejected from the crater in considerable quantity, especially in 1794. Its variety, the ceylanite, is found very perfectly crystallized in the Monte Somma. The form of both is the simple octohedron, sometimes beautifully truncated on the angles, and with other occasional differences.

Topaz occurs, but in very minute crystals, in Monte Somma, as also, I believe, the *schorlite* or schorlous topaz. Several varieties of rhomboidal quartz of course occur. Of these *chalcedony* is the principal; and, on the whole, quartz cannot be considered as an abundant production of Vesuvius. Under the species of fusible quartz we have the *obsidian* and *pumice.* The former is extremely scarce, and is hardly considered a Vesuvian mineral. I have, however, two curious specimens of it. In one from the old crater of Monte Somma, the obsidian, of a beautiful velvet black, and a high degre of lustre, is contained in ovoidal cavities of a leucitic lava; the other is of so late production as October 1822. *Pumice* is another uncommon production of the volcano, and it seems to belong, if I do not mistake, wholly to those masses ejected by the eruptions of the Monte Somma. My specimen I found among such fragments in the Fossa Grande. Breislak asserts † that near Castelamare he found much pumice, which must have come at a former period from Mount Vesuvius, of the thickness of two or three feet. As far as the account goes, however, it may as well belong to the ancient pumiceous conglo-

* It occurs also in the extinct volcanos near Rome, and on the banks of the Rhine.

† Vol. i. p. 26.

merates of the bay as to the more recent operations of the volcano. The rarity of this mineral is interesting in an archælogical view; and I have given some account of it in my Essay on the Building Materials used by the Romans in the last No. of this *Journal*, p. 38, &c.

Of the genus *chrysolite*, we find in Vesuvius the *olivine* or volcanic chrysolite in great perfection. Its colour is pale and yellowish green, and it is generally found massive in volcanic rocks, or in grains ejected from the crater. I have seen a fine specimen beautifully crystallized in a four-sided prism, with the angles truncated, forming additional sides. Of the *garnet*, Vesuvius produces several varieties. The most important is the idocrase, or *Vesuvian*,—a beautiful mineral, generally imbedded in calcareous rocks, and of a colour between brown and green. The form of its crystals varies extremely. The maximum number of sides, according to Haüy, is not less than *ninety*. See also Fig. 96, Vol. ii. of Mohs' *Mineralogy* by Haidinger. It commonly occurs in some modification of the four-sided prism, frequently with four smaller truncating planes, and the terminations variously bevelled and acuminated. The lustre is vitreous, frequently approaching resinous, and the sides of the prisms are streaked longitudinally. Though the pyramidal garnets of Vesuvius are the most esteemed, they are found in other parts of Europe in *primitive* mountains, especially at Arendal in Norway. Among the other varieties of garnet, the *melanite* is the most important; its form is usually the rhomboidal dodecahedron; and it is of a fine velvet black colour. It is found in the calcareous rocks of Monte Somma; but its most important locality is at Albano and Frescati, near Rome. It is probable that the *colophonite* or resinous garnet also occurs at Vesuvius. The *common* garnet occurs very generally massive, and of various colours in this volcano.

Of the metals we have little to say. I have already noticed the remarkable occurrence of gold chemically detected in the volcanic sand of 1822, and have mentioned a green salt of copper in its proper place. Probably the only substance which occurs under the external metallic character in Vesuvius is iron. The *specular iron ore* is here found in great beauty. We have it in small and splendent concretions superimposed on trachytic tufa at St Anastasia behind Monte Somma. I have also a specimen in which the crystals are placed in cavities of a leucitic lava of so late a date as 1817; but the most magnificent specimens are those which occur in broad plates as brilliant as highly burnished steel, and not liable to tarnish. It occurs lining the walls of cavities in calcareous masses. The magnetic or octohedral iron ore also occurs, and abounds in some lavas.

Sulphur is an abundant production of the active volcano. The hemiprismatic sulphur or red *orpiment*, in which arsenic abounds, is found in the crater. My specimen was produced by the eruption of 1822. The common or *prismatic* sulphur is rarely found crystallized, although very pure. It is either in filamentous crusts investing the rocks of the crater, or in globular concretions, or else in acicular crystallizations.

At the southern base of Vesuvius, about a mile from shore, there is under water a spring of *petroleum*, from which, when the sea is perfectly calm, bubbles of the mineral oil, the size of a pea, may be seen rising, which, on reaching the surface of the water, make yellowish brown marks three or four inches in diameter, and soon dissipate, leaving a very disagreeable smell, which is carried by the wind to some distance.* It undoubtedly owes its origin to the volcano.

Here I must close this imperfect enumeration of the most conspicuous simple minerals of Vesuvius. I shall only add the names of six new minerals from the appendix of Haidinger, which occur here, and generally here alone, but whose characters have been very imperfectly determined. *Breislakite*, (see p. 209;) *Comptonite*, (see the *Edin. Phil. Journal*, iv. 131;) *Forsterite*, *Humite*, *Somervillite*, and *Sulphate of Potash*; likewise *Davyne*, (see No. xiv. p. 326.)

The minerals of Vesuvius doubtless require much elucidation; and should Messrs Monticelli and Covelli succeed in their efforts towards this end, they will perform an important benefit to science. I now close this paper with the hope that those who may read it with attention, will, notwithstanding its many imperfections and omissions, derive both pleasure and profit from the perusal. Of this I am convinced, that they

* This notice is from Breislak, *Campanie*, i. 241.

could not have procured the information they might have desired on the subject of Vesuvius, without bringing together a number of unconnected and some scarce works in different languages, and gone through a toilsome and too often unsatisfactory course of reading. Should any thing I may have myself advanced be considered unimportant or inconclusive, I shall feel satisfied if I have merely simplified the labour of research, or given a stimulus to farther inquiry on an interesting, but too much neglected subject. Δ

Art. II.—*Account of an Apparatus for grinding and polishing the Specula of Reflecting Telescopes.* By the Right Honourable Lord Oxmantown, M. P. Communicated by the Author.

In Plate IV. Fig. 2, AB represents the bed of a large power lathe, CD a shaft connected with the steam engine, EF the floor of the room, GH the ceiling, and IK a large lathe head for very heavy work. Motion is communicated by a band from the shaft CD to the lathe IK, and by bands through a succession of wheels, as represented in the figure to the speculum LM. LM, therefore, revolves with a motion slower than VW, in the proportion of the product of the radii of the wheels transmitting the motion to the product of the radii of the wheels receiving it.

NO represents either the polishing or the grinding tool. PQ is a rod resting against a limber spring RS, and passing through the flat rod TU into a hole in the tool NO. The rod TU is furnished with a joint X, so that when the eccentric VW revolves, the rod XU reciprocates steadily through the guides Y,Y, carrying with it the rod PQ, and of course the tool NO. From S a weight hangs proportioned to the size of the speculum or glass, as the tool alone would be too light.

To make use of this apparatus the speculum LM is secured to the centre of the chuck, as represented in the figure, by means of very soft pitch and wooden pegs driven into the chuck. The tool NO of lead and tin of the proper curve is then placed upon it, and the rods PQ and TU arranged as in the plate. At the commencement of the operation, to expedite the process, the speculum may be made to revolve with considerable rapidity by altering the arrangement of the bands communicating the motion; and the tool NO, for the same purpose, may be prevented from turning by a pin screwed into it, which catches against the rod TU. Coarse emery is now introduced between the tool and speculum through a hole in the tool; and the reciprocating motion of NO, combined with the rotatory motion of LM, will soon bring the speculum to a good surface, though not truly spherical. The focal length of NO being now a little changed, it is replaced by another tool composed of lead and tin, and NO is now suffered to revolve with the speculum, the pin that prevented it being removed; besides the bands are now arranged as in the figure, to give a slow motion to the speculum, and emery of different degrees of fineness is made use of, till the surface of the speculum is extremely smooth.

No fresh emery should now be added for at least a quarter of an hour; and the speed of the shaft CD, and of course of the whole apparatus, is reduced during that time one-half. This seems favourable to the production of a very accurate spherical surface.

The speculum will then be ready to be polished, for which purpose the tool is to be covered in the usual manner with a coat of pitch of the proper consistency, and the usual polishing powder applied. At the commencement the shaft CD may revolve with its ordinary speed, and a considerable weight may be applied to the spring RS; this will almost immediately bring the pitch exactly to the same curve as the speculum, and the polish will rapidly proceed; however, towards the end of the operation both the speed of the apparatus and the weight must be greatly diminished.

It appears, then, that the friction by which the polishing and the latter part of the grinding is effected arises from the reciprocating motion of the tool. The circular motion of the speculum is merely for the purpose of continually altering the direction of the strokes resulting from the reciprocating motion. The tool will not revolve exactly in the same time as the speculum; this is to a certain extent useful; but would be prejudicial if friction were produced by it amounting to any sensible quantity. It is principally for the purpose of obviating this that the speculum is made to revolve so slowly. I have tried the introduction of another motion into the process by fixing the guides YY on eccentrics revolving very slowly, and having a very small eccentricity. This seems to be an improvement; but as it renders the machine more complicated, and as I have not yet tried it sufficiently to be able to speak with certainty of its good effect, I have not represented it in the figure.

It is evident that a considerable number of specula or lenses may be worked at the same time, by increasing the number of the wheels Z. I have not, however, extended the apparatus beyond what the figure represents, having no occasion for it.

The annexed sketch has no pretensions to the accuracy of a working drawing. The scale is merely for the purpose of giving a general idea of the proportions of the parts: The machine would be sufficiently large to grind and polish a speculum of three feet diameter or perhaps larger. Should an instrument-maker think it worth his while to construct an apparatus on the above principle, probably one on one-third of the scale would be sufficient for his purposes;—it might be moved by men and a porter's wheel. The quantity of power necessary would of course depend upon the velocity of the machine, and the size and number of the specula to be worked.

The engine I make use of in my laboratory is a two horse power; and from some loose experiments with it, I should think that a one horse power would be fully sufficient for three or four specula six inches diameter. The rod T U may make a stroke of about an inch for a speculum of the above dimensions, and the revolutions of the speculum may be to the revolution of the eccentric as 1 : 300 or 400. For specula of six inches diameter a day will be found sufficient to complete the process.

It is evident that the object of this apparatus is to communicate an accurate spherical figure. Should it be proposed to attempt the parabolic curve, the motion recommended for that purpose might be imitated by means of the eccentric guides and the slow circular motion of the speculum; and with this advantage, that, were it found really successful, the same result would probably be always afterwards obtained;

but, from reasons which I have stated in an account of an attempt to improve the reflector, (see last Number, p. 25.) I fear the parabolic curve is inconsistent with an accurate surface.

In Fig. 3, AB represents a lathe for cutting the tools for grinding specula and lenses. The mandril works between brass jaws secured by a variety of screw bolts to prevent any shake. It is more to be depended upon than one of the common construction, and admits of easier adjustment. CD performs the office of the slide puppet of a common lathe, but is steadier, and in other respects preferable to it. The triangular bar EF is moved backwards and forwards by the screw G. IH is a light frame of wood. K the cutting edge. IM a rod of iron made flat at I and pierced with a small hole. The rod IM may be drawn out more or less; and then it can be secured by a screw.

To cut a convex tool, the lathe AB and puppet CD are placed upon the bed of the lathe, Fig. 2, A and F being turned towards each other. The axis of the mandril AB and of the triangular bar CD are then brought into the same right line, and placed at the proper distance. The frame IH is then adjusted so that the interval between the hole at I and K shall be exactly equal to the radius of the tool to be cut. The extremity of the bar IM is then inserted into the horizontal slit in the bar EF, and then secured by a steel pin, upon which it plays, and the edge K is carried by a slide rest along the surface of the tool, which had been previously fixed on at B, and in a horizontal line corresponding with its diameter; and the impression it makes may be regulated by the screw C. A very accurate spherical surface of exactly the required radius will thus be formed. A concave tool is cut in the same manner, only the lathe AB is reversed, and a simple radius is substituted for the frame IH.

I have cut tools with this of twelve feet radii, but shorter radii are more manageable.

The whole of the above apparatus has been very lately constructed. When it has been more used, improvements will no doubt suggest themselves. The interposition of another wheel and spindle between VW and LM would be of use; as it is rather difficult without it to communicate a sufficiently slow motion to the speculum; but, upon the whole, I think this machinery will be found greatly to abridge the labour and increase the certainty of the process of working specula and lenses.

Art. III.—*Experiments with the Vegetable Poison with which the Nagas* are stated to tip their Arrows.* By P. Breton, Esq. Surgeon Superintendant of the School of Native Doctors, Calcutta. Communicated by George Swinton, Esq.

1827, *June 24th.*—This substance, (which is soluble in water,) softened with a few drops of spirits of wine, was on the point of a lancet inserted in the inside of the thighs of two pigeons. Vomiting two or three times, and three or four evacuations (one or two of which were watery) occurred, general uneasiness and languor were manifested, and they both died in a convulsive fit of about two minutes duration, one in forty minutes, and the other in forty-two minutes after the insertion of this poison.

June 28th.—Fifteen minutes after 2 p. m. the poison was in a similar manner inserted in the inside of both thighs of a pigeon, and the effect was as follows: Nineteen minutes after two, two motions in quick succession; twenty-two minutes after two, slight vomiting, and general uneasiness and languor manifested; thirty-four minutes after two, slight vomiting as before; thirty-six minutes after two again vomiting repeated, and a copious watery evacuation, and the pigeon died in a convulsive fit, which lasted about one minute and a half, at the expiration of thirty-seven minutes after the insertion of the poison.

Nineteen minutes after 2 p. m. a second pigeon was in a similar manner infected. Upwards of half an hour elapsed without any symptom being apparent. It then couched, and seemed a little drowsy. A few minutes afterwards it rose and walked about for a few minutes on a table on which it was placed, and again couched and remained upwards of an hour without any other apparent symptom than languor. Giddi-

* The hill tribes between Sylhet and Munnipore.

ness then came on, and it rose and attempted to move. The giddiness remained two or three minutes, and returned in the same manner at an interval of a quarter of an hour. At half past three it had a copious watery evacuation, and from that period it remained in a languid state without any other symptoms being manifested, until ten minutes after six, when a slight convulsive fit came on, and it died two minutes afterwards.

A third and fourth pigeon were infected in the same manner with this poison. In both, symptoms were manifested similar to those which were apparent in the first pigeon, but less violent, and they both died in similar convulsions of about two minutes duration; the third pigeon in forty-five minutes, and the fourth pigeon in forty-two minutes after the poison was inserted.

In the inside of both thighs of two rabbits the poison was inserted with the point of a lancet. Ten minutes afterwards the first rabbit manifested general uneasiness, its respiration became very quick, and a tremulous motion of its sides and flanks was perceptible. About half an hour after the poison was inserted, a copious watery evacuation took place, and then it appeared to be getting languid. It, however, moved about occasionally on the table without any other apparent symptoms than those described, till the coming on of a convulsive fit, when it suddenly made a bound, struggled violently for two or three minutes, and died at the expiration of fifty-seven minutes after the insertion of the poison.

The second rabbit for upwards of a quarter of an hour appeared unaffected. It then gasped for three or four minutes, as if oppressed by sickness of stomach and difficulty of breathing, became languid, and had a copious watery evacuation. It remained languid, and suddenly it bounded up from the table, and in a convulsive fit struggled violently for about two minutes, and died in twenty-nine minutes from the period of the insertion of the poison.

The rabbits and pigeons were full grown, and in the thighs of each the quantity of poison inserted could not have exceeded five or six grains, yet symptoms were manifested indicative of considerable excitement and irritation, and in all of them, excepting one pigeon, death was produced in less than an hour, a proof of the poisonous quality of this vegetable substance, of which we are at present in possession of no name.

From the circumstance of a fowl having been killed in five minutes by the insertion of this poison, according to the statement of Captain Grant, it is probable that in its recent state its power is very active, but from a single experiment no decided inference can be drawn.

P. Breton, *Surgeon.*

Calcutta, *July 6th*, 1827.

NOTE BY THE EDITOR.

Mr Swinton has transmitted to us some of the poison (in the state of a dried gum) used by Mr Breton in the preceding experiments, which we have sent to an eminent chemist for the purpose of analysis. It was obtained by Captain Grant, who drew up the following memoranda.

"I send some of the poison with which the Nagas poison their arrows. I tried its *virtue* on a fowl, by putting a little on the point of a penknife, and slightly piercing it. The bird died in five minutes. The whole of the Nagas to the E. N. E. and S. E. of the valley of Munnipore use it. They make it into a paste with *tobacco water*, and rub it on the points of their arrows. Whilst on my late trip in Kubboo, I used every endeavour to find out the tree, but I could not succeed. The Nagas could not be induced by promises of reward to discover it; but always referred me from one to another. They all agreed in their account of the tree, and described it as being of enormous size. The poison is extracted by making incisions in the bark, from which it oozes. The men who are emloyed in collecting it are obliged to take the greatest precautions, and cover their mouths and nostrils while they are engaged in this occupation. They are fed by the hand of a second person all the time, and for several days after they have given up working. They also say that the trees are found at some place in the neighbourhood of Kubboo."

ART. IV.—*Farther observations on the Construction of Achromatic Telescopes with a fluid concave lens, instead of the usual lens of Flint Glass.* * By PETER BARLOW, Esq. F. R S. &c.

WE have already in two successive papers, (No. xiv. p. 335, and No. xv. p. 93,) made our readers acquainted with the improvements on the achromatic telescope proposed by Professor Barlow ; and we are sure that they will partake in our gratification when we inform them, that the Board of Longitude has authorized him to carry on his experiments at their expence.

Since the date of Professor Barlow's last communication to this *Journal*, he has had several opportunities of applying his telescope with six inches aperture and seven feet in length to the examination of double stars.

" With this instrument," says he, " the small star in Polaris is so distinct and brilliant with a power of 143, that its transit might be taken with the utmost certainty. The small stars in α Lyræ, Aldebaran, Rigel, ε Bootis, &c. are very distinctly exhibited ; amongst the larger close double stars, Castor and γ Leonis are well defined with a power of 300 ; and amongst the smaller double stars I may mention ω Aurigæ, 52 Orionis, ζ Orionis, and a variety of others of the same class. The belts and double ring of Saturn are well exhibited with a power of 150 ; and the belts and satellites of Jupiter are very tolerably defined with the same power, but will not bear a higher power than about 200, in his present situation, which is certainly not favourable : in both cases the discs of the planets are satisfactorily white, and belts and shadows well marked ; but in Jupiter, and perhaps in both, there is some uncorrected colour round the edge of the disc."

" Besides the advantages attending this principle of construction, which were formerly pointed out, I am willing to hope that another very important one (which I have not, however, been able at present practically to demonstrate) may still be effected ; namely, the reduction of what has been termed the

* The paper of which this is an abstract was read before the Royal Society of London on the 17th January 1828. Ed.

secondary spectrum, either to zero or to a very inconsiderable amount. In order to examine the practicability of this object, let us first consider the two lenses in contact, and inquire into the conditions requisite for uniting the violet, the red, and the mean ray, which latter may be accounted that on the confine of the violet and red sides of the spectrum. Let the focal length of the mean ray in the plate lens be f, and the length of the focus beyond f, viz. the red side of the spectrum, be r, its whole focus being $f + r$; let f', r' and of course $f' + r'$ denote the same in the correcting fluid lens: then, in order that the red ray may coincide with the mean ray, we must have

$$\frac{1}{f} - \frac{1}{f'} = \frac{1}{f+r} - \frac{1}{f'+r}$$

Now $$\frac{1}{f+r} = \frac{1}{f} - \frac{r}{f'(f+r)}$$

and $$\frac{1}{f'+r'} = \frac{1}{f'} - \frac{r'}{f'(f'+r')}$$

therefore, when $$\frac{1}{f} - \frac{1}{f'} = \frac{1}{f+r} - \frac{1}{f'+r'}$$

we must have $$\frac{r}{f(f+r)} = \frac{r'}{f'(f'+r')}$$

and therefore, $$f : f' :: \frac{r}{f-r} : \frac{r'}{f'+r'}$$

That is, the mean focal lengths must be to each other as the red part of the focus divided by the whole focal length of the red ray, or, as the dispersive powers for this side of the spectrum, in each lens.

"In the same way, if we denote by v and v' the length of the violet part of each focus; then to have the violet and the mean ray coincide, we must have

$$\frac{1}{f} - \frac{1}{f'} = \frac{1}{f-v} - \frac{1}{f'-v'},$$

and as before, we shall find that this can only take place when

$$\frac{v}{f(f-v)} = \frac{v'}{f'(f'-v')} : \text{ or when } f : f' :: \frac{v}{f-v} : \frac{v'}{f'-v'};$$

hence, in order to unite these three colours, the conditions must be that

$$\frac{r}{f+r} : \frac{v}{f-v} :: \frac{r'}{f'+r'} : \frac{v'}{f'-v'}$$

"But as f, r and v, in one case, and f', r and v', in the other, are dependent and proportional in each respective focus, if these proportions do not arise from the natural properties of the two media, they cannot be produced by art, while the lenses are in contact; but in any case where the violet side of the correcting or concave lens exceeds that of the red in a greater proportion than the violet exceeds the red in the convex lens, and if the dispersive ratio be so great as to admit of the lenses being sufficiently opened from each other, then such a distance may be found as shall produce the above proportion; and hence unite these three rays in one common focus, or at least approximate towards this result.

"Let the distance of the lenses be d, and let the plate focus remain as before f, then the negative focus must be reduced till $\frac{(f-d)^2}{ff'}$ = dispersion.*

"Conceive this length to be found, which may still be denoted by f', and r' and v' may also denote the same as before, the ratio $\frac{r'}{f'-r'}$ to $\frac{v'}{f'-v'}$, will likewise still remain the same.

"But the coloured focus of the plate lens remaining the same as before, while the mean focus is changed from f to $f-d$; we must now, in order to unite the three rays, have

$$\frac{r}{f-d+r} : \frac{v}{f-a-v} :: \frac{r'}{f'+r'} : \frac{v}{f'-v'}.$$

The two latter terms remaining in the same ratio, while the two former may be varied at pleasure by changing the value of d; which will have no effect on the ratio of the latter terms, although the actual value of f', r' and v', must necessarily vary for every change in the value of d.

"Let the constant ratio of the latter terms be $m : n$; then we have to find d, such that

$$\frac{}{f-d+r} : \frac{v}{f-v-v} :: m : n; \text{ or, } \frac{nr}{f-d+r} = \frac{mv}{f-d-v}$$

which reduced, gives $d = \frac{mvf + mvr - nrf + nvr}{m - nr}$

"If now a', a'', a''' be taken to denote the refractive indices of the red, green, and violet ray in the front lens, we shall find f, r and v, to be to each other as 1, $\frac{a''-a'}{a'}$, and $\frac{a'''-a''}{a'''}$; and

* *Phil. Trans.* 1827, ART. XV.

substituting these proportional values for the above letters, our expression becomes

$$d = f\, a'' \left\{ \frac{m\,(a''' - a'') - n\,(a'' - a')}{m\,a'\,(a''' - a'') - n\,a'''\,(a'' - a')} \right\}$$

"In like manner, if α', α'', α''' be taken to denote the refractive indices of the red, green, and violet ray in the correcting lens, then we shall find

$$\frac{r'}{f' + r'} : \frac{v}{f' - v'} :: m : n :: \alpha'' - \alpha' : \alpha''' - \alpha''$$

which latter may therefore be substituted for m and n.

"The formula then becomes

$$d = f\, a'' \left\{ \frac{(\alpha'' - \alpha')\,(a''' - a'') - (\alpha''' - \alpha'')\,(a'' - a')}{(\alpha'' - \alpha')\,(a''' - a'')\,a' - (\alpha''' - \alpha'')\,(a'' - a')\,a'''} \right\}$$

an expression for the distance in terms of the indices and focus only.

"In plate glass, according to Fraunhofer, $a' = .515$, $a'' = .525$, and $a''' = 535$. Which value being substituted, give

$$d = f \left\{ \frac{(\alpha'' - \alpha') - (\alpha''' - \alpha'')}{.981\,(\alpha'' - \alpha') - 1.019\,(\alpha''' - \alpha'')} \right\}$$

In flint glass, from the same authority, $\alpha' = .602$, $\alpha'' = .620$, $\alpha''' = .640$. Which numbers being substituted, give $d = .734 f$. An impracticable distance in this case, because the dispersive power of flint glass is not great enough to correct the plate lens when so far removed.

If these indices had been .602, .621, and .640, then we should find $d = 0$, or the lenses ought then to be in contact. A change therefore of .001 in the index of the green ray changes the distances of the lenses from nothing to nearly three-fourths of the whole focus of the plate; consequently, the determination of the proper distance to combine the three colours, when the media are such as to admit of it, depends upon the most delicate determination of the indices of the red, green, and violet rays; but these being so determined, and the dispersive power of the medium being great enough, the most complete union may be effected.

Whether the sulphuret of carbon fall within this limit or not, I am not at present able to say. I have attempted to find the indices of the different colours by means of a prism; but it is extremely difficult to determine the limits of the different shades, and perhaps after all the best way is by actual experiment on the telescope itself. Fearful in the beginning of advancing too far in opening the lenses, the first experiment was made with the fluid at a very inconsiderable distance behind the plate, and the quantity of uncorrected colour was very great. I next tried a distance of 18 inches, and the uncorrected colour was considerably less than before, but still too great. With this distance the experiment was witnessed by Captain Kater. I next opened the lenses 24 inches, and at this distance the experiment was witnessed by Professor Airy, who still detected some uncorrected colour, which, however, is not sensible to my eye till the telescope is applied with a high power to Jupiter, Venus, or some bright star; neither was this defect felt in any sensible degree by Mr South or Captain Beaufort, who were also present.

From the gradual diminution of the outstanding purple by opening the lenses from contact to 24 inches, I suspect with a distance of 32 inches (which is perhaps the most I can venture upon with a focus of 48 inches for my plate,) that the red would be outstanding; and if so, the proper point must be between these limits.

This, however, remains to be verified by experiment. Should it be effected, we may enumerate the advantages of this telescope as follow :—

1. It renders us independent of flint glass.

2. It enables us to increase the aperture of the telescope to a very considerable extent.

3. It gives us all the light, field, and focal power of a telescope of one and a-half times at least, probably of twice the length of the tube.

4. It is presumed that further experiments may enable us to find such a distance for the lenses as shall reduce what has been termed the secondary spectrum (inseparable from the usual construction,) either to zero or to an inconsiderable amount.

Note.—It may be proper to state, that, between the temperature of 31° in February and 84° in August, and again at 31° in December or November, I found no appreciable difference in the index noting the focal length of the telescope. The fluid has even been put in a state of ebullition by the application of red hot iron, and in a very few minutes has become transparent, and the focus remained either exactly or very nearly the same.*

Art. V.—*On the time at which Nearchus left the Indus.* Communicated by the Author.

The connection of astronomy and chronology is a subject of great interest as well as usefulness. It may not appear at first sight to be a matter of much importance whether an event took place a few days sooner or a few days later; but there is great satisfaction, when, from the unerring aspect of the heavenly bodies, we are able to fix the time at which any thing occurred. This gives a degree of precision as well as of authenticity and certainty to an epoch which could hardly be derived from any other source. With this view the following remarks were drawn up. They do not lead us, indeed, to a variation from a received interpretation, but they remove some difficulty which may have remained on previous suggestions, and may add something to that conclusiveness on which the mind loves to rest.

Dr Vincent's valuable work on the voyage of Nearchus may not be in every one's hand; it will be right, therefore, to quote the words of it in making the statement of the present subject; and it will make the whole more easily understood by general readers. He says†, "in regard to the second departure from the Indus, we have the united testimony of Strabo and Arrian with a shade of difference, which, though it might be well to reconcile, is not an object of importance. The date of Arrian is the 20th of Boedromion, the date of Strabo is the evening rising of the Pleiades, and both profess the authority of Nearchus.

"The evening rising of the Pleiades is fixed by Columella

* Since this note was written Professor Barlow has found that the change of position of the lens is .134 of an inch between 57° and each extreme, and that the refractive index of the fluid is as its density.—Ed.

† P. 34.

for the 6th of the Ides (that is, the 10th,) of October; we have therefore the intended sense of our author exhibited in the clearest light."

After some discussion, Dr Vincent * fixes on the 1st of October for the time mentioned by Arrian. Between this and the date derived from Columella there is a considerable difference, which Dr Vincent "never having had leisure to pursue the science of astronomy," was unable to account for. He therefore applied to Mr Wales and Dr Horsley; and the dissertations with which they supplied him are printed at the end of the volume.

Calculating for the time and country in which Columella lived, Mr Wales found † that the point of the ecliptic, which set as the lucida Pleiadum rose, was ♎ 29° 7′ 9″, and in this point the sun then was on the 19th of October. He likewise found that the point which rose as the star set was ♏ 4° 20′, which point the sun occupied on the 29th of October. The former of these dates differs nine days from the time assigned by Columella, which, as we have before-mentioned, was the 10th of October; and the latter differs ten days from his time, which was the 8th of November; for he says vi. Idus Novembris vergiliæ mane occidunt.

Mr Wales examined the effect which the precession of the equinox would have produced between the time of Columella and that of Alexander; but he found that the alteration would not have amounted to more than two days ‡, which was not enough to clear up the difficulty. But it may be remarked, as he observes §, that one of these errors is in defect, and the other in excess. And "it is manifest the star's rising cannot be observed when it rises exactly as the sun sets, nor can its setting be seen when it sets exactly as the sun rises, on account of the daylight; but perhaps the one might be seen by a good eye in the latitude of Rome, nine or ten days before, and the other as much after the time when the two circumstances happened together; and I have not a doubt but that the difference between Columella's observation and my calculation is to be attributed to this cause."

* P. 496. † P. 501. ‡ P. 503. § P. 502.

Dr Horsley does not merely reason on Mr Wales's calculations. He goes himself completely through the whole problem, and, making allowance for the effect of refraction, he finds that "*the 19th of October (Styl. Jul.) was the day of the acronychal rising of lucida Pleiadum upon the horizon of the mouth of the Indus in the year before Christ 326." He then discusses the date of the 20th of Boedromion from the *Athenian Calendar*, and says †, "it is certain that on one of these two days, either the 30th of September or the 1st of October, Nearchus sailed from the mouth of the Indus, according to Arrian; consequently, he had been eighteen or nineteen days at sea before the day came of the acronychal rising of lucida Pleiadum; taking acronychal rising strictly, according to the mathematical definition of the terms." He goes on to reason on these results, and then says, "after various conjectures and many long calculations, I am entirely persuaded that Mr Wales's very ingenious conjecture, by which he reconciles his calculation of the acronychal rising of the Pleiades at Rome, in the year of our Lord 42, with Columella's date, is the only true solution of the difficulty ‡. It certainly was very natural (and it was the only way for popular use) for the ancients to call that the evening of the acronychal rising, on which they first missed the light of the rising star." Dr Horsley, however, does not satisfy himself with a loose estimate of the number of days which might intervene between the time at which the star would cease to be visible and that at which it would really set. He reduces it to certainty by calculation. "Lucida Pleiadum," he adds, "is a star of the third magnitude; and Ptolemy says, that stars of the third magnitude first become visible when the sun is sunk 14° below the horizon." Applying this to the given time and place, he found that on the § 30th of September the star might have been still visible; "but the next evening, the 1st of October, the sun would be only 13° 37′ 15″ below the horizon when the star was rising. This evening therefore the star could not be seen upon the horizon. It appears, therefore, that what these mariners would call the acronychal rising of the Pleiades, took place

* P. 514. † P. 517. ‡ P. 518. § P 519.

either on the very day the fleet sailed, or the next, or at the latest, the next day but one."

In a * postscript to his dissertation, (which is addressed to Dr Vincent,) he mentions, that after he had finished his calculations, he almost accidentally met with a passage in Usher, in which the evening rising of the Pleiades is said to take place on the 1st of October. He considers that Usher makes this assertion on the authority of Euctemon, as cited by Geminus; and then adds with some exultation, "had you had the ill luck to consult Usher's Ephemeris on Geminus, instead of Columella, you would not have proposed this question to Wales or me, for you would have taken it for granted that Strabo and Arrian agreed. Had either he or I consulted them before we calculated, we perhaps should not have engaged in the labour of these calculations. We should have advised you to follow Euctemon without regard to Columella, describing the phenomena of another climate in another age; but then we should not have discovered what Wales has conjectured, and my calculations, I think, put out of doubt; that when the ancients speak of acronychal risings, they are to be understood of the sensible acronysm; and this is a principle which may prevent many mistakes in deducing conclusions in chronology for these astronomical characters of time which the ancients used."

It is not uncommon even for able men to be carried away by the pleasure of a fancied discovery, and to make every thing bend to the view which they have taken. This is the case with Dr Horsley in the present instance; and perhaps it is not too much to say, that, if we wish for the exact truth, we must seek for it in the contrary of almost every part of the preceding passage. There is so much in Columella on the times of the risings and settings of the stars, that we cannot wonder at Dr Vincent's having recourse to him for his date. He seems to have stated the question merely as a difficulty which he had found in reconciling this authority with the time mentioned by Arrian; it is easy, therefore, to see the direction which was given to Mr Wales's investigation. We may trace the same effect, though more remotely, on Dr Horsley; for, although he particularly says,† "I have not

* P. 521. † P. 505.

concerned myself at all with Columella's risings and settings," still, if "ill luck" had not turned the inquiry into that point, his investigations would probably have taken a different direction. This discussion so completely supplies all the necessary calculations, that we should have had to regret any thing which had curtailed it: but he was a scholar as well as a mathematician; and if, without any previous bias, he had gone to the original text of Strabo, he most probably would have consulted, as he ought, the Greek astronomers for an interpretation of it. He would have found that Geminus would have led him to the truth; and instead of the confusion, which made him think that he had discovered something yet unobserved about the acronychal risings and settings, he would have found that Euctemon's was the only date to which Strabo's words could be properly applied. It may be remarked, likewise, that there is an inversion of regular and legitimate method in the course of his reasoning. The coincidence of date which he arrives at must certainly leave a strong impression of the accuracy of the conjecture which leads to it; but still it cannot be denied that in this we shall rather have established our premises from our conclusion, than have proved the point in question by a sound course of reasoning. We have arrived at what will afford a very probable solution of our difficulty; but there is something still wanting to show that the proposed solution is really the true one. This is what now remains to be more particularly considered.

When any precision is required, the observations of the heavenly bodies on the horizon are the very worst which can be made. The effects of refraction at such very low altitudes are great, and liable to so many variations, that allowances cannot always be made for them with certainty, even in the present state of our knowledge: and when we consider that the appearance and disappearance of stars, as they are affected by the sun's light, will vary (even in the same place) with their different degrees of brilliancy, the state of the atmosphere, the powers of perception in the eye of the observer, it is evident that great latitude must be allowed for the times which are fixed for these phenomena. It is only astonishing that these epochs come so near to the truth; and this can only be accounted for by the constant care and attention which were applied by the ancients to these observations. At one time, indeed, the whole of astronomy comprised hardly any thing else; and they certainly possessed many advantages, when more accurate means of information were unknown, for the common purposes of human life. Since modern science has directed us to better ways of observation, these have of course become neglected, and disuse has thrown a degree of obscurity over them, when, in truth, there is nothing really intricate in their nature. When a star rose exactly at the same time in the morning with the sun, or set exactly at the same time with it in the evening, it was said to rise or set cosmically: and when a star rose exactly at the same time in the evening at which the sun set, or set in the morning exactly at sunrise, it was said to rise or set acronychally.

These were the four fundamental combinations, by the returns of which the ancients marked their seasons; but, as the stars cannot be visible when the sun is on the horizon, they could never be the objects of immediate observations. It became necessary, therefore, both for approximation to the true synchronisms and for estimates of the lapse of time, to observe the stars as long as they were visible before sunrise, and as soon as they became visible after sunset; and it is clear, from this general view, that whether we consider them cosmically or acronychally, the visible risings must always be later than the true, and, on the contrary, that the visible settings must take place sooner than the true.

When the star emerged from the sun's light, so as to be first distinguished before day-break in the east, it was said to rise heliacally; and when it sunk into the sun's light, so as to cease to be visible in the west after sunset, it was said to set heliacally. These phenomena are so repeatedly alluded to, that, if Strabo's date had been the morning instead of the evening rising of the Pleiades, it is impossible that Dr Horsley could have had any difficulty. But we have here a very remarkable instance of the use and influence of names. The ancients did not confine themselves to the strict acronychal risings and settings; they likewise attended particularly to the last visible rising of a star in the evening, and its first visible setting in the morning. These last had the same analogy to the acronychal rising and settings which the heliacal had to the cosmical; but they appear to have had no generic title assigned to them, and consequently to have escaped both the friends to whom Dr Vincent applied. They had, however, particular names, which not only distinguished them, but likewise would have removed all possible doubt about this passage, if they had been properly attended to.

Strabo * says, *ο Νεαρχος . . . . . μετοπωρυ κατα πλειαδος επιτολην εσπεριαν αρξασθαι τυ πλυ.* Now, had he meant to refer to the strict acronychal setting, as Mr Wales and Dr Horsley have supposed through the whole of their dissertations, he would have used the word *ανατολη*, and not *επιτολη*. This Dr Horsley, if his thoughts had not been turned into a different direction, would probably have noticed; for he refers to Geminus; and that very author says in the beginning of his eleventh chapter, that there is a great difference in the meanings of the two words. Autolycus, however, marks the specific difference between them in the manner which is most to our present purpose; for he defines it to be *εσπερια ανατολη, οταν αμα τω ηλιω δυνοντι αστρον τι ανατελλη*, and to be *εσπερια επιτολη, οταν μετα το τον ηλιον δυναι αστρον τι εσχατως φανη ανατελλον.* It is impossible for words to be found which could show with greater perspicuity, that Strabo has exactly said what Horsley, after expending much thought and labour, had at last conjectured that he meant to say. But if Dr Horsley after all came to a right conclusion in this particular instance, he arrived at it by a method, which, by too rapid a generalizing, has made him lay down an erroneous rule. It is natural that most dates would be assigned by the visible rather than by the true risings and settings; these were more familiar to the mind, and more easily determined; but it is not true that the two ideas were confounded, or when the acronychal risings and settings are mentioned we are always to understand "the sensible acronysm." In English and in Latin there is a want of distinctive names, which may often create an ambiguity; but the richness of the Greek language gives us more precision, in that, as Geminus points out, *δυσις* for the real setting answers to *ανατολη*, and *κρυψις*, for the

* Lib. xv

loss of the visible object answers to επιβολη. I do not mean to assert that these terms are never misapplied; but Strabo has not been guilty of this critical inaccuracy; their very existence proves the reality of the separate ideas; and this is in itself sufficient to show that there is no foundation for what Dr Horsley has mistaken for a discovery of great use to the chronologist.

S. P. R.

OXFORD, *July* 1828.

ART. VI.—*On the relative quantities of steam condensed in vessels with bright metallic and blackened surfaces.* By R. W. FOX, Esq. Vice-President of the Royal Geological Society of Cornwall. Communicated by WILLIAM J. HENWOOD, F. G. S.

Two cubical vessels of tin plate, of which the surface of one was bright, and that of the other covered with lamp-black, were connected with a steam boiler, by tubes so inclined towards the latter as to allow all water obtaining from condensation in the tubes to return to it. The vessels were of equal dimensions, four inches side, and the experiment was made in a close room, of which the temperature was 52°; that of the steam being at a mean of 215°. The water was withdrawn by cocks properly adjusted for the purpose; and at the expiration of seventy-two minutes, the bright vessel had afforded 5.7, and the blackened one 10.2 cubic inches. Now, supposing steam of this temperature to be 1600 times rarer than water, in twenty-four hours the condensation from one foot of blackened surface would be 489600 cubic inches, or 1736 gallons of steam, and from an equal extent of bright metallic surface 273600 cubic inches, or 972 gallons. Hence the condensing energies of a blackened and polished metallic surface were to one another as 1736 is to 972. When the difference between the temperature of the heated body and that of the surrounding medium is greater, the effect will be proportionally augmented.

But when currents obtain it is probable that the effect will be increased in both; but that the ratio of this increase will be greater for the bright than for the blackened surface. Considerable currents of air could not be avoided in the case detailed in the observations on Huel Towan engine.

Art. VII.—*Account of the climate and agriculture of Soobathoo and Kotgurh.* By Captain Patrick Gerard of the Bengal Native Infantry. Communicated by the Author.

Soobathoo, a small fort and military post, occupied by the 1st Nusseeree, or 6th local battalion, or hill-corps, is situated in North latitude 30° 58′, and east longitude 76° 59′, about 4205 feet by barometrical measurement above the level of the sea, and about 3000 feet above the protected Seikh states, in the plains of Hindoostan. Its horizontal distance from the latter, from which it is separated by two intermediate ranges of low hills, is ten miles; from the nearest point of the Himalayah chain about sixty-five miles; from the Sutliij, or Sutoodra (the ancient Hesudrus,) twenty-four; and from Kotgurh, forty. It is the chief place of the Purgunnah of the same name, and was formerly comprised in the state of Thakooraee, or lordship of Theoouthul; but was ceded to the British Government at the termination of the war with the Goorkha power.

The Pergunnah of Soobathoo is a sort of flat or table-land, having mountains in the neighbourhood from 4600 to 8000 feet in height above the sea. Its general aspect is open and much exposed; and being comparatively low and near the plains, it is in some degree subject to the effects of the hot winds, which blow from thence during the months of April, May, and June, although the intermediate ranges are considerably elevated above it. The fort lies on the right bank of a branch of the small river Gumbrer, which flows about 1100 feet below it on the south-west, and at the distance of one mile in a straight line. From the table-land there is a very steep descent towards the south-west and north-east, whilst the south-east and north-west sides are bounded by ranges of moderate elevation. The hills in the immediate neighbourhood are almost entirely destitute of wood, while those at a short distance are covered on their northern faces with large pines of the common species, shrubs, and bushes.

The neighbourhood of Soobathoo, considering all things, and especially the oppressive treatment experienced by the inhabitants under the Goorkha rule, is rather populous, and the surrounding flats and slopes are highly cultivated. The country is studded with numerous, though for the most part small villages, few of them containing more than from four to six, twelve, or fifteen houses or families. The number of the villages has increased to an astonishing degree since Soobathoo became a military post, and subject to British jurisdiction.

The appearance of the country is pleasing to the eye of a stranger, though differing widely from that of the interior. The climate is extremely agreeable, the mean temperature being no higher than about 65°. During May and June it is sometimes rather hot; but it seldom becomes what is called oppressive in a house. Taking it all in all, it is very healthy throughout the year. Fevers and rheumatisms are the predominant complaints; the latter prevail most in the cold weather, the former during the periodical rains, (which commence towards the end of June), and generally whenever the weather is damp or subject to sudden changes. Cases of fever, however, are remarkably few here compared to the plains. When the winter is rigorous snow falls in January and February to the depth of about four inches; but it seldom lies on the ground above two or three days, in consequence of the low and exposed situation of the country, and the power of the sun's rays. Hoar frosts commence in November, and vanish about the beginning or middle of March. In severe seasons, during the latter part of December, January, and the early part of February, standing water freezes to a considerable thickness. The season of the rains, which, generally speaking, are rather heavy, terminates sometimes about the middle or end of September, at other times not till beyond the middle of October.

The country around Soobathoo is much cultivated, and agriculture carried on to a considerable extent, and this is rapidly on the increase wherever the inhabitants from the adjacent states, who are often obliged to fly from the tyranny and oppression of their petty rulers, can obtain arable lands sufficient for the maintenance of themselves and their families.

The declivities of the hills and mountains, which are unobstructed by rocks, are very generally cultivated, and are cut and laid out with a considerable deal of labour into ledges or sloping fields, of all shapes and dimensions, but in general having much resemblance to the steps of a ladder placed in an inclined position. These are supported by embankments formed mostly of earth, but sometimes of stone. All flats or pieces of table-land are carefully cultivated. Those on the banks of rivers and streams are planted chiefly with rice, from the convenience of obtaining water for irrigation. The rice crops are most luxuriant, and yield a plentiful return to the farmer. The best rice, which is uncommonly cheap, is reckoned superior to any of a similar kind produced in the plains near this quarter.

The productions of the country around Soobathoo are very various. The following are the most important:—Indian corn, cotton, opium in a small quantity, rice of several kinds, wheat, jow (barley,) koda or murwa, (*Paspalum scrobiculatum*,) various kinds of pulse, the several species of bathoo (*Amaranthus anardhana*,) oogul (*Panicum emarginatum*,) kuchalloo, or pinalloo (the Jerusalem artichoke, I believe,) kounguee, cheena (*Panicum miliaceum*,) bujra, ginger, which is a great article of export trade, being much superior to that produced in the plains, and scarcely inferior, in point of size and quality, to that which is grown in China; tobacco, lustum or garlic, chillees or red pepper; besides a great variety of others, including some common vegetables, which it is hardly necessary to notice, as they differ but little from those raised in the plains of Hindoostan.

In regard to fruit trees, there are abundance of apricots, peaches, walnuts, wild pears, raspberries of a purple colour, large and plentiful; also, thaephul (*Amyris heptaphylla*,) and a variety of other wild fruits.

Kotgurh, a small village and military out-post, occupied by a detachment of the 1st Nusseeree battalion, is situated on the left bank of the Sutliij, in north latitude 31° 19′, and east lon gitude 77° 30′. It lies on the slope of a range, which rises to the height of 10,656 feet above the level of the sea, and is crowned by Wartoo or Huttoo Fort, now dismantled and in ruins. This range separates the dell of the Sutliij from those of the Pubber, Jumna, and Tons, and the other great rivers to the south-east.

The cantonment of Kotgurh is 6634 feet above the sea, the difference of level between it and Soobathoo being 2429 feet, which answers to a mean decrement of temperature of nearly 10°. The Sutliij is about four miles distant in a straight line to the north-west, the bed of the river being about 4000 feet lower than Kotgurh, from which there is a steep descent to it the whole way. The distance from the plains of Hindoostan is about fifty miles, and from the nearest point of the Himalayaha twenty-five.*

Kotgurh enjoys a delightful climate throughout the year. The rains commence about the 20th or 25th of June, and continue to the end of September, and sometimes even to the middle of October; occasionally also they terminate by the 15th of September. In general they are heavier and more protracted than in the plains. They are followed by what may be called autumn, which lasts all October and the greater part of November, according to the mildness or severity of the season; after which, winter with all its horrors sets in. The temperature during the rainy season is quite pleasant, though sometimes a little chilly. When the sun at any time breaks through the clouds, it rarely rises to 72° in the house; but this heat, in a humid atmosphere which checks evaporation, occasionally feels close.

During the months of April, May, and June,—that period of the year so scorching and oppressive in the plains of Hindoostan,—the climate of Kotgurh is cool and agreeable in the shade, and within doors a cloth coat rarely feels uncomfortable; but in the open air it is very hot; for although the mean temperature of the climate does not exceed that of London above two or three degrees, the power of the sun's rays is intense.

* Munnee Maira, the nearest town in Plain-level, being about one mile distant from the foot of the hills, is not less than 1200 feet above the level of the sea.

The winters here resemble those of Europe, but are less severe. Frosts commence before the middle of October, and in December, January, and February, snow falls, and lies in shaded places to the northward, from one to three feet deep. Sometimes it falls so early as the middle of November, sometimes also so late as the beginning of March; but at these seasons it never continues on the ground, for although, in some respects, great elevation is equivalent to high geographical latitude, putting the climate of Kotgurh pretty much on a par with that of the south of England, yet, owing to the much greater perpendicularity of the sun's rays at the former place, they have very considerable power even in winter, and in exposed situations the snow melts away in a few days of sunshine. The air, however, continues very sharp, and frosty nights prevail during the greater part of March. It is worthy of remark, that the flakes of snow are here extremely large,—much larger than I remember ever to have seen them in Europe.

At Kotgurh, and places of similar elevation, spring may be said to commence about the middle or latter end of March, (although this depends greatly on the nature of the season,) and to continue all April. May is often rude and disagreeable; if rainy, fires and woollen clothes are indispensable to comfort.

The harvest, or reaping season, commences in May, and terminates about the end of June. The jow, or barley, is the grain which ripens earliest. The kunuk, or wheat, and the cowa jow (*Hordeum cœleste*,) are fully a month later. In situations more elevated than the neighbourhood of Kotgurh, the crops are often very backward. The wheat, especially, is frequently not housed till some time after the rainy season has fairly set in. The consequence is that great part of the grain never ripens, and the natives are obliged to reap it while partially in a green immature state, (the ear being full, however,) in order to preserve the whole from injury and destruction.

Kotgurh is surrounded on three sides by thick woods, in which woods there is a number of rhododendrons, pines, and oaks; and, indeed, there are to be found in the neighbourhood almost every tree, shrub, and plant, indigenous to Europe, besides a variety of others unknown. *

The vegetable productions are much the same as those of Soobathoo. The following may be mentioned as the chief: Several kinds of rice, mostly of the coarser sort; jow, or barley; coua jou, (*Hordeum cœleste*;) kunuk, or wheat; phuphura, or phuphur, (*Panicum tartaricum*;) cogul, (*Panicum emarginatum*;) chuberee, or jaburee, the grain of which differs little in appearance from that of the phuphur and cogul; opium in considerable quantities for export trade; three species of bathoo, (*Amaranthus anardhana*,) red, black, and white; kuchalloo, or pinalloo, (Jerusalem artichoke); various kinds of pulse; a small quantity of coarse tobacco; a small quantity of cotton and ginger on the banks of the Sutliij and other rivers; Indian corn in a limited quantity; koungee, cheena, (*Panicum miliaceum*;) and murwa or koda, (*Paspalum scrobiculatum* †.)

The principal fruits are apricots, peaches, cherries, small and very acid; apples, pears, a few grapes, mulberries; bymee, or bymbee, a hardy species of apricot or peach, the stone of which much resembles that of the common apricot, which is very abundant throughout the hills; filberts, hazel-nuts, horse-chestnuts, several kinds of black raspberries, strawberries, with a great variety of other fruits, the indigenous productions of the country.

In the interior of the hills oats grow spontaneously among the wheat and barley fields; but the grain of it is so small that the natives make no use of it, and seem to be entirely ignorant that it is an excellent and nourishing food for cattle.

Two hardy species of rice are cultivated in elevated situations, assisted by irrigation. The crops of both are exposed to occasional falls of snow, which they sustain apparently with-

* Among these is a species of small red bamboo, which attains to the height of eight or twelve feet, growing all over the higher mountains. It is used for a variety of domestic purposes; and if introduced into Britain, might prove a valuable acquisition to the peasantry, to gardeners, and to many other classes of the community.

† Cogul, phuphura, jaburee, and pinpalloo, are more peculiar to the interior of the mountains, where they thrive much better than in the lower hills.

out injury. These species are, I believe, yet unknown in botany, and their introduction into Britain and other parts of Europe might prove an important acquisition. They are both of the coarser sort.

Kotgurh was formerly comprised in the Purgunnah of Lundhock, one of the divisions of the independent petty state of Kotgoonoo; but was ceded to the British government shortly after the termination of the war with Nepaul in this quarter, in 1815.

The natives of this part of the country are subject to the goitre, or large swelling in the neck. The other complaints most prevalent among them are fevers and rheumatism.

The general aspect of the country around Kotgurh differs materially from that of the lower mountains near the plains. The ranges are more regular, and the hills are lofty and abrupt. The villages are few, and in general very small; the population is scanty and scattered, and does not seem to be on the increase *. The quantity of waste land is very considerable; but great part of it evidently appears to have been cultivated at an antecedent period, indicating beyond a doubt that the country was better peopled formerly than it is now. Most of the villages are more or less in ruins, and some of the houses which are still standing are unoccupied. This may be partly accounted for by the tyrannical measures frequently resorted to by the Goorkha chiefs to keep a refractory people under subjection.

In addition to what has been formerly mentioned of the agriculture of this part of the country, the following observations may be made.

* The circumstance of population being stationary may be easily accounted for by the frequency of female infanticide; by the prevalence of the revolting custom of polyandry, or a plurality of husbands to one wife; by the promiscuous intercourse which takes place between the sexes, from the early age of eight or ten, female chastity being here entirely unknown; and by the existence of slavery. The first of these, so far as I know, is now of rare occurrence in those states which have been subjected to British authority; and the traffic in slaves, which was formerly carried on to a considerable extent with the plains of Hindoostan, especially from the lower hills, has certainly of late years much diminished. It is therefore to be expected that population will now begin to increase.

Immediately after the rains cease, and whilst the soil is yet in a moist state, the zumeendars, or farmers, begin to plough, and to sow wheat, barley, and coua jow, being the principal grains on which the inhabitants at this elevation are dependent. These are buried under the snow during the winter months. When much snow falls, the produce of these grains is very considerable; but when there does not, and the ground is not sufficiently saturated with rain during the latter part of February and the early part of March, the crops are very poor, and not unfrequently scarcity ensues, and sometimes, though seldom, the natives are reduced to a state of extreme wretchedness. In places more elevated than Kotgurh the grain often suffers considerable injury from a severe winter; while lower down, and on the banks of the river Sutliij, the wheat and barley crops yield but a small return to the husbandman even in good seasons. This, however, greatly depends on the quantity of rain which falls during the season. The low lands and flats on the banks of the rivers and streams are more adapted to the cultivation of coarse rice, which thrives there remarkably well, and yields a plentiful return. *

After the different grain crops on the high lands have attained the height of two or three inches, the natives in the interior make a practice of spreading manure over them, which (they say) is the means of materially increasing their value.

Bullocks are the only animals used in all stages of agriculture in the mountains on the hither side of the Himalayas. All grain is trodden out by them with their mouths muzzled, in the same manner as in the plains of India. The grain after being cut is bound into small sheaves, and allowed to lie and dry in the sun for some time, after which it is stocked; subsequently it is spread out in circular flats paved with stones, and trodden out as above-mentioned.

The same sort of rude plough used in the plains is employed also in the hills, and the implements of husbandry are few, and of little worth.

The fields on the sides of steep mountains are formed into

* Bamboos and some of the tropical fruits grow on the banks of the Sutliij, the climate of the hills being extremely diversified, according to the elevation above the level of the sea.

inclined terraces of all sizes and descriptions, and supported by stone walls. On the banks of the Sutliij and other rivers where the principal produce is rice, the fields are invariably partitioned out into flats, to allow the water necessary for irrigation to cover the whole surface equally.

The seasons at Kotgurh are greatly more backward than in the plains of Hindoostan, nearly corresponding with those in the central parts of Europe. In other words, the harvest is fully a month or six weeks later than at Soobathoo, where again it is a month behind that of the plains.

We begin to sow European vegetables in February and March, and plant potatoes in March, April, and May. The reaping season on the banks of the Sutliij, in the neighbourhood of Kotgurh, where the heat is extremely great and oppressive, is, if any thing, earlier than about Soobathoo, and in situations of similar elevation above the sea. The crops of wheat and barley are more luxuriant and productive about Kotgurh than they are in the lower hills; and coua jow, which is little inferior to the wheat in quality and productiveness, thrive at a less elevation,—at least the natives never cultivate it.

The wheat, barley, and cowa jow crops, are succeeded by phuphura, cogul, chuberee, and the several kinds of bathoo, which are all cut down and taken in before the winter commences.

Art. VIII.—*Observations on Ventriloquism.** By Dugald Stewart, Esq.

Numberless facts might be adduced, to show how very much the effects of all the imitative arts are aided by the imagination of the spectator or of the hearer. But I shall confine myself at present to an example which, as far as I know, has not hitherto attracted the notice of philosophers;—I mean the art of the *Ventriloquist*,—an art, which, if I am not mistaken, will be found, on examination, to bear a closer analogy to the nobler art of the painter, than we should, at first sight, be disposed to apprehend.

* From his *Elements of the Philosophy of the Human Mind*, Vol. iii. p. 229. Appendix.

In what follows, I take for granted that my readers are acquainted with the distinction, so finely illustrated by Bishop Berkeley, between the original and the acquired perceptions of our different senses; more particularly, between the original and the acquired perceptions of the eye and of the ear. It is on the former of these senses that Berkeley has chiefly enlarged; and *this* he has done with such a fulness and clearness of illustration, that succeeding writers have in general done nothing more than to repeat over his reasonings, with very little, either of alteration or of addition. The metaphysical problems relating to the sense of *hearing* have been hitherto overlooked by almost all our physiologists, although they present various subjects of inquiry, not less curious and difficult than those connected with the theory of vision.

The senses of hearing and of seeing agree in this, that they both convey to us intimations concerning the *distances*, and also concerning the *directions* of their respective objects. The intimations, indeed, which we receive by the former, are by no means so precise as those of the latter. They are, however, such as to be of essential use to us in the common concerns of life. That one sound comes from the immediate neighbourhood,—another from a distance; one sound from above,—another from below; one from before,—another from behind; one from the right hand,—another from the left, are judgments which we have every moment occasion to form, and which we form with the most perfect confidence.

With respect to the *signs* which enable us to form our estimates of *distance* by the ear, there is little or no difficulty; as they seem to consist merely of the different gradations of which sounds are susceptible in point of loudness and of distinctness. In what manner our estimates of *direction* are formed, has not I think, been as yet satisfactorily explained; nor, indeed, do I know of any writer whatever, excepting Mr Gough of Kendal, who has even attempted the solution of the problem. The difficulty attending it arises, probably, in some measure, from the imperfection of our knowledge concerning the theory of sound; a subject which, after all the researches of Sir Isaac Newton, continues to be involved in considerable obscurity. One thing seems to be pretty obvious, that the effect of which we are *conscious* depends on the *mechanical* impression connected with the direction in which the *last impulse* is made on the organ of hearing; but how this impulse is modified according to the position of the sonorous body, (although that it is so, our daily experience leaves no doubt,) it is not an easy matter to imagine.

If this conclusion be admitted, the imitation of the ventriloquist (in so far as *direction* is concerned) would appear to be not only unaccountable, but quite impossible; inasmuch as the effect on the hearer's ear, which serves to him as a *sign* of the place of the object, does not depend on any particular modification of sound which a mimic can copy, but on the *actual* direction in which the sound falls upon the organ.

Mr Gough himself seems to be sensible of this, and, accordingly, he supposes the art of the ventriloquist to consist in a power of throwing his voice at pleasure towards the different walls of a room, so as to produce an *echo* in that particular direction which suits his purpose. His own words are: "He who is master of this art, *has nothing to do* but to place his mouth obliquely to the company, and *to dart his words*, if I may use the expression, against an opposing object, whence they will be reflected immediately, so as to strike the ears of the audience from an unexpected quarter, in consequence of which, the reflector will appear to be the speaker." But to this theory, two obvious and insurmountable objections occur: 1*st*, Supposing the ventriloquist to possess this very extraordinary power of producing an echo in a room where none was ever heard before, it still remains to be explained, how this echo comes to drown, or rather to *annihilate* the original sound. In every case of echo, *two* sounds at least are heard. Whence is it, then, that the echo of the ventriloquist's voice should so completely supplant the original sound, as to occupy solely and exclusively the attention of the audience?

2*d*, Mr Gough's theory proceeds altogether on the supposition, that the art of ventriloquism can be practised only within the walls of a room; whereas I apprehend the fact to be, that it may be exercised, at least, with equal advantage, in the open air. If this last statement be correct, it puts an end to the controversy at once.

I was much pleased to observe the coincidence between both these remarks, (which struck me when I first read Mr Gough's paper,) and the following strictures on his theory of ventriloquism, in a very ingenious article of the Edinburgh Review. After quoting the same passage which I have already referred to, the reviewer proceeds thus:

"Though this comprehends the scope of the author's doctrine, we are of opinion that it affords a deficient and inadequate explanation even of the case that he relates, in which the ventriloquist performed his operations in a confined room. The power of projecting the voice against a plain wall, so that it shall be reflected to a given point, is difficult, and we may almost say impossible of attainment. But, granting that this power were attained, the reflected tones of the voice must be a mere echo, whilst the sounds proceeding immediately from the mouth of the speaker, being both louder in degree, and prior in point of time, must necessarily, as is the case in every echo, drown the first parts of the reflected sounds, and make the remainder appear evidently different from the original. The author seems to have been led into this theory by the analogy of light, without perhaps duly considering that the particles of light move successively in direct lines; whereas the undulations of sound must necessarily expand and enlarge, as they proceed on from the sounding body. But the feats of ventriloquism are often performed *sub dio*, when no means for reflecting the voice can be present, and where, of course, the author's doctrine cannot in any respect apply. He has omitted to mention a cause which has a very powerful influence in effecting the deception, viz. the expectation excited in the spectator or hearer, by the artist having previously informed him from whence he proposes to make the sounds proceed. This circumstance, of raising expectation almost to belief, aided by a peculiarly happy talent for imitating singular or striking sounds, such, for example, as the cries of a child in the act of suffocation, is perhaps a more probable explanation of the phenomena of ventriloquism."*

In the conclusion of the foregoing passage, the reviewer alludes to the influence of *Imagination* in aiding the illusions

* *Edinburgh Review,* Vol. ii. pp. 194, 195.

of the ventriloquist; a circumstance which Mr Gough has altogether overlooked, but which, in my opinion, is one of the chief principles to be attended to in this discussion. Indeed, I am strongly inclined to think, that the art of the ventriloquist, *when he produces a deception with respect to direction*, consists less in his imitative faculty, than in the address with which he manages the imaginations of his audience. In this respect ventriloquism and painting appear to me to be exact counterparts to each other. The painter can copy, with mathematical accuracy, the signs of different *direction*; but it is impossible for him to copy *all the signs* connected with difference of *distance*,—for this obvious reason, that the objects in his representation are all at the *same* distance from the eye, and, consequently, are viewed without any change in its conformation, or in the inclination of the optic axes. The ventriloquist, on the other hand, can copy the signs of different *distances*, but not the signs of different *directions*. We know, however, in the case of the eye, that if all the signs of different direction be copied, as in a correct perspective drawing, the imagination is able to supply, in a considerable degree, the signs of different distances. The imitation may not be so perfect as to produce any thing approaching to a deception; but the effect is powerfully assisted by the imagination of the spectator, who, in this, as in all other imitative arts, consults his own pleasure most effectually, when he yields himself up, without resistance, to the agreeable delusions practised on him by the artist. In like manner, in the case of the ear, is it not probable, from analogy, that if the ventriloquist can imitate the signs of different *distances*, the imagination may supply the signs of different *directions*? For this purpose, however, it is necessary that the imagination should be under the management of the ventriloquist;—a management which a little experience and address will easily enable him to acquire; and also, that the ear should be deprived of every aid which it is accustomed to receive from the eye, in judging of the local situations of objects. That both of these things are, to a certain extent, within the reach of his art, will appear from the following slight remarks.

1*st*, The ventriloquist, by concealing the motions of his lips, may contrive to bring the whole of his exhibition under the cognizance of the ear alone. Of the few persons of this description, whom I have happened to see, I have uniformly observed, that all of them contrived, under one pretext or another, to conceal their faces, while they were practising their imitations. One of the number remarked to me, that the art of ventriloquism would be perfect, if it were possible only to speak distinctly, without any movement of the lips at all.*

2d, The ventriloquist may direct the imagination towards that particular quarter from which the sound is supposed to proceed. The possibility of this appears from many facts. I have seen a person, by counterfeiting the gesticulations of a performer on the violin, while he imitated the music with his voice, rivet the eyes of his audience on the instrument, though every sound they heard proceeded from his own mouth. I have seen another, by imitating the barking of a lap-dog, direct the eyes of a whole company below the table.

A mimic of considerable powers, (the late Savile Carey) who, among his various other exhibitions, imitated very successfully the whistling of the wind blowing into a room through a narrow chink, told me, that, by way of experiment, he had frequently practised this deception in the corner of a coffee-house; and that he seldom failed to see some of the company rise to examine the tightness of the windows; while others, more intent upon their newspapers, contented themselves with putting on their hats, and buttoning their coats,

The same thing is exemplified on a greater scale in those theatres (formerly not uncommon on the Continent,) where a performer on the stage exhibits the dumb-show of singing, with

* Are not the deceptions of this kind, exemplified in some of the exhibitions of Mathews, facilitated by the slight paralytic distortion of his mouth to one side of the face? In consequence of this accident, when he wishes to conceal the motion of his lips, he has only to turn the other side of his face to the spectators. They, however, who have had the pleasure of seeing him, will readily acknowledge, that this circumstance goes but a very little way to account for his powers as a Ventriloquist. It may contribute something to give a freer scope to their exercise; but by far the greater part of the illusion depends on his singular talents as a mimic, combined with that ascendant over the imaginations of his audience, which he owes to a superiority of comic genus and of theatrical skill, seldom found in union with that secondary accomplishment.

his lips, and eyes, and gestures, while another, unseen, supplies the music with his voice. The deception in such cases, it is well known, is so complete *(at least at first)* as to impose on the nicest ear and quickest eye. The case I suspect to be very similar with the deceptions of the Ventriloquist; whose art seems to me to amount chiefly to a certain degree of address or trick, in misleading the imagination with respect to direction.* The rest resolves entirely into a particuliar modification of mimicry—*that of the signs of distance*—superadded to the other powers which mimics in general possess. Among these powers, that which ventriloquists seem in general most carefully to cultivate, is the power of imitating the modification of sounds which arises from their *obstruction*; of imitating, for example, the voice of a person heard from the adjoining apartment, or from the floor below; or the rattling of a carriage as it passes along the street.

The deception, after all, has but narrow limits; and, I suspect, owes no inconsiderable part of its effect to the sudden surprise which it occasions. It may make up completely for a small difference of direction, but is easily detected, if the difference be considerable, and if the experiment be continued for a length of time. Accordingly, it is only in very large theatres, that the division of labour, which I have just now mentioned in the art of the opera-singer, has been attempted with any considerable degree of success. In the progress of the entertainment, I have, in general, become distinctly sensible of the imposition; and have sometimes wondered that it should have misled me for a moment.

It is generally imagined that ventriloquists possess some peculiar organic faculty which is denied to other men. By the ancients they were supposed to have a power of fetching a voice from the belly or stomach. Hence they were called Εγγαστριμυθοι.

* Mr Gough, who had the misfortune to be blind from his infancy, could not possibly form any judgment, from his own experience, of the length to which this last species of deception may be carried by the help of false intimations or signs skilfully addressed to the eye. It is not, therefore, surprising, that he should have been led to adopt some of those conclusions which I have already taken the liberty to controvert. His paper, on the whole, reflects the highest honour, both on his philosophical sagacity, and on his talents as an accurate and skilful observer.

Mr Gray, in his comments upon Plato, seems plainly to have given credit to this supposition. "Those" (says he) "who are possessed of this faculty," (that is, of fetching a voice from the belly or stomach,) "can manage their voice in so wonderful a manner that it shall seem to come from what part they please, not of themselves only, but of any other person in the company, or even from the bottom of a well, down a chimney, from below stairs, &c. &c. of which I myself have been witness *." In what manner this faculty of fetching a voice from the belly or stomach should enable the possessor to work all these apparent miracles, Mr Gray has not attempted to explain. Among the moderns, a different theory has become prevalent,—that this peculiar faculty consists in the power of speaking in the act of *inspiration.* Hobbes is the earliest author, by whom I have found this idea started: "A man" (says he) "that has practised to speak by *drawing in his breath,* (which kind of men in ancient time were called *Ventriloqui,*) and so make the weakness of his voice seem to proceed, not from the weak impulsion of the organs of speech, but from distance of place, is able to make very many men believe it is a voice from Heaven, whatsoever he pleases to tell them †." The same theory has been adopted in the present times by philosophers of the highest name, and has received countenance from some very accurate observers of my own acquaintance.

* Gray's *Works,* Edit. by Mathias, vol. ii. p. 424.

† Hobbes *Of a Christian Commonwealth,* Chap. xxxvii.—If the ventriloquist really possesses this power, it is probably much less by *weakening* the voice, (as Hobbes supposes) than by divesting it of all the common marks of direction and of locality, that so unnatural a modification of speech is rendered subservient to the purposes of the impostor.

In Plato's *Dialogue,* entitled *Sophista,* the following words occur: Εντος ὑποφθεγγομενον, ὡς ατοπον Ευρυκλεα. (Plato, Ed. Serrani, vol. i. p. 252. C.) Mr Gray remarks on this passage that Eurycles was an Εγγαστριμυθος, and that those who had the same faculty were called after him *Euryclitæ.* Serranus translates ατοπον, *importunum et absurdum.* Is it not more reasonable to suppose that Plato used the word ατοπον in its literal, and, in this case, much more appropriate sense, to denote the distinguishing faculty of a ventriloquist, by which he contrives to appear *without place or position,* or, which comes to the same thing, to change his apparent place at pleasure: in the words of Seneca, Nusquam est, qui ubique est.—(Sen. Epist. 2.)

For my own part, I must acknowledge that I entertain great doubts about the fact, as I cannot conceive what aid the ventriloquist could derive in the exercise of his art, from such an extraordinary power, if it were really in his possession. My opportunities, however, of witnessing such exhibitions have been but few, and never afforded me access to a particular examination of the performer; I would be understood, therefore, rather to propose a query for the consideration of others, than to give a decided opinion of my own *. That the imagination alone of the spectators, when skilfully managed, may be rendered subservient, in a considerable degree, to the purposes of the ventriloquist, I am fully satisfied; and I am rather inclined to think that, when seconded by such powers of imitation as some mimics possess, it is quite sufficient to account for all the phenomena of ventriloquism of which I have ever heard.

Suppose, for example, a ventriloquist to personate a father in the attitude of listening from a window to the voice of his child, who is exposed to some sudden and imminent danger below. It is easy to conceive him possessed of such theatrical skill, as will transport in imagination the audience to the spot where the child is supposed to be placed, and so rivet their attention to what is passing there, as will render his imitation of its feeble and distant cries a much more imposing illusion than it would otherwise be; or, to take a case which is seldom omitted among feats of ventriloquism,—suppose the performer to carry on an imaginary dialogue up a chimney with a chimney-sweeper in danger of suffocation. How imperfect an imitation of a person in such unusual circumstances will be sufficient, if aided by tolerable theatrical powers, to produce such a degree of resemblance as will occasion that amusing surprise and wonder, which are, more or less, the objects of all the Imitative Arts. Even in the case of *painting*, a perfectly complete deception is never the aim of the artist; as a great part of the pleasure arises from the perception of the *difficulty surmounted*, and consequently would be diminished if the painter should to

* I shall ever regret that the state of my health rendered it impossible for me to attend the extraordinary, and, by all accounts, unparalleled performances lately exhibited in Scotland by M. Alexandre.

appearance have achieved an impossibility. "Deception," (says Sir Joshua Reynolds) "which is so often recommended by writers on the theory of painting, instead of advancing the art, is, in reality, carrying it back to its infant state *." Diderot plainly entertained the same idea, and has expressed it still more explicitly, and with much greater precision. "Les arts d'imitation sont toujours fondés sur une hypothèse; ce n'est pas le vrai qui nous charme, *c'est le mensonge approchant de la verité le plus prés possible* †." In these few words, Diderot has conveyed completely my notion of the source of the pleasure afforded by the imitations of the ventriloquist.

From the very interesting and intelligent narrative of Captain Lyon, it appears that the art of ventriloquism is not unknown among the Esquimaux, and that it is employed by them for the same purposes to which it was so often made subservient in the ancient world. The following passage appears to me so curious, that I shall transcribe the whole of it.

"Amongst our Igloolik acquaintances, were two female and a few male wizards, of whom the principal was Toolemak. This personage was cunning aud intelligent, and, whether professionally, or from his skill in the chase, but perhaps from both reasons, was considered by all the tribe as a man of importance. As I invariably paid great deference to his opinion on all subjects connected with his calling, he freely communicated to me his superior knowledge, and did not scruple to allow of my being present at his interview with Tornga, or his patron spirit. In consequence of this, I took an early opportunity of requesting my friend to exhibit his skill in my cabin. His old wife was with him, and by much flattery, and an accidental display of a glittering knife and some beads, she assisted me in obtaining my request. *All light excluded,* our sorcerer began chanting to his wife with great vehemence, and she, in return, answered by singing the Amna-aya, which was not discontinued during the whole ceremony. As far as I could hear, he afterwards began turning himself rapidly

* Reynold's *Works,* vol. iii. p. 176. Third edition.

† Diderot, Observations sur un ouvrage intitulé, "*Garrick* et les Acteurs Anglois." *Mémoires Historiques,* &c., par M. le Baron de Grimm, tom. i. p. 100. Londres, chez Colburn, 1814.

round, and, in a loud powerful voice, vociferated for Tornga with great impatience, at the same time blowing and snorting like a Walrus. His noise, impatience, and agitation, increased every moment, and he at length seated himself on the deck, varying his tones, and making a rustling with his clothes.

"Suddenly the voice seemed smothered, and was so managed as to sound as if retreating beneath the deck, each moment becoming more distant, and ultimately giving the idea of being many feet below the cabin, when it ceased entirely. His wife now, in answer to my queries, informed me very seriously, that he had dived, and that he would send up Tornga. Accordingly, in about half a minute, a distant blowing was heard very slowly approaching, and a voice, which differed from that we at first had heard, was at times mingled with the blowing, until at length both sounds became distinct, and the old woman informed me that Tornga was come to answer my questions. I accordingly asked several questions of the sagacious spirit, to each of which inquiries I received an answer by two loud slaps on the deck, which I was given to understand was favourable. A very hollow, yet powerful voice, certainly much different from the tones of Toolemak, now chanted for some time, and a strange jumble of hisses, groans, shouts, and gabblings like a turkey, succeeded in rapid order. The old woman sang with increased energy; and, as I took it for granted that this was all intended to astonish the Kabloona, I cried repeatedly that I was very much afraid. This, as I expected, added fuel to the fire, until the poor immortal, exhausted by its own might, asked leave to retire. The voice gradually sunk from our hearing, as at first, and a very indistinct hissing succeeded: in its advance, it sounded like the tone produced by the wind on the base chord of an Eolian harp; this was soon changed to a rapid hiss like that of a rocket, and Toolemak, with a yell, announced his return. I had held my breath at the first distant hissing, and twice exhausted myself, yet our conjurer did not once respire, and even his returning and powerful yell was uttered without a previous stop or inspiration of air *."

* Captain Lyon's *Private Journal*, pp. 359, 360.

What follows is a farther proof of the extent and versatility of the imitative powers possessed by some of these savages.

"Ohotook, and his intelligent wife Iligliak, paid me a visit, and from them I obtained the names of many birds and animals, by showing specimens and drawings. Their little boy, an ugly and stupid-looking young glutton, astonished me by the aptitude with which he imitated the cries of each creature as it was exhibited. The young ducks answering the distant call of their mother, had all the effect of ventriloquism; indeed, every sound, from the angry growl of a bear, to the sharp hum of a muskitoe, was given in a wonderful manner by this boy *."

Art. IX.—*Account of the Performances of different Ventriloquists, with Observations on the Art of Ventriloquism.*

We have laid before our readers the preceding ingenious speculations of our late distinguished countryman, Mr Dugald Stewart, on a subject equally connected with metaphysics and natural philosophy. Like every thing which comes from his pen, they are marked with the sagacity of his great mind; and though they do not contain the true explanation of ventriloquism, owing perhaps to his not having attended sufficiently to the physical part of the inquiry, yet they have overturned many erroneous hypotheses which had been previously entertained, and have set the subject in a juster point of view than any in which it had hitherto been placed.

Having had occasion to study the performances of some of the most distinguished ventriloquists, and to make several experiments on the direction of sound, we hope to be able to give an explanation of the art, free from all ambiguity, and to separate the ventriloquists into two classes, the *real* and the *fictitious*, both of which produce the same effect by different means; the former by the aid of an art which the latter cannot command, but the latter with an effect which is increased by the very want of that art of which the former is possessed.

Before we proceed, however, to the consideration of this part of the subject, we must make the reader acquainted with the

* Captain Lyon's *Private Journal*, pp. 149. 150,

actual performances of some of the most distinguished ventriloquists, in order that he may understand the variety of effects which are within the power of the artist, and consequently the phenomena which require explanation.

I. *Account of the Performances of the Ventriloquist M. St Gille.*

M. St Gille was a grocer at St Germain en Laye, near Paris. His performances were carefully studied by the Abbé de la Chapelle, F.R.S. who has published an account of them in a work entitled *Le Ventriloque*, which appeared in 1772.

The Abbé being seated with him on the opposite side of a fire-place in a parlour on the ground-floor, observed him very attentively. After they had conversed about half an hour, the Abbé heard himself suddenly called by his name and title in a voice which seemed to come from the roof of a house at a distance; and while he was pointing to the house from which the voice had appeared to him to proceed, he was still more astonished to hear the words, *it was not from that quarter*, issuing from beneath the earth at one corner of the room, apparently in the same voice as before. In short, according to the Abbé, this voice played as it were everywhere about him, and seemed to proceed from every quarter or distance from which the operator chose to transmit it to him. Although the Abbé was conscious that the voice proceeded from the mouth of M. St Gille, yet he appeared to him absolutely *mute while he was exercising his art, and no change in his countenance could be discovered.* He noticed, however, that M. St Gille always presented the profile of his face to him while he was performing.

Having on another occasion taken shelter from a storm in a neighbouring convent, M. St Gille found the monks in mourning for an esteemed member of their community who had been recently buried. When they were pointing out to him the tomb of their deceased brother, and lamenting the slight honours which had been conferred on his memory, a voice was suddenly heard to issue from the roof of the choir, bewailing the condition of the deceased in purgatory, and reproving the brotherhood for their want of zeal. The news of this strange event drew the whole community to the church, when the voice repeated its lamentations and reproaches, and the whole convent fell on their faces and vowed to make a reparation of their error. They accordingly chaunted a full choir *a de profundis*, during the intervals of which the spirit of the departed monk accordingly expressed his satisfaction at these pious exercises. The prior afterwards inveighed against the incredulity of the moderns, and the subject of apparitions; and it was with great difficulty that M. St Gille convinced them that the whole was a deception.

M. St Gille gave another proof of his skill before a large party, consisting of Commissioners from the Royal Academy of Sciences at Paris, and other persons of the highest rank, together with a lady who was not in the secret, and who was merely informed that an aerial spirit had lately established itself in that part of St Germain en Laye, and that the present party had been assembled to inquire into its truth. After the party had sat down to dinner in the open air, the spirit addressed the lady in a voice that seemed to come from above their heads; sometimes it spoke to her from the trees around them, and from the surface of the ground at a great distance, or from a considerable depth under her feet. Having been thus addressed for above two hours, the lady was firmly convinced of the existence of the spirit, and could scarcely be undeceived.

II. *Account of the Performances of the Ventriloquist Louis Brabant, Valet de Chambre to Francis I.*

Louis Brabant had fallen in love with a rich and beautiful heiress, but, from his humble condition, he was rejected by the parents as an unsuitable match. Upon the death of her father, Louis paid a visit to the widow, and he had no sooner entered the house than she heard herself accosted in the voice of her deceased husband, which seemed to proceed from above,—"Give my daughter in marriage to Louis Brabant, who is a man of large fortune and excellent character. I now endure the inexpressible torments of purgatory for having refused her to him. Obey this admonition and I shall soon be delivered. You will thus provide a worthy husband to your daughter, and procure everlasting repose to the soul of your poor husband." This awful command, which had no appearance of proceeding from Louis, *whose countenance exhibited no change, and whose lips were close and motionless*, was instantly attended to, and the widow announced her compliance with the wishes of her departed husband.

As Louis, however, required money for the completion of the marriage, he ventured to work upon the fears of one Cornu, an old and wealthy banker at Lyons, who had amassed immense riches by usury and extortion, and, like the possessor of ill-gotten treasures, was troubled with remorse of conscience.

Having obtained an interview with the miser, he introduced the subject of demons and spectres, and the torments of purgatory ; and, during an interval of silence, a voice, resembling that of the banker's deceased father, was heard complaining of his dreadful situation in purgatory, and calling upon him to rescue him from his sufferings, by putting into the hands of Louis Brabant a large sum to redeem the Christians that were enslaved by the Turks, and also threatening him with eternal damnation if he did not thus expiate his own sins. The old banker, however, seems to have taken these advices into consideration, for the ventriloquist was under the necessity of paying him a second visit. On this occasion he heard from above the complaints and groans of his father, and of all his deceased relations, entreating him for the love of God, and in the name of every saint in the kalendar, to have mercy on his own soul and theirs. The number and loudness of their complaints subdued the hitherto impregnable spirit of Cornu, who gave Louis ten thousand crowns, after which he returned to Paris and completed his marriage. When the banker was afterwards undeceived, he is said to have been so mortified that he died of vexation.

M. De La Chapelle, from whose work these two cases are extracted, and who paid particular attention to the performances of M. St Gille, is of opinion that the factitious voice employed on these occasions proceeds from the inner parts of the mouth and throat, and that it may be acquired by almost any person ardently desirous of obtaining it. We may add, however, that the possession of this power is, as we shall afterwards see, but a small part of the art of the ventriloquist.

III. *Account of the Performances of the Ventriloquist M. Fitz-James.*

M. Fitz-James, a celebrated ventriloquist, who performed in Paris in 1802, exhibited his art in London in 1803. Mr William Nicholson, an acute and sagacious observer, has given the following account of his performances.

After a comic piece had been read by Monsieur Volange, M. Fitz-James, who was sitting among the audience, went forward and expressed his suspicion that the ventriloquism was to be performed by the voices of persons concealed under a platform, which was covered with green cloth. Replies were given to his observations apparently from beneath the stage; and he followed the voices with the action and manner of a person whose curiosity was strongly excited, making remarks in his own voice, and answering rapidly and immediately in a voice which no one would have ascribed to him. He then addressed a bust, which appeared to answer his questions in character; and after conversing with another bust in the same manner, he turned round, and, in a neat and perspicuous speech, explained the nature of the subject of our attention; and from what he stated and exhibited before us, it appeared that by long practice he had acquired the faculty of speaking during the inspiration of the breath with nearly the same articulation, though not so loud, nor so variously modulated, as the ordinary voice formed by expiration of the air. The unusual voice being formed in the cavity of the lungs is very different in effect from the other. Perhaps it may issue in a great measure through the trunk of the individual. We should scarcely be disposed to ascribe any definite direction to it, and, consequently, are readily led to suppose it to come from the place best adapted to what was said. So that when he went to the door and asked, "Are you there?" to a person supposed to be in the passage, the answer in the unusual voice was immediately ascribed by the audience to a person actually in the passage; and upon shutting the door and withdrawing from it, when he turned round, directing his voice to the door, and said, "Stay there till I call you." The answer, which was lower, and well adapted to the supposed distance and obstacle interposed, appeared still more strikingly to be out of the room. He then looked up to the ceiling, and called out in his own voice, "What are you doing above?—Do you intend to come down?" to which an immediate answer was given, which seemed to be in the room above. "I am coming down directly." The same deception was practised, on the supposition of a person being under the floor, who answered in the unusual but a very different voice from the other, "that he was down in the cellar putting away some wine." An excellent deception of the watchman crying the hour on the street, and approaching nearer the house till he came opposite the window, was practised. Our attention was directed to the street by the marked attention which Fitz-James himself appeared to pay to the sound. He threw up the sash and asked the hour, which was immediately answered in the same tone, but clearer and louder; but upon his shutting the window again, the watchman proceeded less audibly, and all at once the voice became very faint; and Fitz-James, in his natural voice, then said, he has turned the corner. In all these instances, as well as others which were exhibited to the very great entertainment and surprise of the spectators, the acute observer will perceive that the direction of the sound was imaginary, and arose entirely from the well-studied and skilful combinations of the performer. Other scenes which were to follow required the imagination to be too completely misled to admit of the actor being seen. He went behind a folding screen in one corner of the room, when he counterfeited the knocking at a door. One person called from within, and was answered by a different person from without, who was admitted; and we found, from the conversation of the parties, that the latter was in pain, and desirous of having a tooth extracted. The dialogue, and all the particulars of the operation that followed, would require a long discourse, if I were to attempt to describe them to the reader. The imitation of the natural and modulated voice of the operator, encouraging, soothing, and talking with his patient, the confusion, terror, and apprehension of the sufferer, the inarticulate noise produced by the chairs and apparatus, upon the whole, constituted a mass of sounds which produced a strange but comic effect. Loose observers would not have hesitated to assert that they heard more than one voice at a time; and though this certainly could not be the case, and it did not appear so to me, yet the transitions were so instantaneous, without the least pause between, that the notion might be very easily generated. The removal of the screen satisfied the spectators that one performer had effected the whole.

The actor then proceeded to show us specimens of his art as a mimic; but here the power he had acquired over the muscles of his face was fully as strange as the modulations of his voice. In several instances he caused the opposite muscles to act differently from each other; so that while one side of his face expressed mirth and laughter, the other side appeared to be weeping. About eight or ten faces were shown to us in succession as he came from behind the screen, which, together with the general habits and gait of the individual, totally altered him.

In one instance he was tall, thin, and melancholic; and the instant afterwards, with no greater interval of time than to pass round behind the screen, he appeared bloated with obesity, and staggering with fulness. The same man at one time exhibited his face simple, unaffected, and void of character, and the next moment it was covered with wrinkles expressing slyness, mirth, and whim of different descriptions. How far this discipline may be easy or difficult I know not, but he certainly appeared to me to be far superior to the most practised masters of the countenance I have ever seen.

During this exhibition, he imitated the sound of an organ, the ringing of a bell, the noises produced by the great hydraulic machine of Marly, and the opening and shutting of a snuff-box.

His principal performance, however, consisted in the debates at the meeting of Nanterre, in which there were twenty different speakers, as is asserted in his advertisement; and certainly the number of different voices was very great.

Much entertainment was afforded by the subject, which was taken from the late times of anarchy and convulsion in France, when the lowest, the most ignorant part of society, was called upon to decide the fate of a whole people by the energies of folly and brute violence. The same remark may be applied to this debate as to the other scene respecting tooth-drawing, namely, that the quick and sudden transitions, and the great differences in the voices gave the audience various notions, as well with regard to the number of speakers, as to their positions, and the direction of their voices."

M. Richerand, who saw the performances of Fitz-James at Paris, takes a different view of the matter from Mr Nicholson. He says, that every time the ventriloquist exerted this unusual peculiarity, he suffered distension in the epigastric region; that sometimes he perceived the wind rolling even lower; and that he could not long continue the exertion without fatigue. Richerand believes that the whole mechanism of this art consists in a slow, gradual expiration, drawn in such a way that the artist either makes use of the influence exerted by volition over the muscles of the parietes of the thorax, or that he keeps the epiglottis down by the base of the tongue, the apex of which is not carried beyond the dental arches.

He always made a strong inspiration just before this long expiration, and thus conveyed into the lungs a considerable mass of air, the exit of which he managed with such address. Repletion of the stomach, therefore, greatly incommoded the talent of M. Fitz-James, by preventing the diaphragm from descending sufficiently to admit of a dilatation of the thorax, in proportion to the quantity of air that the lungs should receive. By accelerating or retarding the exit of the air, he can imitate different voices, and induce his auditors to believe that the interlocutors of a dialogue kept up by himself alone are placed at different distances.

(To be continued in next Number.)

Art. X.—*On a Mass of Native Iron from the Desert of Atacama in Peru.* By Thomas Allan, Esq. F.R.S.E.*

When in London in the spring of 1827, Mr Parish had the kindness to show me some specimens which he had just re-

* From the *Edinburgh Transactions,* vol. xi. part i. p. 223.

ceived from his son, Mr Woodbine Parish, his Majesty's Consul-General at Buenos Ayres, among which I was surprised and much pleased to find two masses of native iron, exactly similar to the celebrated Siberian block, made known to the scientific world through the exertions of Pallas, having the same vesicular structure, and containing the same straw-yellow coloured olivine firmly imbedded.

I immediately suggested to Mr Parish the propriety of losing no time in making this discovery known, and thereby secure to his son the merit of bringing it before the public; and in order to do this in the most effectual manner, I advised him to present one of the masses to the Royal Society of London, and the other to the Royal Society of Edinburgh; and it is with pleasure that I now find myself deputed to carry his wishes with respct to this Society into execution, by presenting one of the masses as a donation to this institution in the name of his son.

Hitherto the Siberian mass has stood unrivalled, and quite unique. A mass found in Poland in 1809 was said to have resembled it, being vesicular, and having the cavities covered internally with a yellowish-green vitreous substance; but it would have required the cavities in the iron to be *filled* with that substance, to have rendered it similar to the Siberian mass. The other native irons have, I believe, uniformly presented a solid structure, or else, though technically termed spongy, were wholly composed of metallic iron, alloyed as they all are with nickel. It is consequently interesting to find that a mineral so entirely similar to that of Siberia, should have been found abounding in the opposite hemisphere, as appears by the following very curious statement contained in the extracts of two letters from Buenos Ayres, and so abounding as to render it a matter of great astonishment.

"*Account received by Dr Redhead of the Native Iron from the Province of Atacama.*

"The specimens were taken from a heap of the same nature, esteemed at about three quintals. They exist at the mouth of a vein of solid iron *(barra,)* half a yard wide, situated at the foot of a mountain. The opposite plain is strewed with similar fragments. The Indian, who brought these, calls them "*Reventazones*," supposing them to be produced by explosions from the mines. He had been charged to bring a piece of the vein itself, and some of the rock in which it is imbedded; but this he says he could not effect for want of tools. He therefore contented himself with picking up some pieces that were at the foot of the hill, where the mouth of the vein opens. If it be true, as, from the probity of the Indian, who is well known from previous information, and from general report, we must believe it to be, that the metal is in a vein, it ought to be considered as the first phenomenon of this nature that has occurred. What Margraff found in Saxony was probably not of this kind."..................

Extract of a Letter from Woodbine Parish, Esq. Buenos Ayres, April 1827.

"The account given by Dr Redhead has since been fully confirmed by other accounts from different persons. This iron is found in the province of Atacama in Peru, at a distance of about twenty leagues from the port of Cobija, in large masses, imbedded in a mountain, in the neighbourhood of the village of San Pedro, and scattered over the plains at the foot of the mountain in question, for a distance of three or four leagues, in fragments similar to that sent herewith, but some of them of considerable magnitude."

From this statement it appears that the accounts are yet imperfect, and that we have only the authority of an Indian to depend upon. It was by the same species of authority that Pallas was led to his mass, obtained from Medvedef a Cosaque, who was found to be accurately correct. The apology of the Indian for not bringing a portion of the vein attached to the rock, as he was desired to do, is a very plausible one; but the structure of this iron is so entirely dissimilar from the product of any vein of iron that we are acquainted with, that it is highly probable the scattered fragments will be found to differ entirely from any ore which the veins of that country may produce. It was the theory of the Indian, that these fragments, which, according to Mr Parish's subsequent statement, appear to be scattered over a district extending to three or four leagues, were produced by explosions from the veins. He had consequently a theory to support; and we know here something of the difficulty with which geological opinions are abandoned. Our Indian, therefore, who is admitted to be a man of observation, would probably decline to produce specimens calculated to overset his former assertions, as it is very improbable that he would be sent for the purpose of obtaining specimens without the tools necessary to secure the success of his mission.

The desert of Atacama, as it is termed in the maps, is situated on the shore of the Pacific, between Chili and Peru. The town of Atacama lies in lat. 23° 30′ south, and long. 69° 30′ west, about half-way between the ocean and the volcanic range which runs along the western edge of the great peninsula.

Connected with, though independent of this notice, I may mention, that it is also to Mr Woodbine Parish that the British Museum is indebted for another remarkable mass of native iron, presented some time ago in the name of that gentleman by Sir H. Davy. The history of it is unfortunately not given in detail. It is considered by Mr Parish to be the same mass described in the *Philosophical Transactions* of 1788 by Reuban de Celis, which was found in the province of Chaco Galamba. But there is a great discrepancy in the weight. It is rather surprising that no accurate description of this mass has as yet met the eye of the public, although it is itself placed under its aspect on the steps of the great stair of the Museum.

Art. XI.—*Examination of the Specimen of Native Iron from the Desert of Atacama in Peru.* * By Edward Turner, M. D. F. R. S. Ed., Professor of Chemistry in the London University.

The native iron from the desert of Atacama in Peru has externally all the characters of meteoric iron. The metal in the specimen is tough, of a whiter colour than common iron, and is covered on most parts with a thin film of the oxide of iron. The interstices contain olivine.

The specific gravity of some clean fragments is 6.687; and

* This article forms an appendix to the preceding paper of Mr Allan.

the density of a portion which has been forged into the form of a nail is 7.488.

To ascertain if the specimen is analogous to meteoric iron in composition, as well as in its appearance, 29.44 grains of it were exposed to the action of nitro-muriatic acid, and were completely dissolved by that menstruum. The solution, after being moderately diluted with cold water, was gradually neutralized by the bi-carbonate of potash, with the view of precipitating the iron, and retaining the cobalt and nickel in solution by the excess of carbonic acid.

The hydrated red oxide of iron, after being collected on a filter, and carefully washed, was taken up by oxalic acid, which did not leave any residue. It did not therefore contain any nickel or cobalt.

The solution from which the iron had been removed by the bi-carbonate of potash had a green tint; and on expelling the free carbonic acid by heat, the hydrous carbonate of nickel subsided. The precipitation was completed by the aid of pure potash. The precipitate, after being washed, was treated by a solution of oxalic acid, and was thus converted into the granular oxalate of nickel. The acidulous solution of oxalic acid did not strike a blue colour with the ferrocyanate of potash, nor yield a precipitate when neutralized with ammonia, and consequently was free from iron.

The oxalate of nickel was dissolved in pure ammonia; and after it had separated from the liquid by the gradual dissipation of the alkali, the remaining liquid had a pale pink colour, and on evaporation yielded a minute residue, which, when fused with borax, yielded a blue bead. It was therefore oxalate of cobalt.

The oxalate of nickel was decomposed by heat, and yielded 4.174 grains of the protoxide of nickel; equivalent, according to the atomic tables of Dr Thomson, to 3.192 grains, or 10.84, per cent. of metallic nickel. The total quantity of cobalt is less than 1 per cent.

I do not rely with confidence on the numerical result of the analysis; for while the complete separation of cobalt and nickel from each other is attended, as is well known to analysts, with considerable difficulty, I was obliged by circumstances to conduct the examination in too hurried a manner to admit of minute accuracy. Of the essential point, however, the presence of cobalt and nickel, there is no doubt; and hence we may safely infer that this specimen is of meteoric origin. Professor Stromeyer, in an elaborate investigation of these productions, has detected cobalt as well as nickel, in every specimen of meteoric iron which he has examined; whereas a similar metallic compound of these metals has never yet been discovered in the earth.

ART. XII.—*Table of the Variations of the Magnetic Needle, according to the latest observations.* By Professor HANSTEEN. Communicated by the Author.

THE following table, which Professor Hansteen was so kind as to communicate to us before his departure for Siberia, is a continuation of those tables which he published in his able work, entitled *Untersuchungen über den Magnetismus der Erde.* Christiania, 1817. We have already communicated to our readers the early measures of the variation of the needle; and we are therefore glad to be able to complete that series of valuable observations by the following list.

I.—*Denmark, Norway, Sweden, and Finland.*

Anholt Island,	Bugge,	1788,	19° 8′ W.
Abo Finland,	Hansteen,	Sept. 27, 1825,	11 20
Brahestad Finl.	————	Sept. 1825,	10 38
Christiansand,	Wibe,	Mar. 18, 1782,	20 0
Christiania,	Rick,	May 17, 1780,	18 42
	Hansteen,	Mar. 10, 1817,	20 3
		May 22, 1818,	19 59
		Aug. 28, 1821,	19 57
		Sept. 12, 1821,	19 43
		Sept. 26, 1821,	19 34
		May 24, 1822,	19 47
Dagerort Isl.	Schulten,	1800,	12 0
Fredriksteen Norw.	Vibe,	Mar. 24, 1779,	18 0
Jinnska Utön,	Schulten,	1800,	13 00
Gran Norw.	Hansteen,	1821,	18 50

Hammerfest,	Sabine,		1823,	11° 26′
Gottska Sandoe,	Schulten,		1800,	14 40
Landsort Sw.	———		1800,	15 20 W.
Nörstaböe Norw.	Hansteen,		1821,	22 12
Pitea Sw.	———		1825,	10 6
Svarfvarort Sw.	Schulten,		1800,	13 40
Throndhjem Norw.	Hansteen,	July 28,	1825,	19 36
Tornea Finnl.	———	Aug.	1825,	12 7
Ullensvang Norw.	———		1821,	22 51
Uleaborg Finl.	Julin,		1791,	10 0
	Hansteen,		1825,	9 32
Uloma Cassel N.	Marelins,	Sept.	1761,	10 45
Wardoe Norw.	Christie,	July 7,	1816,	5 57
Wasa Finnl.	Osterblad,	Oct. 4,	1811,	11 45
		Mar. 17,	1815,	12 1
		Apr. 25,	1825,	12 38

II.—*Russia.*

Astracan,	Chr. Burrough,	Apr. 17,	1580,	13 40 W.
Archangelsk,	Lütke,		1800,	0 30 W.
	——		1824,	2 7 E.
Colmogro,	St. Burrough,	May 23,	1557,	5 10 E.
Dogs-nose,	———	June 2,	1557,	4 0 E.
Jokanskish Isl.	Lütke,		1800,	1 30 N.
	——		1824,	1 7 E.
Kildin Isl.	——		1824,	1 2 W.
Krakau,	Leski,		1821,	14 30 W.
			1769,	3 30 E.
Matotschki Nov. Zem.	Lutke,		1824,	10 34 E.
Olenish Isl.	——		1824,	1 23 W.
Mescwa,		Aug.	1732,	5 26 W.
	Sternberg,		1790,	3 47 W.
	Goldbach,		1805,	5 24 W.
Petersburg,	Wisniewsky,	June	1817,	7 15 6 W.
	———	Sept.	1818,	7 27 5
Peczora,	St. Burrough,	July 17,	1556,	3 30 W.
Seven Islands,	Lütke,		1824,	0 30 W.
Tri Ostrowe Isl.	St. Burrough,	June 16,	1557,	3 30 E.
Udinsk,	Schubert,		1805,	2 40 E.
Waigats Isl.	St. Burrough,		1556,	8 0 W.

III.—*Germany, Netherlands, and Switzerland.*

Aurich Neth.	Oltmanns,	Mar.	1819,	20 43 W.

Aurich Neth.	Oltmanns,	June	1819,	20° 51
	———	——	1820,	20 41
	———	——	1821,	20 46½
	———	Sept.	1821,	20 35
Berlin,	Erman,	Oct. 4,	1825,	17 40 W.
		—— 13,	1825,	17 41
		—— 14,	1825,	17 40
Bentheim,	Oltmanns,	Nov. 11,	1817,	19 41
Bochholt,	———		1822,	20 58
Emden,	———		1816,	20 42
Kirchesepe,	———	Sept. 30,	1817,	20 18½
Kremsmünster,	Schwarzenbrunner		1815,	17 20
			1816,	17 15
			1817,	16 45
			1818,	16 40
			1819,	16 40
			1820,	16 20
			1821,	16 28
			1822,	16 30
			1823,	16 28
			1824,	16 25
Leipzig,	Schmidel,	July 12,	1825,	17 45
Meppen,	Oltmanns,	Sept. 11,	1817,	20 37
Nordhorn,	———	Nov. 12,	1817,	19 53
Wisens,	———	Apr.	1821,	20 32
Wittmund,	———	——	1819,	20 30
		May, June,	1819,	20 39
		July	1821,	20 36

IV.—*France.*

Brest,			1818,	25 7 W.
Cherbourg,	Fitzmaurice,		1813,	26 47
Havre de Grace,	Chappe,	Sept. 26,	1768,	19 42
Lyons,		Nov.	1751,	15 45
			1752,	16 0
		Dec.	1755,	16 30
		——	1757,	17 15
			1760,	18 30
			1761,	18 45
Ouessant Isl.	Bradley,		1806,	26 45
Paris,		Oct. 12,	1816,	22 25 W.
		Feb. 10,	1817,	22 17

Paris,		1818,	22° 21.6′	
		1819,	22 29	
	Arago,	June 13, 1824,	22 23¼	
Toulon Cape Side,	Edw. Strode,	Apr. 25, 1811,	19 10	

V.—*England and Scotland.*

Edinburgh,	J. Jardine,	Oct. 29, 1808,	27 31.8	
	———	Nov. 3, 1809,	27 35.2	
	———	Sept. 29, 1812,	28 8.0	
	Wallace,	July 9, 1823,	27 48.0	
Gravesend,	Christ. Hall,	June 12, 1576,	11 30	E.
Hermitage Hill, Leith,	Andr. Waddel	1823,	27 0	W.
London,		June 1806,	24 8.6	
		Sept. 1807,	10.2	
		June 1808,	10.0	
		Sept. 1811,	14.0	
		Oct. 1812,	16.5	
		Sept. 1813,	16.7	
		June 1815,	17.8	
		—— 1816,	17.9	
	Lee,	—— 1817,	17.0	
	——	—— 1818,	15.7	
		1819,	14.8	
		1820,	11.7	
		1821,	11.3	
		1822,	9.9	
		1823,	9.8	
Stromness Orkn.	Franklin,	June 3, 1819,	27 50	

VI.—*Portugal, Spain, and Italy.*

Alicante,	Atkinson,	Sept. 4, 1800,	19 25.
Aulona,	Smyth,	1818,	14 0
Barcelona,	———	1785,	18 0
Budua,	———	1818,	14 56
Cadiz,	Chappe,	Oct. 29, 1768,	19 12
Carthagena,	Simpson,	March 1789,	18 45
	Atkinson,	June 2, 1798,	19 3
Cabrera Isl.	Seymore Finch.	Sept. 29, 1789,	19 0
Corunna,	Bradley,	1806,	20 47
Durazzo,	Atkinson,	1818,	15 58
Eba,	Rumker,	June 15, 1818,	18 19

Portoferraio, Piombino,	Rumker,	June 16, 1818,	16° 29′
Fiumicino,	———	—— 19, ——	17 45
Gorgonna,	———	—— 2, ——	19 0
Girgenti,	———	July 18, 1818,	17 30
Ischia,	Atkinson,	June 16, 1798,	18 22
Lagos Bay,	Simpson,	Oct. 25, 1788,	18 0
Leghorn,	Geddes,	—— 20, 1731,	9 42
		1785,	18 0
	Knight,	1795,	19 20
	Rumker,	July 8-11, 1818,	19 20
Lisbon,	Franzini,	1811,	22 45
Maritimo,	W. Chalder,	Aug. 6, 1807,	19 40
Maritimo Isl.	Rumker,	May 28, 1818,	17 0
	———	July 16, 1818,	18 0
Malaga Bay,	Simpson,	Dec. 1, 1788,	19 50
Malta,	J. Lombard,	1612,	11 0
Minorca C. Mola,	E. Strode,	Apr. 15, 1811,	19 30
Palermo C. Guals,		1790,	17 0
	Piazzi,	1814,	18 30
Ustica,	Rumker,	July 15, 1818,	17 30
Vido Ft. Alessandro,	Smyth,	——	14 34

VII.—*Hungary and Turkey.*

Constantinople,	Beauchamp,	1797,	12 33
Corfu,	Smyth,	1818,	14 34
Maudry Bay,	Inglefield,	1793,	13 20
Imbro Isl. Dard.	W. Chalder,	Aug. 27, 1807,	12 32
Trebizonde,	Beauchamp,	1797,	8 14

VIII.—*Asia and neighbouring Islands.*

Alceste Island,	Mayne,	July 21, 1816,	2 3 W.
Basils Bay,	———	Sep. 4, 1816,	2 0 W.
Bata Harb.	Vashon,	Apr. 15, 1803,	1 23 W.
Bildih,	Chr. Burrough,	June 11, 1580,	10 40 W.
Cheaton Bay,	Mayne,	Aug. 22, 1816,	2 10 W.
Cape Comorin,	Bas. Hall.	Mar. 30, 1815,	2 9 E.
Congo River,	Fitzmaurice,	July 1816,	25 58 W.
Ceylon,			
Pointe de Galle,	B. Hall,	Apr. 2, 1814,	2 15 E.
Trincomalee,	———	Sep. 27, 1812,	1 9 E.

Derbent,	C. Burrough,	Oct. 1580,	11° 0′	W.
Hyderabad,	Morison,	June 27, 1804,	1 16	E.
Batavia, Java,	B. Hall,	July 29, 1814,	0 17	E.
Sourabaya,	Dentrecasteaux,	Oct. 1793,	2 31	W.
	Duperrey,	Sep. 1824,	0 10.4	W.
Lam-Get Isl.	Mayne,	June 16, 1816,	0 9	W.
Macao.	Malespina,	Apr. 21, 1792,	1 12	E.
Madras,	Kempton,	1809,	3 0	E.
Morebat Bay,	J. Smith,	1781,	6 40	
Muscat-Cove,	J. Cluer,	1785,	6 0	
Mocha,	Richardson,	1795,	11 0	
Murray's Sound,	Mayne.	Sep. 8, 1816,	2 0	W.
Napakiang Roads, Port Melville,	B. Hall,	Oct. 8, 1816,	0 52	W.
Pecho Mouth,	Mayne,	July 27, 1816,	2 14	W.
Princes Isl.	Fitzmaurice,	May 16, ——	20 7	W.
Sandy Isl.	Mayne,	July 27, ——	2 14	W.
Achen, Sumatra,	B. Hall,	May, 1, 1814,	2 25	E.

IX.—*Africa and neighbouring Islands.*

Alexandria,	Chazelles,	May 11, 1694,	12 48	W.
	Smyth,	Apr. 8, 1822,	10 58	
Alboran I.	Rumker,	Jan. 8, 1818,	21 28½	
Africa Islands,	Campbell,	1802,	7 44	
Ascension,	Brine,	1816,	15 30	
	Duperrey,	Jan. 1825,	16 52	
Akromar,	Rüppel,	March 1823,	11 16	
Ambucol,	———	Apr. ——	10 46	
Fayal, Azores,	Reid.	1814,	23 30	
Bareedy Harb.	G. Trotter,	1776,	13 53	
Bomba,	Smyth,	1821,	14 55	
Bourbon S. Denys.	Fitzmaurice,	Aug. 10, 1813,	17 20	
Canaries, Funchal,	J. Bowen,	1802,	19 10	
	Horsburgh,	1811,	21 0	
	Shortland,	1813,	22 0	
	Sharpe,	1816,	21 10	
	Bartholomew,	Feb. 1819,	21 32	
	White,	Mar. 24, 1819,	19 10	
	Rumker,	July 5, 1821,	25 58	
S. Cruz Bay, Teneriffe,	Codd,	1816,	21 20	

Orotava,	Meynell,		1816,	20° 33′
S. Cruz,	Bartholomew,	Feb. 16,	1819,	18 53
	Duperrey,	Aug. 29,	1822,	21 0
Chagos (Diego Garcia)				
	A. Blair,		1786,	1 59
Eleven Islands,	Blair,		——	2 10
Comorrish Islands,				
Mayotta,	J. Barker,		1750,	20 0
Cape Verd Isl.				
Porto Praya,	Dickinson,		1812,	10 15
	Bartholomew,	Mar. 18,	1819,	13 30
Bonavista,	————	Apr. 8-9,	——	14 2
Mayo,	————	Apr.	1819,	13 9
Sal,	————	Feb. 26,	1819,	14 5
Mauritius (Gard. Pr.)	Flinders,	Aug.	1805,	11 42½
	Fitzmaurice,	Mar. 15,	1813,	16 40
	Duperrey,	Oct.	1824,	13 46
Cape Good Hope,				
Table Bay,	Dentrecasteaux,		1792,	24 30
	Fitzmaurice,		1813,	28 0
Cape Town,	Bain,		——	27 30
Goree,	J. Bowen,		1801,	16 0
	J. Brown,		1815,	19 35
	Bartholomew,	Mar. 21,	1819,	15 50
Goughs Isl.	Jackson,	—— 4,	1732,	0 0
	Fitzmaurice,	Dec.	1813,	11 51
Kossics Bay,	Dobbie,		1799,	11 15
St Helena,	Smith,	Apr.	1793,	15 28
Jamestown,	Ross,		1815,	17 30
	Meynell,		1816,	17 30
Jamestown,	Duperrey,	Dec.	1824,	19 34.5
Mozambique Harb.	Inverarity,		1802,	18 40
Madagascar,				
Majambo B.	Inverarity,	Feb.	1803,	16 25
Morvundava,		Aug. 14,	1714,	22 30
Augustin's B.	Horsburgh,		1798,	23 30
			1804,	24 0
Bembatooka B.	————		1802,	17 30
Narrcenda B.	————		——	15 50
Patta,	Crichton,		1751,	16 17
Pr. of Wales Isl.	Finlayson,		1819,	22 30

Relief Cape,	Rice,	Aug.	1797,	26° 40′
	Fitzmaurice,		1814,	29 20
Rasalgate,			1810,	5 20
Suez Harb.	Robinson,		1777,	12 6
Tristan D'Acunha,	Fitzmaurice,	Mar. 6,	1813,	9 51 N.
Tripoli,	Smyth,		1816,	16 50
	———	June	1822,	16 35
St. Thomas' Isl.	Fitzmaurice,	May 20,	1816,	22 48
Quiloa Isl.				17 22

X.—*America and neighbouring Islands.*

Acapulco,	Malespina,	Apr. 29,	1791,	7 44 E.
	B. Hall,		1821,	8 46 E.
Arica,	Frezier,		1713,	8 0 E.
	B. Hall,		1821,	10 25 E.
Arauca,	———		——	18 22 E
Ancon,	———		——	10 25 E.
Baffins three Isles,	Sabine,	July 12,	1818,	80 44 W.
S. Blas Californ.	Malespina,	Apr. 12,	1791,	7 28 E.
	B. Hall,		1821,	8 40 E.
Brandon House,	Fiddler,		1808,	12 12 E.
Big Lake,	——		1807,	8 0
Barbadoes,				
Carlisle Bay,	Codd,			4 30 E.
Curaçao,		July 18,	1704,	6 40 E.
	Farley,	May 24,	1814,	4 0 E.
	Bentley,	Mar. 10,	1818,	5 1 E.
Cayman,			1787,	7 0 E.
			1815,	6 45 E.
Callao Castle,	B. Hall,		1821,	10 3 E.
Carthagena,	Don Ulloa,	Nov.	1735,	8 0 E.
	Vashon,	Jan.	1787,	11 0
	Ouinton,	May	1813,	6 32
Point Coles,	Hall,		1821,	10 18 E.
Charlton House,	Fiddler,		1807,	15 16 E.
Chepewyan Fort,	Mackenzie,			16 0 E.
Cuba,				
Havanna,			1815,	7 0 E.
	Allen,	Aug.	1816,	5 30
Caripe,	Humboldt,	Sept. 20,	1799,	3 15
S. Carlos de Chiloe,	Malespina,	Feb. 8,	1790,	17 36 E.
Conception,	———	Nov. 21,	1791,	14 52 E.

Coquimbo,	Frezier,		1712,	10° 0′ E.
	Malespina,	Apr. 28,	1791,	11 46
	B. Hall,		1821,	14 0
Callao de Lima,	Frezier,		1713,	10 0 E.
	Malespina,	June 7,	1791,	9 37½
	Duperrey,	Mar. 3,	1823,	9 30
S. Catharina,	———	Oct.	1822,	6 25 E.
Churchill Fort,	Fiddler,		1807,	5 39 E.
S. Croix Island,	Zahrtmann,	July 14,	1826,	1 15 E.
Dominica,				
Pr. Rupert. Bay,	Ross,	June 22,	1760,	3 20 E.
	White,	Apr. 8,	1819,	2 40 E.
Puerto Deseado,	Malespina,	Dec. 7,	1789,	19 50 E.
Domingo,				
C. Français,	Don Ulloa,		1745,	5 15 E.
Alta Vela,	Bentley,	Feb.	1818,	5 21 E.
Port Egmont,	Malespina,	Dec. 19,	1790,	22 34 E.
Erie Fort,	Fitz Owen,		1817,	1 42 E.
Sta. Fé de Bogota,	Humboldt,			7 35 E.
Fernando Noronha,	Don Ulloa,	May	1745,	2 10 E.
Guayra,	Humboldt,	Jan. 24,	1800,	4 20 E.
	Farley,	June 3,	1814,	4 53
Guayaquil,	Malespina,	Oct. 11,	1791,	9 11 E.
	B. Hall,		1821,	9 5
Guadaloupe,			1809,	4 55 E.
Guasco,	B. Hall,		1821,	13 30 E.
Hare Island,	Sabine,	June	1818,	71 58 W.
Juan Fernandez,	Don. G. Juan,		1744,	8 30 E.
			1802,	14 0
Jamaica P. Royal,	Gardner,	Nov.	1789,	6 30 E.
	De Mayne,		1817,	4 40
Lima,	Don Ulloa,	Dec.	1740,	9 2 E.
	Span. Chart,		1802,	9 50
Mexico,	Humboldt,	Dec.	1803,	8 8 E.
Mobile Bay,	Kent,	———	1814,	6 30 E.
Martinique,	Don Juan,		1735,	6 0 E.
F. Royal,	Codd,		1816,	6 45
S. Martha,	Bouguer,		1743,	6 35 E.
Mas-a-fuera,	Span. Chart,		1802	13 0 E.
Mohawk Bay,	J. Harris,		1815,	0 4 E.
Port Mulgrave,	Malespina,	July 1,	1791,	26 40 E.
Le Maire Str.	Frezier,		1712,	24 0 E.
Mollendo,	B. Hall,		1821,	11 5 E.

Mocha Isl.	B. Hall,	1821,	19° 34′ E.
Montevideo,	Malespina,	Sep. 23, 1789,	13 40 E.
	Beaufort,	Aug. 1807,	13 20
Monterras,	Malespina,	Sep. 23, 1791,	10 56 E.
Niagara Fort,	Fitz Owen,	1817,	1 27 E.
Nuacho,	B. Hall,	1821,	9 36 E.
Nootka,	Malespina,	Aug. 17, 1791,	22 30 E.
Panama,	Don Ulloa,	Nov. 1755,	7 49 E.
	Malespina,	Dec. 3, 1791,	7 49
	Span. Chart,	1802,	8 0
	B. Hall,	1821,	7 0
Payta,	———	1821,	9 0 E.
	Duperrey,	Mar. 8, 1823,	8 56 E.
S. Pescadores,	B. Hall,	1821,	11 20 E.
Porto-Bello,	Don Ulloa,	Nov. 1735,	8 40 E.
		1814,	8 30
		1815,	6 0
Pr. of Wales' Fort,		1798,	1 0 E.
		1807,	5 39
		Sep. 3, 1813,	6 0
Pernambuco,	Hewett,	1815,	3 0 W.
Penedo S. Pietro,	Crichton,	1813,	6 0 W.
La Plata,	Bouguer,	1743,	8 30 E.
Cuito,	Humboldt,	Feb. 1802,	9 24 E.
Realeyo,	Malespina,	Jan. 23, 1791,	9 20 E.
Rio Janeiro,	Rumker,	1821,	3 21 E.
Talcahuana,	Malespina,	Nov. 21, 1793,	14 52 E.
	B. Hall,	1821,	15 30
Fort Galvez,	Duperrey,	Feb. 1823,	16 16.4
S. Thomas Isl.	Henderson,	1816,	2 24 E.
Vera Cruz,	Chappe,	Mar. 15, 1769,	6 28 E.
	Mahony,	1815,	10 37
	Wise,	Apr. 27, 1819,	9 16
Valparaiso,	Feuillé,	Mar. 11, 1709,	9 30 E.
	Don Juan,	1744,	12 30
	Malespina,	Mar. 20, 1791,	13 39
	Vancouver,	1795,	14 49
	Span. Chart,	1802,	14 55
	B. Hall,	1821,	14 43
Valdivia,	Moraleda,	1788,	17 30 E.
S. Vincent's Isl.	Kent,	Mar. 31, 1814,	7 30 E.
William's Fort,	Beechy,	Dec. 8, 1816,	5 30 E.
Wollaston's Lake,	Fiddler,	1807,	18 2 E.

Ylo,	Span. Chart,		1802,	10° 30′ E.
York Fort,	Fiddler,		1807,	4 55 E.
	Franklin.	Sep.	1819,	6 0.3 E.

XI.—*Australia.*

Amboyna,	Duperrey,	Oct.	1823,	0 28 E.
Bouroa, Cayeli,	———	Sep. 29,	1823,	0 31.8 E.
Ceram, Selema B.	Th. Hayward,	July	1796,	0 41 E.
Dory Harbour, N. G.	Duperrey,	——	1824,	1 35.6 E.
Galapagos, Isl.	B. Hall,		1821,	8 20 E.
Guaxon Marian Isl.	Malespina,	Feb. 22,	1792,	3 16 E.
Jervis Bay,	Weatherhead,		1800,	9 0 E.
King's I. Elephant Bay,	J. Murray,		1802,	3 30 E.
Manilla,	Malespina.	July 18,	1792,	0 17½ E.
Manava Port. N. Zeal.	Duperrey,	Apr.	1824,	13 21.6 E.
N. Caledonia, Port S. Vincent,	Will. Kent,		1803,	10 56 E.
Oyster Bay, N. Holl.	J. H. Cox,		1789,	6 40 E.
Otaheite Point,	Duperrey,	May	1823,	6 40.4 E.
Offak,	———	Sept.	1823,	1 1.7 E.
Port Praslin,	———	Aug.	1823,	6 48.4 E.
Pulo Leah,	Hayward,	Mar. 1,	1816,	0 52½ W.
Pulo Penang,	A. Blair,		1787,	0 11 W.
Port Cornwallis,	Austen,		1809,	1 57 E.
Port Phillip,	Flinders,		1802,	8 0 E.
Port Jackson,	Malespina,	Mar. 18,	1793,	8 46 E.
	Duperrey,	Jan. Feb.	1824,	8 56
Paramatta,	Rumker,	Oct. 23,	1822,	8 43.8 E.
		Feb. 10,	1813,	– 46.8
		—— 12,	——	– 43.0
		—— 14,	——	– 34.0
		—— 15,	——	– 37.8
		—— 17,	——	– 35.0
		—— 17,	——	– 49.2
		Mar. 10,	——	– 51.5
		—— 14,	——	– 37.2
		—— 19,	——	– 38.6
		—— 20,	——	– 40.1
		—— 21,	——	– 53.7
		—— 22,	——	– 39.8

Paramatta,		Mar. 26,	1813,	8° 47.5′ E.
		—— 27,	——	- 50.5
		—— 31,	——	- 43.5
Halan, Havre de la Coquille,	Duperrey,	June	1823,	9 20.5

ART. XIII.—*On the Parasitic Formation of Mineral Species, depending upon Gradual Changes which take place in the Interior of Minerals, while their External Form remains the same.* * By WILLIAM HAIDINGER, ESQ. F. R. S. Edin.

THE mutual attraction of the elements of mineral bodies cannot at present enter into play on so extensive a scale as during the formation of those enormous masses of rocks which form a great portion of our globe; for these bodies are the result of the very action of the elements on each other, by which they have arrived at a settled state. There are some agents, however, which we daily observe to affect the constitution of minerals that are prone to decomposition. Many species of the class of salts are continually destroyed by their solution in water, and regenerated by its evaporation. Iron-pyrites, exposed to the alternating influence of water, the oxygen of the atmosphere, and natural changes of temperature produced in the course of the seasons, or by the decomposition of the substances themselves, will effloresce, and yield sulphate of iron. Heat, and the disengagement of powerful acids from active volcanos and burning coal-seams, give rise to the formation of a number of new substances, while those which existed before are destroyed. Usually even the last trace which could lead us to discover from what source the new substances draw their origin is lost; but there are examples in which the form peculiar to the crystals of the decomposed substances is entirely preserved, while the rest of their properties undergo greater or less changes. The consideration of these constitutes the object of this communication.

These mineral productions have been called *pseudomorphoses*, a name expressive of their nature, if we attend only to etymology, since the form is not the one belonging to the sub-

* Abridged from the *Edinburgh Transactions*, vol. xi. part i. p. 73.

stance; but the definition given of them requires that they should be produced by the deposition of crystals in an empty mould, left in the surrounding mass, by a decomposed crystal of another species. The names proposed by Haüy, *épigeniés*, and by Breithaupt *metamorphous* crystals, are more objectionable, in an etymological point of view, than the usual denomination; and as they were neither circumscribed by accurate definitions, nor applied exclusively to this kind of formation of substances, we need not be over careful in making use of any of them by preference, particularly since difficulties might arise from the circumstance, that the effect of the decomposition is not always the same, and that only some cases will be found in which the entire form is preserved, while it is considerably impaired, though still recognizable in others, and frequently altogether lost. If we were to select a particular word for this kind of formation, the most appropriate expression would be *parasitic*, to denote the intrusive nature of the new compounds, in prejudice of those which existed before.

The facts met with in nature are highly interesting, and deserve the particular attention of naturalists, in order to complete the series in which they are here considered.

I. *Changes in Substances having the same composition.*

The chemical mixture, essential to the common *vitriol of zinc*, is a dimorphous one, or one of those which are capable of crystallizing in two different kinds of forms, incompatible with each other. The most common of them is derived from a scalene four-sided pyramid, which has its three axes perpendicular to each other, and is comprised in the prismatic system. It is deposited from solutions not sufficiently concentrated to form a crystalline skin on their surface, and at temperatures below 126° Fahrenheit. Above that temperature a highly concentrated liquid yields crystals of another species, whose forms are derived from a scalene four-sided pyramid, having its axis inclined on the base, and belonging to the hemi-prismatic system. The chemical composition of both substances is expressed in the formula by Berzelius, of $\ddot{Z}n\,\ddot{S}^2 + 14Aq$, which is derived from Mitscherlich's analysis of the prismatic species, giving oxide of zinc 27.67, sulphuric acid 27.57, and water 44.76.

To Prof. Mitscherlich we are likewise indebted for the following curious fact, (*Edin. Journal of Science*, vol. iv. p. 301.) When a crystal of the salt, with a form belonging to the prismatic system, is heated above a temperature of 126°, we may observe certain points at its surface become opaque, and then bunches of crystals shoot out from these points in the interior of the original specimen. Since this is transparent, and the newly formed crystals almost opaque, or of a milky whiteness, they are easily distinguished from the surrounding mass while they continue to grow. In a short time the whole is converted into an aggregate of those crystals, diverging from several centres that are situated on the surface of the original crystal. No water escapes during this process except what may have been accidentally included in the lamellæ of the specimen. This circumstance proves the identity of the chemical composition of the two species, one of which is formed within that space which is occupied by the other up to the very moment of the decomposition of the latter, which gives rise to the new substance.

I have obtained crystals of the hemi-prismatic species, more transparent than usual, by exposing to crystallization on a warm stove a highly concentrated solution of the salt, well covered and wrapped up. The remaining liquid having been decanted, the crystals obtained were dried and slowly cooled in the same manner. If they are taken out of the solution singly, and cooled rapidly, they soon lose their transparency, and when broken, frequently present an aggregate of crystals of the prismatic species, which is likewise immediately produced by drops of the solution remaining on the surface of the hemi-prismatic crystals. Change of temperature is the only agent upon which, in both cases, the change of the position of particles within the solid mass depends.

The isomorphism of zinc and magnium is remarkably distinct in the regular forms, with all their peculiarities, and in the cleavage of their sulphates. But it extends even to the phenomena described above of sulphate of zinc. They both give exactly the same results.

The specific gravity of the hemi-prismatic species has not been ascertained. It is very probable that it does not materially differ from that of the prismatic species, as the change from one to the other takes place without producing a considerable change in the appearance of the shape of the crystals. When Arragonite is exposed to heat it becomes opaque, and splits violently into multitudes of small particles previous to its giving off any of its carbonic acid. It is highly probable that it is thus transformed into common Calcareous spar, which requires more space to exist in than Arragonite, nearly in the ratio of 29 to 27, their contents of Carbonate of lime being equal, and no attention given to the accidental and variable contents of carbonate of strontia. Perhaps the separation of the particles is assisted by the unequal expansion of the rhombohedral individuals in the direction of their axis, and perpendicular upon it.

I must mention here another example of the formation of crystals in the place of a solid mass, consisting of the same chemical ingredients. M. Beudant, I believe, first called the attention of naturalists to the fact, that the whitish coat with which *Barley-sugar* is covered, when it is kept for some time, shows a fibrous structure, the direction of the fibres being perpendicular to the surface of the specimens. When the decomposition, which here only affects the form and arrangement of particles, is allowed to proceed farther, crystals of sugar-candy are formed in the space formerly occupied by a homogeneous mass which presented the most perfect conchoidal fracture, and not a trace of crystalline structure. *

II. *Changes dependent upon the presence of Water.*

Haüy's *Chaux sulfatée épigène*, is a substance familiar to every mineralogist. His view of it is perfectly correct: it was *Anhydrite*, and is changed into *Gypsum*, by combining with a portion of water. The original cleavage planes, still

* *Barley-sugar* has no double refraction, and has the same general relation to sugar that *melted quartz* (which has no double refraction) has to *crystallized quartz*. When by the attraction of moisture from the air it is gradually dissolved, the particles of *sugar* liberated from their constrained position form doubly refracting crystals of *sugar*, or the whitish fibrous coat mentioned in the text. Hence we are here presented with the singular fact of a substance gradually passing from a simply refracting mass to a doubly refracting crystal.—Editor.

discoverable in the white, opaque, and faintly glimmering masses, would give no argument of weight for uniting the two species into one; and yet considerations of this kind have induced some mineralogists to join blue copper and malachite into one species. These traces are not, however, produced by cleavage, which is the mere tendency of the particles of Anhydrite to separate more easily in certain directions than in others; but they are owing to actual fissures in the direction of the planes of cleavage, visible in every fresh or not decomposed variety of the species. On these fissures, and still more distinctly on some larger irregular ones traversing the masses, distinct crystals of gypsum are formed. Of the latter, I have seen several specimens from Aussee in Stiria, in the collection of Gratz. The decomposed individuals are much smaller in these than in the varieties from Pesay in Savoy, described by Haüy.

The absorption of water from the atmosphere, in saline substances, is usually attended with a solution of the latter in the water so attracted; that is to say, they *deliquesce*, and change their form, in passing from one state of aggregation into another. The reverse also very frequently takes place. Crystals *effloresce* by losing their water, and are converted into a loose mass of a pulverulent consistency, which retains the original shape, but readily gives way to the pressure of the finger, and falls into powder. Prismatic glauber-salt, prismatic natron-salt, and others, are familiar examples of this change. Many more might be quoted of the numerous cases of what chemists call *spontaneous decompositions*, depending upon loss of water, oxidation, &c. Among a great many facts of a similar nature, observed by Prof. Mitscherlich, during my stay in Berlin in the winter of 1825, I shall mention here a very interesting one, in which a crystallized substance was formed within another, by the application of heat, and a loss of water thereby occasioned. He exposed crystals of the ordinary hydrous protosulphate of iron, immersed in alcohol, to a degree of temperature equal to the boiling point of that liquid. Decomposition ensued, though the external shape of the crystals remained unchanged. On being taken out of the liquid, and broken, each of them was found hollow, and presented a geode of bright crystals, deposited on the planes of the original ones.

The crystals had the form of low eight-sided prisms, belonging to the prismatic system, and contained exactly half the water which is required in the mixture of the original species.

III. *Changes in Minerals containing Copper.*

[This Section of Mr Haidinger's paper has already been published by himself in this *Journal*, No. xiii. p. 126—134.]

IV. *Changes in Minerals containing Iron.*

Through the exertions of the late travellers in Brazil, we have become acquainted with octahedral crystals, often of considerable magnitude, of a particular ore of iron. They afford a red streak, and seem to contradict the character of the species of *octahedral iron-ore* in the characteristic of Mohs, (*Mineralogy*, Transl. vol. i. p. 439,) namely, that it should have a black streak. On a more close inspection, however, the octahedral masses are found to be composed of a great number of small crystals, resembling those of the rhombohedral iron ore, a species, one of whose characters is in fact the red streak observed. A specimen from Siberia, given to Mr Allan by Sir A. Crichton, presents the same change, excepting that in this specimen the individuals of the rhombohedral iron-ore are so minute, that they form a compact mass, contained within smooth planes, having the situation of the faces of a regular octahedron. As in the decomposed anhydrite, these planes are not the remains of cleavage, but they existed in the octahedral iron-ore previous to its decomposition, as fissures parallel to its octahedral cleavage. The chemical change necessary for transforming the mixture of octahedral iron-ore into that of rhombohedral iron-ore, is a very slight one, the former being a compound of one atom of protoxide and two of peroxide of iron, expressed by Berzelius's formula $\ddot{\mathrm{F}}\mathrm{e} + 2\,\dddot{\mathrm{F}}\mathrm{e}$, while the latter is the pure peroxide, or $\dddot{\mathrm{F}}\mathrm{e}$. The relative contents of oxygen are 28.215 and 30.66 per cent. There is a group of crystals from Vesuvius in Mr Allan's cabinet, elucidating, by their coarser texture, the explanation given of the Brazilian octahedrons. The rough form of an octahedron is produced by very distinct flat crystals, united in various positions, of the rhombohedral species, the face perpendicular to the axis of the fundamental rhombohedrons being much enlarged. Some of them have their broad faces in the direction of the faces of the octahedron; and in some of the octahedral groups this circumstance has produced a kind of raised reticulated appearance on the adjoining faces of the original octahedron, which the newly formed crystals intersect, and project beyond them. The changes which affect the sparry iron deserve our particular notice, as they are not only highly interesting in themselves, but have been well attended to at all those places where this species forms the predominant ore of iron. The characteristic chemical ingredient of it is the carbonate of iron, $\ddot{F}e\,\ddot{C}^2$, in which the protoxide of iron and the carbonic acid are in the ratio of 61.47 and 38.53. It contains occasionally an admixture of the carbonates of lime, magnesia, and manganese. The colour of the original varieties is usually a pale yellow, inclining to gray; the lustre and transparency are considerable. When left exposed to the action of the atmosphere, the surface soon assumes a brown tint, which by degrees penetrates deeper into the substance of the crystals. Some lustre even then remains, and cleavage is still observable. Specimens bounded by fissures on all sides, or broken out of a solid mass, when examined in this stage of their decomposition, often still contains a nucleus of the yellowish-gray undecomposed substance. When the decomposition has arrived at its end, every trace of cleavage has disappeared, the fracture of perfectly well pronounced crystalline shapes is uneven, or earthy, and the colour a dark brown, which is likewise visible in its streak. The substance now consists of a compact variety of the hydrate of peroxide of iron, whose chemical composition is expressed in the formula $2\,\dddot{F}e + 3$ Aq. and which contains 14.7 per cent of water. One atom of the carbon contained in the original compound will therefore go away in the state of carbonic acid, while the other must be transformed into oxide of carbon, in order to convert the protoxide of iron into a peroxide. The change in those masses has taken place so insensibly, that the action of the power of crystallization was prevented, and the interior presents a pretty uniform texture; but, at the same time, some particles of the hydrate of iron commonly also follow their own innate attraction, and form geodes of brown hematite, that is, of prismatic iron-ore. Hüttenberg in Carinthia has perhaps no equal in illustrating the exactness of this explanation, for the distinctness of the specimens which it affords. The geodes occurring at that place, of various sizes, are very frequently adorned with crystals of Arragonite, of calcareous spar, of prismatic manganese-ore, or with the silvery flakes of another manganesian mineral, whose exact chemical composition has not yet been ascertained. With the decomposition of the sparry iron is also intimately connected the formation of those beautiful coralloidal varieties of *Arragonite* known by the name of *flos ferri*, which are found in caverns near the surface of the rocks, as at Eisenerz in Stiria.

The *Ankerite*, or *paratomous lime-haloide* of Mohs, is also apt to be decomposed in a similar manner. But as it is a compound of the carbonates of lime and iron, in which the former amounts to more than half the weight, only what might be termed a skeleton of the hydrate of iron remains, while the rest of the ingredients disappear by the action of chemical agents. The texture of the remaining mass is much less compact than that of the residue left by the decomposition of the sparry iron.

The product of the decomposition of the two species last mentioned is exactly the same as the substance which remains, when iron-pyrites suffers a decomposition, without changing its form. Both species, the hexahedral and the prismatic iron-pyrites, having the same mixture, are also subject to the same change: the sulphur goes away, and the iron takes up oxygen and water; the decomposition proceeds from the surface. We often see crystals covered on the surface with a brown tarnish, and this is the first stage of the change. There are specimens with a thin coat of the hydrate of iron; there are others consisting almost entirely of the latter, with only a nucleus left of the original bisulphuret of iron. Such are found at Wochein in Carniola, where this hydrate of peroxide of iron, produced from the decomposition of the bisulphuret, occurs in such abundance and pureness, that it is melted as a very valuable ore of iron. The iron extracted from it is particularly remarkable for its softness.

V. *Changes in Minerals containing Lead.*

The mineral called *Native Minium* is probably, in every instance in which it has yet been observed, the product of decomposition of some other substance containing lead. Such is the variety which M. Bergemann of Berlin found in the lead mines of Kall, in the Eiffel in Germany, where the ore, chiefly the sulphuret and carbonate of lead, is dug out in irregular masses, from the loose earth, to the inconsiderable depth of a few fathoms. To him I have been indebted for several distinct crystals, possessing the regular forms of the di-prismatic lead-baryte, not only in regard to the simple prisms and pyramids of which the combinations consist, and the striæ on the surface of some of them, but also in regard to the identical mode of being joined in twin-crystals. The beautiful red colour, which in these compact masses much more nearly approaches the colour of vermilion, than in the best varieties of the usual minium in the state of powder, and the apparent homogeneity of the mass in the conchoidal fracture, together with the external crystalline appearance of it, at first rendered it extremely probable that this was actually a species of original formation; a supposition which proved to be erroneous, on the substance being more accurately examined. In the present case, it is carbonate of lead, or $\dot{Pb}\,\ddot{C}^2$, according to Berzelius's formula, corresponding to 83.52 oxide of lead, and 16.48 carbonic acid, which is changed into the red oxide of lead, or $\dddot{Pb}$, containing 10.38 per cent. of oxygen. In order to explain this change, we must suppose, that of the two atoms of carbon contained in the original compound, one goes away in the state of carbonic acid, and the other in that of oxide of carbon, one of the atoms of oxygen being employed to convert the yellow oxide contained in the carbonate of lead into red oxide. The best artificial minium is obtained by a change exactly analogous to what we find in nature. Carbonate of lead, in the state of an impalpable powder, is exposed to heat, care being taken to stir it continually, in order to renew the surface exposed to the air. If crystals of the di-prismatic lead-baryte be heated in a glass tube, the first application of heat changes them into a red mass, which, however, at a higher temperature, loses an additional portion of oxygen, and becomes yellow on cooling. It then contains lead 92.83, and oxygen 7.17, and is $\ddot{P}b$, or protoxide of lead.

The *Hexahedral lead-glance*, consisting of one atom of lead and two of sulphur, $Pb\ S^2$, in the proportions of 86.55 and 13.45, is very liable to decomposition by means of the natural agents. There are examples of compact varieties of prismatic lead-baryte formed by its decomposition, and still presenting the traces of fissures parallel to the hexahedral cleavage planes of the original species. The prismatic lead-baryte consists entirely of sulphate of lead ($\ddot{P}b\ \ddot{\dot{S}}^2$,) in which the two ingredients, lead and sulphur, are in the same ratio as in the lead-glance: the two species are chemically distinguished from each other only by the presence of the oxygen in the sulphate. The form of the hexahedral lead-glance, however, is not always recognizable in the products of its decomposition, though there can be no doubt, that, in many cases, the numerous crystalline species of the genus lead-baryte are formed in this way in the veins. Those who might be still inclined to doubt should visit the repositories of these species at Leadhills, a place conspicuous in the annals of the mineral collector for the beauty of the specimens with which his cabinet is adorned. They occur there in a vein in greywacke, filled with a clayey mass, in which nodules of the minerals containing the lead are imbedded. On their outside they are almost uniformly covered with crystals of the carbonate, more rarely of the phosphate, of lead. In the drusy cavities which they include, are deposited the rarer species of the sulphato-carbonate, the sulphato-tri-carbonate, the cupreous sulphate, and the cupreous sulphato-carbonate, and likewise the phosphates and sulphates of lead. These cavities also are frequently lined with fine crystals of the carbonate itself. A piece of the sulphuret, with bright cleavage planes, is often discovered, engaged among all these species, whose formation so much depends upon its previous existence. In such cases, we find the sulphuret corroded and rounded, presenting a surface nearly similar to that of hexahedral rock-salt, or gypsum that have been exposed to the dripping of water. The space between it and the external coating is often filled with water, when the nodules are found in the mine. Mr Baird gave a pretty complete account of the changes by which the oxidized species are formed from the sulphuret.—*Mem. Wern. Soc.* iv. p. 508.

Miners pretty generally have an opinion, that the contents of metallic veins are not always the same, and that they are often working such as are not yet *ripe*, or would have been more productive, if attacked at a later period. This opinion is founded chiefly on a belief, that blende is changed into lead-glance. We are not entitled by observation to admit of such a change; and though in this manner it does not appear that we can come too soon with our mining operations, we see plainly that at least, as at Leadhills, we may come too late; for that vein which now contains the carbonates, and sulphates, and phosphates, must have been once replete with the much more valuable sulphuret of lead. Evidently, also, those among the Freiberg veins have been opened too late, which now are found to contain the large six-sided prisms of iron-pyrites, produced by the decomposition of that valuable ore, the brittle silver, or prismatic melane-glance of Mohs; this, at least, is the only species to which we can attribute the shape of those prisms, although they themselves remain in some measure problematical.

The changes are not at an end, even with the complete destruction of the sulphuret. I must, in particular, mention three cases, all of them in specimens from Leadhills, in the cabinet of Mr Allan, in support of this observation. One of them has distinctly the form of large, perfectly recognizable crystals, with a rough surface, however, of the prismatic lead-baryte. The whole of the substance of the crystals is a granular tissue of minute crystals of the di-prismatic lead-baryte. The sulphate, $\dot{P}b\,\dddot{S}^2$, containing 73.56 per cent. oxide of lead, has been here converted into carbonate, $\dot{P}b\,\ddot{C}^2$, which contains 83.52 per cent. of the same ingredient. The form in the second case is that of the low six-sided prisms of the axotomous lead-baryte, with pretty smooth surfaces. Its substance is an aggregated mass of crystals, likewise of the di-prismatic lead-baryte, but presenting in their distribution much resemblance to the mode in which the individuals of malachite are arranged, which replace the crystals of the blue copper. The sulphato-tri-carbonate has here given way to the carbonate of lead. The third specimen, like the preceding one, has the form of the axotomous lead-baryte; but, beside white crystals of the di-prismatic, also yellow ones of the rhombohedral lead-baryte are found to occupy the space originally taken up by the axotomous lead-baryte. Here the carbonate and the phosphate have replaced the sulphato-tri-carbonate of lead.

A very interesting change of the *Sulphuret of lead* into a granular *mixture of carbonate and phosphate*, was mentioned to me by M. Von Weissenbach of Freyberg, who had first observed it, and who likewise showed me the specimens he had collected on the spot, at the mine called *Unverhofft Glück an der Achte*, near Schwarzenberg in Saxony. The original forms of the lead-glance, regular octahedrons, were still distinctly visible; but they consisted of a tissue of white and green crystals of the di-prismatic and rhombohedral lead-baryte. There was a black friable residue left, which was considered as friable lead-glance. Such a substance is often left on the surface of decomposing lead-glance, where, even in the portions that yield to the pressure of the nail, and soil the fingers, some traces of cleavage continue. Very good examples of it occur at Mies in Bohemia, along with the well-known large crystals of carbonate of lead. Selb also observed black di-prismatic lead-baryte in the shape of cubes, originating from, and containing particles of, lead-glance, from the Michael mine in the territory of Geroldsegg in Swabia. (Leonhard's *Hand. Oryktog.* 2d edit. p. 293.)

The changes described above are not of a rare occurrence in the various mining districts, not only in such where the works are carrying on in actual veins, but also in those which are situated in metalliferous beds. It has been very generally observed, that such mineral repositories yield crystals chiefly in their upper levels, and that they are found more compact when the works are carried to a greater depth. They follow, in general, from the oxidation of the original substance. I have seen only one example of the contrary, which was shown to me by Prof. Hausmann, in the museum at Gœttingen. Impressions, of a hexahedral form, produced by lead-glance, contained a residue, of a very loose texture, of native sulphur. This specimen was found in Siberia.

The mineral usually designated by the name of *Blue Lead*, is in some respects the converse of the changes considered above. Its forms are those of the rhombohedral lead-baryte, namely, regular six-sided prisms. The compound of phosphate of lead and chloride of lead, of which their substance originally consisted, has given way to the sulphuret, which usually appears in granular compositions, filling the crystals. The first varieties that were noticed by mineralogists were those from Tschopau in Saxony. I remember having seen specimens of it, entirely consisting of compact galena, but I have not had an opportunity of comparing any again, after having examined some of the other varieties of the same substance. At Huelgoet in Brittany, six-sided and twelve-sided prisms are found, often upwards of an inch in length, and nearly half an inch in thickness, which consist of a coarse-grained compound variety of lead-glance, the component individuals being so large that it is very easy to ascertain their hexahedral cleavage. Sometimes these individuals have one of their hexahedral faces of crystallization coincident with the original surface of the hexagonal prism. The stratum of lead-glance contiguous to the surface of the original crystal is usually separated from the body of it by an empty space, so that it may be very easily broken off. Sometimes only this stratum is in the state of lead-glance, while remains of the original species are still visible in the interior, or part of the crystal only has begun to have a portion contiguous to the surface converted into lead-glance, while the rest presents the adamantine lustre and brown colour of the rhombohedral lead-baryte. In the six-sided prisms of the same kind of formation met with at Wheal Hope in Cornwall, generally a film of lead-glance is also observed near the surface; but the crystals of the sulphuret in their interior are often much more curiously arranged. Partly they are simply composed of a mass of very compact galena, partly also they present, when broken, the appearance of being cleavable with great facility perpendicular to their axis, and at the same time also parallel to the sides of the six-sided prisms, and parallel also to the planes replacing their edges. The smooth planes obtained in this manner are actually the faces of cleavage of the hexahedron peculiar to lead-glance. The individuals of the sulphuret namely, gradually formed in the crystal of the phosphate, assume such positions, that two of their faces are parallel to the sides, and two to the terminations of the six-sided prism; the two remaining ones will be perpendicular to the lateral and the terminal faces. The direction of them appears distinctly in the annexed sketch of the transverse section of a crystal, as indicated by the lines parallel and perpendicular to the sides of the hexagon. On breaking the prisms, we obtain fractures situated like the line *a b c d*, Plate IV. Fig. 4. which I have sometimes observed giving a clear demonstration of the actual composition of the crystal in the manner described. Generally the portion adjoining the centre, as it were the axis of the prism, consists of perfectly compact lead-glance, provided the original species has entirely disappeared; then comes a more or less considerable stratum of the cleavable mass, which, however, is often wanting; and then a coating of a coarser texture. From the mere arrangement of the particles, it is placed beyond a doubt, that the crystals of the sulphuret have not been formed in moulds from the phosphate. They are probably the product of the gradual decomposition of the latter by sulphuretted hydrogen, an explanation which was first proposed by Romé de l'Isle, even though the real chemical composition of the rhombohedral lead-baryte was then unknown, to account for the appearances which he so well describes. *Cristallog.* vol. iii. p. 400. Such a decomposition easily takes place even at the common temperature of the atmosphere, if a stream of sulphuretted hydrogen is allowed to pass over the brown variety from Huelgoet, reduced to powder. Both the phosphate and the chloride of lead are decomposed, sulphuret of lead is formed, while the oxygen, phosphorus and chlorine are carried off, forming hydrophosphoric and hydrochloric acid and water.

VI.—*Changes in Minerals containing Manganese.*

The ores of manganese have not yet been sufficiently examined, in regard to their chemical composition, to allow us clearly to establish the changes that take place in what may be rightly supposed the decomposition of the *prismatoidal manganese-ore*. I have shown on another occasion, *Edin. Journ.*

of Science, vol. iv. p. 41, that the regular forms belonging to that species, are properly found in specimens having a brown streak, a degree of hardness equal or superior to that of fluor, and a specific gravity contained between the limits of 4.3 and 4.4, but that the same form is often united to the character of a black streak, a degree of hardness lower than that of calcareous spar, and a specific gravity often approaching to 4.7. These latter varieties frequently form a coat round the former; and a crystal, whose internal particles afford a brown streak, may give a black streak when the experiment is tried with the outward layers. The form remains the same, and even cleavage continues in those parts whose streak is black; nay, it seems to be more easily obtained, particularly the faces parallel to the short diagonal of the prism of 99° 40′. From chemical considerations, Prof. Gmelin had formed nearly the same opinion in regard to a change of composition within the crystals or crystalline masses of one of the species. One of them is a hydrate of the oxide of manganese, and that is the prismatoidal manganese-ore, giving a brown streak: the other is the hyperoxide, formed by loss of water and absorption of oxygen, and it gives a black streak. Hitherto no crystals of the latter substance have been described, that did not depend upon the previous existence of the prismatoidal manganese-ore. Prof. Rose of Berlin showed me small crystals, having the form of right rhombic prisms, with their acute lateral edges replaced, and measuring 86° 20′ and 93° 40′, a prism not to be found in any of the known varieties of the former species. But the faces not being very bright, and the measurements therefore not quite decisive, inferences drawn from the observed difference in the angles might prove erroneous.

The *Pyramidal Manganese-ore*, too, sometimes appears to be a product of the decomposition of the prismatoidal species. In a specimen in Mr Allan's cabinet, the pyramidal species forms very distinctly the substance of elongated crystals, resembling those of the latter; but unfortunately the decomposition has proceeded so far, that the surface of the original crystals no longer exists, in a manner similar to what occurs in several instances of malachite in the shape of blue copper. We cannot guess at the chemical change taking place here, as the composition of the pyramidal manganese-ore is entirely unknown. From the preference given to the varieties with a black streak above the pyramidal species by the miners of Ihlefeld, where Prof. Rose last summer found the pyramidal species to occur in a particular vein in porphyry, it would appear that this species contains less oxygen than the product of the other kind of the decomposed hydrate. The pyramidal manganese-ore contains no water, at least not to a considerable extent.

VII. *Changes in Minerals containing Baryta.*

A change analogous to some of those described in the genus lead-baryte, is that which affects *Baryto-calcite*, or the hemi-prismatic hal-baryte, a mineral consisting of one atom of carbonate of lime and one of carbonate of baryta. It occurs not only in perfectly formed crystals, with bright surfaces, but also in such as have lost their original brightness, and are covered with a coating of crystals of sulphate of baryta, constituting the chemical composition of the prismatic hal-baryte. There are varieties, also, which still show the exact hemi-prismatic form of the baryto-calcite, but, when broken, do not exhibit a trace of the original foliated texture, being altogether composed of a granular tissue of small crystals of heavy-spar. Sulphuric acid and water must have acted jointly to effect this change, but the decomposition must have proceeded slowly. The carbonic acid is expelled by the former, and the latter will carry away the sulphate of lime which is thus formed, leaving only the sulphate of baryta.

The pure *Carbonate of baryta*, also, which constitutes the chemical substance of the species of *Witherite*, is found in all stages of a decomposition of the same kind; that is, from the state of a carbonate, the base enters that of a sulphate. The decomposition proceeds from the surface. Perfectly bright crystals of the substance are rare, and almost entirely confined to some small drusy cavities in the interior of those large globular shapes occurring at Alston-moor, which are white and opaque on the outside, and more translucent and yellowish within. The white coating is not, however, carbonate, but it consists of a number of minute crystals of sulphate, and is of variable thickness, in some specimens more considerable than in others. Often, too, nothing but the general outline of the original form is left, and large six-sided pyramids or tabular prisms, as we are accustomed to find them in witherite, showing on their outside a drusy surface of numerous crystals of heavy-spar, are found, when broken across, to consist of the same species in aggregated crystals, generally including cavities, from which the original species has disappeared, and which have not been completely filled up. One of the specimens from Dufton, in Mr Allan's cabinet, deserves a particular description. On a support of crystallized calcareous spar and heavy-spar, the latter in rectangular tables of three inches in length and upwards, are deposited the shapes of isosceles six-sided pyramids, some of them two inches long, with a proportional diameter, which were formerly witherite, but now present a surface rough with crystals of heavy-spar, many of them more than a line in length, and of course easily recognizable. While the process of the transformation of carbonate into sulphate was going on, crystallized portions of the latter were likewise deposited on the surface, and particularly along the edges of the original large tabular crystals of heavy-spar, where they assume a position dependent upon the latter, and may be considered only as continuations of the same individuals. The secondary deposit, being of an opaque milky whiteness, may be readily distinguished from the transparent substance of the original crystals. These crystals themselves do not show a homogeneous texture throughout. There are cavities inside of them, often in such multitudes, that the remaining mass of heavy-spar assumes a carious aspect, though still, by its cleavage, showing that it is part of the individual within whose external form it is found. Many of the cavities are filled with small brown crystals of calcareous spar. The crystallization of the calcareous spar, begun in the form of the fundamental rhombohedron R, with yellowish-white faintly translucent matter, as appears from the delineation of colours, was completed by a brownish opaque matter, in the shape of the combination $R - 1 . R + \infty$, the form *dodécaèdre* of Haüy. These brown portions have also a carious aspect, as from decomposition, and are studded with small crystals of heavy-spar of the same kind as that which replaces the crystals of witherite.

VIII. *Changes in Minerals containing Antimony.*

The chemical changes of the minerals containing antimony have not been sufficiently attended to. It is certain that the native antimony takes up oxygen, and then presents a white opaque mass, showing every peculiarity, in respect of form, of the original substance, as I have seen in a specimen in the museum at York. This is probably the *oxide of antimony.* The *prismatoidal antimony-glance* consists of sulphuret of antimony, a mixture of one atom of the metal and three atoms of sulphur, $Sb\ S^3$, the ratio of antimony and sulphur being 72.77 and 27.23. It is converted by decomposition into a yellowish opaque mass, of an earthy aspect, which is proved by experiments with the blowpipe still to contain a notable quantity of sulphur, beside water and antimony. In this case the form is preserved. Sometimes, however, as at Braunsdorf in Saxony, the decomposition is complete, and attended with change of form, in the same manner as the lead-glance. The decomposition begins from the surface, which is corroded, and becomes perfectly smooth. In the cavities thus produced, crystals of the antimony-baryte are deposited, which consist of pure oxide of antimony, one atom of the metal combined with three atoms of oxygen, or $\dddot{Sb}$, the two ingredients being in the ratio of 84.32 to 15.68. Each atom of sulphur is exactly replaced by an atom of oxygen.

(To be concluded in next Number.)

Art. XIV.—*Observations on the Barometer and Thermometer made at Malmanger and Ullensvang in Norway, during a period of thirty years, from* 1798 *to* 1828. By Provost Hertzberg of Ullensvang. Communicated by the Author.

In the Thirteenth Number of this *Journal* we have already published a table of the minimum and maximum height of the barometer, deduced from twenty-nine years' observations, by M. Hertzberg, Provost of Hardunger, and pastor of Kingsverig, in the diocese of Bergen in Norway. In compliance with our request the same accurate observer has communicated to us his observations on the mean state of the barometer and thermometer, and on the temperature of springs, with the view of determining the mean temperature of the parallel of 60° in the old world.

From 1798 to 1807 the observations were made at Malmanger in the diocese of Bergen, in lat. 59° 58′, and at an altitude of 64 Rhinland feet above the sea. From 1807 to 1828 they were made at Ullensvang, in the same diocese, in lat. 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 inches, is reduced to the temperature of 0° of Reaumur's scale.

	Barometer.	Thermometer. Reaumur.	Mean Temperature of May, June, July, August.
1798	27″ 11‴ 6	+6° 99	+13° 3
1799	28 0 2	+6 15	+11 8
1800	27 10 1	+5 84	+10 9
1801	27 11 5	+6 55	+12 8
1802	27 11 2	+4 85	+ 9 5
1803	28 0 1	+4 50	+10 6
1804	27 11 8	+5 30	+10 8
1805	27 11 9	+5 50	+11 1
1806	27 11 6	+5 27	+10 9
1807	27 11 5	+5 10	+11 4
1808	28 0 3	+5 72	+13 0
1809	28 0 4	+5 12	+12 2
1810	28 0 7	+4 96	+10 6
1811	27 11 8	+6 75	+12 0
1812	28 0 4	+7 70	+10 3
1813	28 0 5	+6 63	+12 9
1814	28 0 6	+5 50	+10 9
1815	28 1 1	+5 0	+11 8
1816	27 11 6	+5 70	+12 0
1817	27 11 1	+5 96	+11 2
1818	28 0 1	+6 62	+12 0
1819	28 0 3	+6 50	+12 8
1820	28 0 9	+5 80	+11 9

	Barometer.			Thermometer. Reaumur.		Mean Temperature of May, June, July, August.	
1821	27	11	4	+6	10	+11	0
1822	27	11	9	+6	75	+12	0
1823	27	11	8	+5	64	+10	7
1824	27	9	5	+6	77	+11	9
1825	28	0	1	+6	69	+12	5
1826	28	0	7	+6	75	+12	6
1827	27	11	4	+5	60	+11	3
	27	11	87	+5	08	+11	62

From these observations it appears that the mean temperature of Ullensvang is 43° 6′ of Fahrenheit's scale. This annual temperature agrees with the temperature of constant springs near the sea-shore, which never freeze, and preserve the same temperature in summer and winter. They vary from 5° to 6° of Reaum. (43° to 45° Fahr.)

From the last column, which contains the temperature of the vegetating season, it appears that this temperature was least in the years 1802 and 1812, viz. 9° 5′ in 1802, and 10° 3 in 1812, the mean temperature of that season for thirty years being 11° 62; and it is a curious circumstance that these years were the years of greatest scarcity in Norway, 1802 being greater in this respect than 1812.

Art. XV.—*On the Employment of Equations of Condition in Naval Architecture.* By George Harvey, Esq. F.R.S. Lond. and Edin., F. L. S., Honorary Member of the Society for promoting the Useful Arts of Scotland, &c. &c. Communicated by the Author.

The celebrated Swedish naval architect, Chapman, entertained the idea of deriving all the essential elements of ship-building from different *equations of condition*, and also of referring these to some primitive element or root; and we find from his two works, *A Treatise on Ship-building, with explanations and demonstrations on the Architectura Navalis Mercatoria*, and his " *Investigation to determine, for Ships of the*

Line, their right size and form," that he actually made some progress in carrying out this beautiful idea into much generality and fulness.

During a recent review of some of Chapman's tables, it has appeared to me, that the point to which naval architecture ought to continually approximate as a limit, should be the perfecting of the elements contained in them, or of such others as a more extended experience may at this time possibly suggest; obtaining for them more correct or appropriate coefficients, establishing more completely their necessary relations, and giving to the whole train of inquiry a more extended and philosophical form. Such a method of procedure would be most consistent with the legitimate objects of philosophical inquiry. In the language of the modern analysis, it would be regarding every element of a ship as a *function* of some primitive element; and which, by means of properly prepared coefficients, would admit of every other element being deduced from it. There must, for example, be in every ship some relation between its length, breadth, depth, and displacement; and some process, more accurate than that of a rude approximation, ought to exist by which any one of these elements can be immediately deduced from the others. Between the length and the breadth, and between each of these elements and the depth, there must, in a ship of acknowledged good qualities, be some relations worthy of investigation. The breadth must be a function of the length, and the depth must be connected to each of these by some relation capable of being exhibited in an equation of condition. The area of the main section also may be so connected with the breadth as to be resolvable at first into terms of the length, and ultimately into that of the displacement itself. In like manner may the area of the plane of flotation, the moment of stability, the place of the metacentre, the position of the centre of gravity, and indeed the value of every other element be ultimately traced to the displacement. If the whole length of the water line be denoted by λ, the entire length of the same line between the rabbits must be some function of the same dimensions; and as the former may be shown to be a function of the displacement, so also may the latter. Hence the displacement, or some other appropriate quantity being assumed as a primitive element, every other element may be traced to it, and the whole system of elements thus be exhibited under appropriate equations of condition.

But it may be asked, in attempting to extend the investigation of these elements beyond the limits attained by Chapman, how are these equations of condition to be obtained? To this it may be replied, by EXPERIMENT and OBSERVATION; *by inquiring into the properties of the most approved models that have been already produced;* by grouping together facts, and drawing from their united testimony legitimate results; pouring into the very heart of ship-building the genuine spirit of induction, and throwing over the whole inquiry the mantle of a pure philosophy; viewing facts not as *detached* and *insulated fragments,* but as parts of a system which the progress of inquiry must eventually extend and make perfect.

To those who may be disposed to question the possibility of tracing in the extended manner here alluded to, the connection of the different elements of a ship, we would observe, that some of our ships of war and some vessels of our mercantile marine, possess confessedly better qualities than others. Some indeed are known to have a more than ordinary proportion of good qualities, and as such become proper objects for philosophical examination.* Suppose, for example, that two or more ships of a particular class were selected, whose properties were generally recognized as good, might not many important conclusions be deduced from an analysis of their different elements? † Each ship would have, for example, a given displacement, a given length, a breadth, a main sectional area, a certain stability, a particular position of the metacentre, and many other elements, each of which it would be highly proper to ascertain, and the relation of which to some common element, it would be of the first importance to determine. All these elements would of course possess at first a numerical character; but the generalizing eye of a philosopher would soon trace the existence of laws among the apparently

* Many of the finest models now float in our harbour. The Canopus and Caledonia may be instanced as examples. The latter, though a first rate, possesses all the manageable properties of a frigate.

† See *Annals of Philosophy* for November 1825 and January 1826.

unconnected arithmetical results; and order, and a system of definite relations, would assume the place of irregularity, apparent accident, and chance.

And here also it may be remarked, that it has hitherto been too much the practice of those connected with naval inquiries, to view the various elements of ship-building in the light of *detached and insulated quantities*, and not as parts of a system which possess the most perfect and intimate relation to each other, and incapable in fact of separation. How often, from the imperfect condition of this branch of knowledge, have the most laborious disquisitions on stability, or the displacement, and indeed most of the elements of naval architecture, had this detached and insulated character, their authors neglecting to keep in view the gradually inductive steps by which one branch of the inquiry is led on to another, and how each individual principle of the system is related to the elements that surround it.

No one who investigates the present condition of naval architecture can for a moment allow that it has been benefited in any material degree, by the example which the great reformer of philosophy exhibited to the experimental world. There has been little of what may be truly termed *inductive inquiry* displayed in its history; and it now stands almost a solitary monument of the folly which guided the predecessors of Bacon in the paths of experimental investigation. Yet in no subject is there greater room for the application of the most rigid principles of the inductive logic. Millions of ships have been constructed, but only here and there a successful example has been offered for our contemplation, as if to mock the implicit obedience we pay in the practice of ship-building to uncertain and ill-defined rules.

There is one subject more relating to the tables of Chapman, to which we would briefly advert, and that is *notation*. A simple inspection of the Sweedish engineer's tables will show that their celebrated author did not avail himself of all the advantages that this powerful instrument is capable of imparting. There is more in notation, to adopt a familiar phrase, than first meets the eye. Simplicity, uniformity, generality,—a capability itself of suggesting new relations and inquiries;—

these, and many other particulars, are connected with the great question of notation. And when we have seen the march of whole departments of science retarded for years by the use of barbarous symbols of notation, it is not too much to insist, that in the formulæ and equations of condition that may hereafter be created for the use and extension of naval architecture, some little attention should be paid to the lights that the modern analysis has thrown on this great question. The remotest element of a ship must be connected with some primitive element, by a series of unquestionable laws; laws, dark and mysterious it is true, at present, but which the spirit of a genuine and pure induction will eventually illuminate and make clear. This remote element may, however, be traced to its primitive source by a shorter route, by one process of ratiocination than by another; but by no better method than by the pure light of a legitimate notation can this important object be attained.

PLYMOUTH, *May* 26, 1828.

ART. XVI.—*On the Cultivation of the Science of Shipbuilding*. By GEORGE HARVEY, Esq. F. R. S. Lond. and Edin. Member of the Royal Geological Society of Cornwall, &c. &c. Communicated by the Author.

THE question has often been asked, to what causes are we to attribute the neglect of the science of shipbuilding, which it is said is generally the case in Great Britain; and how is it that States, confessedly our inferiors in maritime importance and strength, should nevertheless excel us in the theoretical construction of their ships? To these interrogations it may be answered, that our triumphant superiority on the ocean affords a ready and probable solution. Our superiority has induced neglect, while other nations, jealous of our nautical power, have strained every nerve to rival and surpass us, and endeavoured to make up the want of numbers by superior constructions. The French, for example, have endeavoured, and in a multitude of cases have succeeded in producing better sailers; and the Americans, by enlarging their scale of the different ships of war, are endeavouring to turn the balance against us. France, to obtain superiority, wisely enlisted on her side the genius and science of her geometers. By prizes, by public rewards, by honourable distinctions, by every thing that could excite emulation and scientific enterprise, she invited her geometricians to consider all the great problems connected with shipbuilding, and to transfuse into the practical operations of her dock-yards all that the most enlightened theories could teach. Some advantages surely must result to an art to which such minds as Bouguer's and D'Alembert's could direct their attention. It is impossible indeed for a mind accustomed to the higher orders of human thought to descend to the lower walks of contemplation, without the latter being in some degree improved. A mere theorist applying his speculations to the practical details of an art can do nothing; but a man whose habits and modes of thought are built upon the genuine principles of inductive science; who looks at shipbuilding neither with the eye of a merely speculative curiosity, nor with the blank intelligence that too often unfortunately characterizes the daily operators in the mechanical arts, can scarcely direct his attention to any one of its departments, without in some degree imparting to it a benefit.

Shipbuilding to Britain, may with perfect justice be styled a NATIONAL ART. It is one even more necessary to our national existence than those miracles of mechanical skill which have placed our arts and manufactures on so proud and elevated a level. Destroy our naval superiority, and our lofty pre-eminence in commerce will soon be humbled in the dust. The navy is the sinews of our strength,—the arm that gives us all our political importance, and makes the name of Britain known, respected, and feared in the remotest regions of the globe. And what, we would ask, is the proud term Navy, which we so often quote with feelings of exultation and hope, but a name identified in the closest and strongest manner with the science of shipbuilding. Give to our navy, therefore, not only numbers, but every advantage which science and intelligence can bestow. Let naval architecture be regarded peculiarly as a *National Art*. Let its first elements, its feeblest beginning—every thing that can contribute to its improvement—be fostered and encouraged. Let public honours and national rewards be bestowed on those who add to its perfection. Let our men of science be induced, like EULER, BOUGUER, and CHAPMAN, to look to it as an object to which their high attainments may be applied, with the full and certain prospect of honour and renown.

PLYMOUTH, *August* 12, 1828.

ART. XVII.—*Remarks on Self-Registering Thermometers, particularly on Mr King's, described in last Number.* Communicated by the Author.

SIR,

ONE of the most important and interesting, but at the same time unfortunately one of the most imperfect of our meteorological instruments, is the self-registering thermometer. Although the ingenious principles on which it has been constructed are perfectly good in theory, yet from a certain degree of mechanical complexity with which they are always accompanied, and the consequent pains required in constructing them, they are seldom found equally unexceptionable in practice. It is not my intention at present to enter upon the general and particular defects of register thermometers and their remedies, which it would require an extensive series of experiments with the instrument in various forms to be able to write upon in a manner commensurate with the importance of the subject, or worthy of a place in the pages of your *Journal.* My present intention is merely to make some remarks which suggested themselves to me on the perusal of a paper connected with this inquiry by Mr King in your last number.

The first form of the instrument which Mr King has described (No. xvii. p. 114, &c.) is manifestly too complex to be generally and accurately useful, and nothing could be less conformable to the principles of the art than the proposal of making the legs separately, and then joining them. The same fundamental plan is adopted in the second form of the thermometer described in page 116, to which I beg to refer the reader; and the mode of indication is every way simple and more effective. The principle may briefly be stated as follows:—That by the expulsion of the mercury from the tube into a convenient receptacle till the temperature reaches its maximum, the orifice of the tube shall become a zero of moveable value, whose value shall be determined by adding the space left unoccupied by mercury (expressed in degrees) to the temperature of the time of observation observed on a common attached thermometer. I think it is above two years since I contrived a plan *perfectly identical* with that of Mr King; but as I never mentioned it to any one, it is obviously impossible that Mr K. should have borrowed his instrument from mine; but what I think it just to state is, that my plan was suggested by Mr Blackadder's thermometer in this *Journal*, No. ix. p. 92, which, though it was only meant for registration at a particular moment of time, is on a principle nearly approaching that above defined. My motto is "palmam qui meruit, ferat;" and it is one which I have before now supported in this *Journal*, and to which you, Sir, have ever been particularly attentive. My wish is therefore merely to remark on the originality of Mr Blackadder's idea, and the feeling which *experience* must necessarily have produced on my mind, that Mr King has borrowed the idea without that acknowledgment which the candour of science seems to require; for my part I have no wish to oppose to him my hitherto unpublished claims to the instrument, and with this I drop the question of priority of invention.

With regard to the merits of this register thermometer, when I first thought of the plan several practical imperfections occurred to me, which prevented me from having it executed. One of these, which regarded the determination of the indications of the instrument, proved on an attentive consideration to be unfounded; but there are defects which I suspect would prove hurtful both to the accuracy and the general adoption of the instrument. The first occurs from the essential principle of the adjustment of the instrument at each observation. It is obvious from Mr King's description above referred to, that after the mercury in the tube has been made by the heat of the hand to join the quantity in the reservoir at the top, while the instrument is held in this upright position, it must be so held until the mercury has resumed the true temperature of the air,—an operation of so much nicety, and of such considerable time to be properly performed, that I do not think it a very advisable *postulatum* in the adjustment of any instrument. If the instrument is delicate, the very heat of the hand or the body is sufficient to prevent this, and if it be clumsy, the difficulty is only tenfold increased. Another imperfection I should foresee is in the method by which the column of mercury is cut short, namely, by its own gravity as it reaches the orifice of the tube. Now, those who are accustomed to the operations of this fluid must be aware of the effects of its great density and cohesion of parts, and that when pressed from the mouth of a tube of any kind it neither trickles off like a fluid of less specific gravity, nor falls off exactly where the tube ceases its support, but that it forms a globule at the mouth of very considerable size, which does not fall till the gravity of the mass exceeds the cohesive attraction it experiences to the remainder of the column. Hence it is clear, that at one time, if the temperature reaches the maximum, and begins to decline just as a drop has fallen from the mouth of the tube, the zero will be correctly at that point, but at another the mercury in the bulb may begin to contract just as the globule has reached its greatest size, when, instead of dropping off, it will gradually retire again into the tube, causing an error, which might, I presume, be frequently considerable. In Mr Blackadder's idea, however, of a register without any index, there is great ingenuity; and in the case he proposes for registration at a particular hour, these objections do not hold, but in my opinion are replaced by others still more serious. It is impossible to conceive that an instrument should be used except by one or two individuals, which requires not merely a time-piece attached, but a whole apparatus of a perpetual burning lamp in one case to keep it warm, and an evaporating contrivance in another to cool it.* Such complexity ill suits with the present state of meteorological science, which finds few enough persons who will pay a due regard to the accurate use of the usual means of information; and there are even some who, like Mr

* See this *Journal*, No. vii. p. 251, and No. ix. p. 93.

King (in last No. p. 118,) are pleased to call a Meteorological Journal "the veriest drudgery in science!"

The thermometer described by this gentleman (Mr K.) is, it will be observed, only a maximum one; and notwithstanding any practical defects, it might perhaps replace well the maximum thermometer of Rutherford, which is very liable to have its index entangled in the mercury. Experience alone can determine how far this adoption might be advisable. One plan I originally thought of, for remedying the necessity of raising the temperature of the column of mercury till it joined the reservoir, and then suffering it to assume the external temperature, was good in theory, but without superior workmanship would not succeed in practice. It consisted in having the air so thoroughly expelled from the instrument, that when the top of the thermometer was raised, by a gentle shake the mercury might run down the tube and join the rest, or that, if the bulb was raised, it should run up to the cistern at the top, and when reversed the column would be continuous. I think that it might be thoroughly freed from air by allowing the fluid first to fill the tube and bulb, and then boiling it in the globular cistern, allowing the air to escape by a capillary orifice left in the top of the cistern, which would at the same moment be closed with the flame of the lamp. Good thermometers, if the diameter of the bore be at all considerable, permit the mercury to flow readily from the bulbs, and return to them with a click. In the present case, therefore, we should make first-rate workmanship necessary to the principle of the instrument, and a tube with large bore, which necessarily destroys the delicacy of the instrument, on which I should principally rely for the superiority of thermometers which do not require an index.

The minimum thermometer of Rutherford is certainly a very excellent instrument, and when not subjected to such sudden changes of temperature as to divide the column of alcohol, is not liable to be out of order. Six's, which registers both extreme heat and cold, is very imperfectly constructed, and is often fallacious in its indications. The one which I daily use is by one of the first London makers, yet it is frequently out of order, and follows imperfectly the atmospheric changes. Much, very much, is to be looked for in the improvement of this thermometer. At some future period I may perhaps resume this subject. In the meantime, I remain your most obedient servant,

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Art. XVIII.—*Description of Pyrolusite, or Prismatic Manganese Ore.* By William Haidinger, Esq. F. R. S. E.

As Mr Haidinger's valuable paper on the manganese ores was drawn up for this *Journal*, and first published in it, we propose to lay before our readers an account of *Pyrolusite*, or *Prismatic* Manganese Ore, which has been established as a new mineral species since the publication of that article. It is given by Mr Haidinger in his enlarged paper on the ores of Manganese in the *Edinburgh Transactions.*

Prismatic Manganèse-Ore.

Pyrolusite.

Grau Braunstein, in part, *Hausmann*, p. 288.

Grey Oxide of Manganese, in part, *Phillips*, p. 243.

Form and cleavage probably belonging to the prismatic system; the cleavage taking place in several directions.

Lustre metallic. Colour iron-black; in very delicate columnar compositions the colour becomes bluish, and the lustre imperfect metallic. Streak black. Opaque.

Rather sectile. Hardness = 2.0 ... 2.5. Sp. gr. = 4.94, a specimen from Elgersburg, and another locality unknown, = 4.819, according to Dr Turner.

Compound Varieties.—Reniform coats. Both columnar and granular composition is often met with, particularly the former; the individuals often radiating from common centres. If the individuals are very delicate, the masses will soil the fingers, and write on paper.

Observations.—The name of *Pyrolusite* alludes to a property, for which this mineral is reckoned the most valuable one among the preceding species. It is derived from πῦρ, *fire*, and λούω, *I wash*, being employed, in consequence of the large quantity of oxygen which it emits at a red heat, to free glass from the brown and green tints produced by carbonaceous matter and protoxide of iron. The manganese of commerce has been for this reason facetiously called by the French *le savon des verriers*, or *le savon du verre*.

There can be no doubt that pyrolusite should form a species of its own, if we only attend to the marked differences in its hardness, strength, &c. from all the rest. As yet, however, its regular forms are unknown. For some time past I have endeavoured to collect specimens either of crystals or cleavable masses of this substance, but have not succeeded in getting any fit for measurement. Mr Von Leonhard kindly communicated to me some crystals from Tiefe Kohlenbach, near Eiserfeld, in the province of Siegen, possessing the form (Plate IV. Fig. 5,) with uneven surfaces, and yielding a black streak. They form a coating on the reniform shapes of the uncleavable manganese-ore, or *Psilomelane.* Professor Gustavus Rose had obtained a similar specimen from the same source; and by some approximate measurements, but which were far from decisive, we found the inclination of a on a, over the small face b, to be $= 86° 20'$. The faces of the horizontal prism d, did not admit of measurement at all. There exists cleavage parallel to a and b, but not very perfect. Among the forms of Prismatoidal Manganese-Ore, (or *Manganite,*) there is no prism, parallel to the axis, which even comes near the one here mentioned, though the approximation at the angles be ever so rude; and the crystals may be therefore considered as the actual type of the species of pyrolusite, which is likewise the opinion of Mr Rose. I have observed crystals of the form of manganite, yielding the characteristic brown streak only in the interior portions of the crystals, while that of the exterior strata is black. This may be the result of one of those changes of substance, the form remaining the same, which are recorded in a preceding part of this volume. It may, however, be also one of those curious instances, where two species, of different forms, enter, as it were, into a regular composition with each other, as in felspar and albite, disthene and staurolite, and others; many of which I have observed, and propose to give an account of, on some future occasion.

Pyrolusite was found by M. Gmelin to be a superoxide of manganese. In most mineralogical works, the descriptions given of the only species that they contain, is made up of the forms and colour of manganite ; and the hardness, streak, and colour of pyrolusite.

This is at once the most common species, and the most useful one, on account of the large quantity of oxygen which it contains. It is *the* ore of manganese properly so called, in an economical point of view, and has been extensively, though not exclusively, worked for in many countries. The principal mines are the ancient ones of Ilmenau, Friedricksroda, Reinwege, Elgersburg, and other places in Thuringia. Almost every one of the varieties, particularly the compound ones, granular and columnar, are found there, consisting of individuals of all sizes. Here, at Oehrenstock, near Ilmenau, are also found the curious shapes of a parasitic formation, which present even the slightest peculiarities of the crystallizations of calcareous spar as to regular form, but consist of a tissue of crystals of pyrolusite, and engaged in a mass of the same description. From the mines of Ehrensdorf near Maehrisch Triebau in Moravia, since their discovery in 1798, many thousand hundred weights of excellent ore have been annually procured. At Ehrensdorf the pyrolusite occurs in large nodules or masses, I could not learn in what rock. It resembles the Thuringian varieties. In Thuringia it forms veins in porphyry, and is often accompanied with heavy spar. It is remarkable that no pyrolusite should have been found at Ihlefeld in the Hartz ; at least there was no trace of it in all those collections which I examined, if we except some thin masses in porphyry, and slender crystals, evidently of the form of manganite, the superficial layers of which yield a black streak, a circumstance which has not yet received a satisfactory explanation.

Pyrolusite is very often the product of decomposition of the brachytypous parachrose-baryte, the carbonate of iron of the latter being converted by the natural agents into the hydrate of the peroxide, while the lime which it occasionally contains is deposited in the shape of calcareous spar or Arragonite, and the manganese is often found covering the surface of decomposed rhombohedrons of the original species, in the shape of minute crystals. In this manner it occurs in the mines of decomposed sparry iron in beds in gneiss at Hüttenberg in Carinthia, at Schmalkalden in Hessia, and other places. It is likewise found in this manner in the counties of Sayn, Siegen, Salm, and Hamm in Prussia, in the veins of sparry iron traversing clay-slate, which are decomposed in the upper levels, and then contain much brown hematite. The localities are chiefly Friedewald and Knorrenberg in the district of Kirchen, Sayn; Streitberg near the town of Siegen, and Horhausen and Herdorf, Siegen; Berge, Salm; the mine Huth, near Hamm. One of the varieties from Horhausen is particularly remarkable for the delicacy of the fibres, which are disposed in small tufts within the geodes of brown hematite, and which greatly resemble the fibrous varieties of prismatoidal antimony-glance. There are specimens of it in the imperial cabinet in Vienna, and in that of Mr Von Struve in Hamburg. Weyer in the county Wied-Runkel, Hirschberg near Ahrensberg, and Bendorf on the Lower Rhine, are likewise named as the localities of superb specimens of pyrolusite. Krettnich on the Blies, west of the Rhine, is likewise one of its localities. Similar varieties occur in the iron mines of Bayreuch, as at Armnehülfe near Schnarchenreuth, and at Arzberg, in those of Platten, for instance Hilfe Gottes, and of Schwarzenthal in Bohemia, in those of Johanngeorgenstadt, Eubenstock, Langenberg, and others in Saxony, also at Reinerz in the county of Glatz, and at Conradswaldau in Silesia.

The finest crystals of pyrolusite occur at Schimmel and Osterfreude near Johanngeorgenstadt, and at Hirschberg in Westphalia. These are chiefly short thick prisms, terminating on their extremities in numerous fibres. Large flattish crystals of great beauty, terminating in sharp elongated pyramids, with curved faces, occur at Maeskamezö, near Maggar Lapos, south of Kapnik in Transylvania, in geodes of brown hematite, and associated with crystals of quartz. This variety is found in a thick bed, of no great extent, of brown iron-ore in gneiss. A similar one occurs also in a similar position at Gyalárn ear Vayda Hunyad in the same country. Cleavable individuals of considerable size are found near Goslar in the Hartz, in a mountain called Gingelsberg, near the Rammelsberg. They are imbedded in small veins of quartz and calcareous spar in clay-slate, particularly where they cross each other. Distinct though small crystals are met with in many of the mines in the west of Germany, for instance at Tiefe Kohlenbach in Siegen; still smaller ones were found many years ago in the Palffy iron-mines of Haerethof near Frohstorf in Austria, associated with gray quartz. Very small crystals are found imbedded in and alternating with layers of black wad in Bayreuth. A variety much resembling the German ones, found in similiar repositories, occurs at the mine of Antonio Pereira near Villa Ricca in Brazil, along with brown hematite and psilomelane, in beds in clay-slate, produced according to Dr Pohl's account, from the decomposition of sparry iron.

Small granular pyrolusite occurs at Skidberget in the parish of Lepand in Dalecarlia, Sweden. But the individuals are often much smaller, and appear in the form of a black sooty substance. Such are frequently found in the iron mines of Raschau and other places in Saxony, also at Platten and other similar repositories in the north of Bohemia; sometimes they include small globules and reniform masses of red hematite, or red iron-ochre. The same pulverulent oxide occurs also at Schladming in Stiria, at Felsöbanya in Hungary, and at Pütten in Austria. Dr Pohl observed several localities of it in Brazil, as at St Toao d'el Rey, with brown hematite; on the road between Anta and S[ta] Rita, in the capitania of Goyaz, and at Banedrinha do Caelho in Minas Geraes. In the latter place it includes numerous reddish nodules, or cylindrical and ramified concretions of indurated clay.

The pyrolusite, as was observed above, is very generally found along with psilomelane. In fact, it is seldom found without it. Another species frequently accompanying it is the brown hematite, and these two species, like the pyrolusite and psilomelane, are often very curiously associated with each other. At Arzberg in Bayreuth crystals of quartz are found covered with a stratum of brown hematite, upon which is deposited another distinct stratum of pyrolusite. In some varieties from Berge in the county of Salm, thin stalactites of brown hematite are uniformly covered with a stratum of pyrolusite. The same is found also in masses of larger dimensions at Friedewalde in the county of Sayn, and in these the concentric disposition of the brown and black layers of the two species, visible in the cross fracture, gives the whole a particularly elegant appearance. Pyrolusite occurs in England at Upton Pine, near Exeter, in Devonshire, and in Cornwall.

The *manganèse oxidé noir barytifère* of Haüy, from Romanèche, near Macon, does not appear to be a simple homogeneous mineral. When examined with the magnifying lens, it exhibits distinctly a compact and a fibrous substance mixed up with each other. The latter, as far as the minuteness of the particles will allow, shows the properties of pyrolusite, its colour and general aspect, and its hardness; for even on the fracture newly obtained this compound soils the fingers, though on the file the hardness appears as high as 5.0...5.5, that is, superior to apatite. The compact mass is aggregated into reniform shapes, which leaves numerous interstices between them. The colour is nearly the same as that of the uncleavable manganese-ore, a bluish or grayish black passing into dark steel-gray. The streak is black, with a slight tinge of brown; the place on the mineral where it has been examined becomes shining.

N. B.—The analysis of pyrolusite, and of the mineral from Romaneche, will be found in page 361 of this Number.

Art. XIX.—*Comparison of the Hourly Mean Temperature at Christiania and Leith in February and July.* By Professor Hansteen. Communicated by the Author.

The observations contained in the following table are given in degrees of Fahrenheit's scale. Those for Christiania were made in the year 1827; and those at Leith are taken from Dr Brewster's paper published in the *Edinburgh Transactions*, vol. x. part ii. and are the means of four years observations made in 1822, 1823, 1824, and 1825.

Hour.		February. Christiania.	February. Leith.	July. Christiania.	July. Leith.
A. M.	1	14°.34	39°.67	55°.97	56°.17
	2	13 .96	39 .75	55 .17	56 .00
	3	13 .01	39 .77	54 .93	55 .59
	4	12 .22	39 .59	55 .15	55 .15
	5	11 .75	39 .35	56 .90	55 .66
	6	11 .42	39 .23	59 .66	56 .72
	7	11 .07	39 .30	61 .28	57 .88
	8	12 .08	39 .27	62 .37	59 .12
	9	12 .75	39 .76	63 .34	60 .50
	10	14 .71	40 .61	64 .45	61 .63
	11	17 .93	41 .51	65 .15	62 .50
	12	19 .55	42 .23	65 .90	63 .84
P. M.	1	21 .74	42 .77	66 .96	63 .94
	2	23 .00	42 .76	67 .02	64 .33
	3	23 .08	42 .80	66 .79	64 .65
	4	22 .15	42 .26	66 .51	64 .70
	5	20 .48	41 .48	65 .93	64 .83
	6	19 .05	40 .99	65 .35	64 .67
	7	17 .87	40 .62	63 .95	63 .84
	8	17 .15	40 .23	62 .74	61 .55
	9	15 .85	39 .91	61 .02	59 .82
	10	15 .13	39 .66	59 .24	58 .55
	11	14 .85	39 .54	57 .96	57 .74
	12	13 .93	39 .52	56 .82	56 .82
Mean,		16°.224	40°.621	61°.690	60°.361

The following Corollaries may be drawn from this table.

1. *The daily variation of Temperature is in Christiania much greater than in Leith, especially in the Winter.*

	February. Christ.	February. Leith.	July. Christ.	July. Leith.
Min.	11°.07	39°23	54°.93	55°.15
Max.	23 .08	42 .80	67 .02	64 .83
Diff. =	12°.01	3°.57	12°.09	9°.68

2. *The yearly Variation from Minimum in February to Maximum in July is also much greater in Christiania than in Leith.*

	Christ.	Leith.
Mean of Febr. =	16°.224	40°.621
——— July, =	61 .690	60 .361
Difference, =	45°.466	19°740

The cause of these small variations in the climate of Leith I suppose to be the mist from the sea, and the unclear sky, which tempers the cold of the night and of the winter, and absorbs the heat of the rays of the sun during the day and in summer.

CHRISTIANIA, 17th April 1828.

ART. XX.—*On a New Cleavage in Calcareous Spar, with a notice of a method of detecting Secondary Cleavages in Minerals.* By DAVID BREWSTER, LL. D. F. R. S. Lond. and Sec. R. S. Edin.

IN different papers printed in the *Philosophical Transactions*, (1815, p. 270,) in the *Edinburgh Transactions* (vol. viii. p. 165,) and in the *Transactions of the Geological Society* (vol. v.) I have had occasion to direct the attention of philosophers to the optical and mineralogical properties of a very interesting, though a very common structure in calcareous spar. This structure displays itself in the appearance of one or more reflecting planes parallel to the edges which contain the obtuse angle, and bisecting the acute angles of the rhomboidal faces.

These reflecting planes were regarded by Huygens, (who first observed them,) Brougham, Mohs, and other philosophers, as fissures in the crystal, and on that supposition they endeavoured to explain the curious and beautiful optical phenomena to which they gave rise. From a minute examination, however, of a great number of specimens, I succeeded in determining that these reflecting faces were the faces of thin plates or veins of calcareous spar, varying in thickness from the 1000dth of an inch upwards, and having a position transverse to that of the rhomb which contained them, and I put this conclusion beyond a doubt by inserting veins of calcareous spar and sulphate of lime between prisms of calcareous spar having the same position as those which compose the natural rhomb.

This view of the subject has been adopted by scientific mineralogists, and the reflecting faces referred to have been appropriately denominated by Professor Mohs *faces of composition.* The cohesion between these faces of composition is extremely powerful; but when a separation is effected by a smart and well directed blow, the disunited faces possess the most perfect smoothness and the highest polish.

Hence we see the mistake committed by Count Bournon and some other mineralogists, who, in obtaining these planes of false cleavage, regarded them as real, and ascribed a new primitive form to calcareous spar. In order to prove that a real cleavage of this description does not exist in calcareous spar, we have only to extract from a pure mass of calcareous spar two rhombs, one perfectly homogeneous and free of veins, as can easily be ascertained, and the other intersected with veins, and we shall find it impossible to obtain any cleavages in the former, while the latter will readily exhibit them, but never in any other place but at a face of composition.

After I had determined, in this manner, that the cleavages described by Bournon and others arose from the separation of the planes of a compound crystal, I was led by an accidental observation to discover a secondary cleavage parallel to these faces of composition, and existing in all crystals of calcareous spar. During the experiments on the action of crystallized surfaces upon light which I have published in the *Philosophical Transactions* for 1819, I had occasion to grind down an artificial face upon one of the edges of the rhomb which contains the obtuse angle. The rough grinding was done upon a coarse file without water, and when the face was slightly smoothed for the purpose of seeing if it was equally inclined to the two adjacent rhomboidal faces, I caused it to reflect the light of a candle. My surprise was considerable when I saw *two images* of the candle in place of one, one nebulous and imperfect, and the other distinct though not very bright. By increasing the angle of reflection to about 80° or more, I soon determined that the imperfect image was reflected from the new and slightly polished surface, while the distinct image was reflected from a number of minute planes torn up by the action of the file, and which had not been touched during the process of smoothing and half polishing the artificial face. By placing the rhomb upon a goniometer, I found that the minute planes were inclined *ten* or *twelve* degrees to the artificial face; and upon grinding down the other edges of the same rhomb, and the corresponding edges of other rhombs, I found *that the minute planes were in every case equally inclined to the adjacent faces of the rhomb, and that they had the same inclination to the third face of the rhomb in the edge which had been removed.*

I made the same experiments on the edges which contain the acute angle of the rhomb, and on the obtuse and acute summits of the rhomb, but I could not detect the slightest trace of reflecting planes, and hence I conclude that there is a *secondary cleavage parallel to the edges of the obtuse angles of the rhomb, and equally inclined to the adjacent rhomboidal faces of which that edge forms the common section;* and that the cleavage form of calcareous spar is a solid, bounded by these six secondary cleavage planes, and the six primary cleavage planes of the rhomb.

The method above described of detecting secondary cleavage planes has, so far as I know, not been previously used by mineralogists, and is applicable to many other minerals, and particularly to salts, and crystals which are easily frangible. In some cases a rasp or large toothed file is very useful; and in others gritty sandstones may be advantageously employed, and sometimes used without water.

While the determination of the cleavages of crystallized bodies is important to the mineralogist as furnishing him with useful discriminating characters, it is of still greater importance to the crystallographer and the natural philosopher. If we consider it under the more general aspect of the determination of the force of cohesion by which the ultimate particles of solid bodies resist separation in different planes, it becomes of great use in ascertaining the form of these ultimate particles; and in the case of crystals like calcareous spar, which possess other remarkable and well determined physical properties, it may enable us to discover some relation between these properties and the form of its ultimate particles.

One example of this species of inquiry has been given by the celebrated Huygens in the fifth chapter of his *Traité de la Lumière;* and as we believe it has never appeared in our language, we shall lay a translation of it before our readers in the subsequent article.

ALLERLY, *August* 27, 1828.

ART. XXI.—*On the Cause of the extraordinary figure of Calcareous Spar, and on its Cleavage in three different directions.* By CHRISTIAN HUYGENS.

THERE are several vegetable and mineral bodies and crystallized salts which are formed with certain angles and regular figures. Among flowers, for example, there are many which have their leaves arranged in regular polygons, to the number of three, four, five, or six sides, but not more; and it deserves to be particularly remarked, not so much that the figure is a polygon, as that it never exceeds the number six.

Rock crystal commonly grows in hexagonal prisms, and diamonds occur which are formed with a square point and polished surface. There is a kind of small flat stones, heaped closely the one above the other, which are all of a pentagonal figure, with their angles rounded and their sides a little bent inwards. The grains of salt which are produced from sea-water affect the form, or at least the angle of the cube; and in the crystallization of other salts, and of sugar, we find other solid angles with surfaces perfectly smooth. Small snow falls almost always formed in minute stars with six points, and sometimes

* Translated from his *Traité de la Lumiére,* chap. v. See the preceding article.

in hexagons whose sides are straight. And I have often observed within water which begins to freeze, a species of flat and thin leaves of ice, whose middle radius throws out branches inclined at an angle of 60°. All these things deserve to be carefully investigated, in order to ascertain how and by what process nature produces them. It seems to me that in general the regularity which is found in these productions arises from the arrangement of the small equal and invisible particles of which they are composed.

In respect to calcareous spar, I say that if there was a pyramid ABCD, Plate IV, Fig. 6, composed of small corpuscles, round and not spherical, but *flat spheroids*, such as would be formed by the revolution of an ellipse GH, Fig. 7, round its lesser axis EF, whose ratio to the greater axis is very nearly that of one to the square root of eight (or 1 to 2.8) : I say then that the solid angle of the point D, will be equal to the obtuse and equilateral angle of this crystal. I say, besides, that if these corpuscles are slightly cemented together, they would, in touching the pyramid, cleave in the direction of faces parallel to those which form the solid angle, and that, by this means, as may be easily seen, they would yield prisms similar to those shown in the figure. The reason is, that in splitting in this manner, every stratum separates itself easily from the neighbouring stratum, because each spheroid detaches itself only from three spheroids of the other stratum, out of which three there is only one which touches with the flat surface, and the two others only at their edges. It is this which causes the surfaces to separate so distinct and well polished, for if any one spheroid of the neighbouring stratum left its place to detach itself from the separated surface, it must detach itself *from six* other spheroids which keep it shut in, and four of which touch by their flat surfaces. Since, therefore, the angles of our crystal, as well as its manner of cleavage, agree exactly with what should take place in a body composed of such spheroids, we have great reason to believe that its particles are formed and arranged in a similar manner.

There is also some appearance that the prisms of this crystal are formed by the rupture of the pyramids, since M. Bartholinus informs us that he once found prisms having the form of a triangular pyramid. But when a mass is only composed internally of these small spheroids thus arranged, whatever form it has without, it is certain, from the same reasons which I have just explained, that it would cleave into similar prisms. It remains to be seen if there are other reasons which confirm this conjecture, and if there are any which oppose it.

It may be objected, that if this crystal is so composed, it will still cleave in other two ways, one of which will be in the direction of planes parallel to ABC, the base of the pyramid, and the other parallel to a plane whose section is marked by the lines GH, HK, KL. To this I reply, that both these cleavages, though practicable, are more difficult than those which are parallel to any of the three planes of the pyramid; and, therefore, in striking the crystal in order to break it, it should always cleave in preference in those three planes than in the two others. If we take a number of spheroids, of the form above-mentioned, and range them in a pyramid, we shall see why the two divisions (parallel to ABC and GHKL) are more difficult. With respect to that parallel to ABC, each spheroid must detach itself from three others which touch by their flat surfaces, which hold firmer than those which touch by their edges; and, besides this, this division will not take place by entire strata, because every one of the spheroids of a stratum is almost never retained by the six of the same stratum which surround it, because they touch only by their edges, so that it adheres easily to the neighbouring stratum, and others to it for the same reason, which produces unequal surfaces. We also find from experiment, that in grinding the crystal on a stone a little rough, directly upon the solid equilateral angle, great facility is experienced in wearing it down in this direction, but great difficulty in polishing it.

With regard to the other cleavage along GHKL, each spheroid must be detached from *five* of the neighbouring stratum, *two* of which touch by their flat surfaces, and two others by their edges; so that this cleavage is even more difficult than that which is made parallel to one of the faces of the crystal, where we have said that each spheroid is detached only from three of the neighbouring stratum only, one of which touches by its flat surface, and the other two by their edges only.

I am satisfied, however, that there are in the crystal strata of this description, because in a piece weighing half a pound *it is divided in its whole length by the plane GHKL, which appears from the prismatic colours diffused over the whole of the plane, although the two pieces are still kept together.** All this proves, then, that the composition of the crystal is such as we have mentioned. To this I add one experiment more, which is, that if we draw a knife in scratching upon any of these natural faces, descending from the obtuse equilateral angle, that is, from the point of the pyramid, we shall find it very hard, while in scratching it in the opposite direction it is easily cut. This follows manifestly from the situation of the small spheroids upon which, in the first case, the knife slides, while in the second case it takes them below like the scales of a fish.

I will not undertake to say any thing respecting the manner in which so many small corpuscles are produced, all equal and similar, nor how they are put into such a fine arrangement; whether they are first formed and then arranged, or whether they arrange themselves as they are produced, which seems to me the most probable. In order to unfold truths so concealed, requires a knowledge of nature greater than we possess. I shall only add, *that these small spheroids may greatly contribute to form the spheroidal waves of light,* (*i. e.* the unusual refraction of *calcareous spar,*) *already supposed, both of them being similarly situated, and having their axes parallel.*

Art. XXII.—*New Researches on Endosmose and Exosmose.*† By M. Dutrochet.

The experiments which I communicated last year to the Aca-

* These are the faces of composition (and not cleavage planes), described in the preceding paper.—Ed.

† Read before the *Academy of Sciences of Paris,* 17th March 1828, and translated from the *Annales des Chimie,* Fev. 1828, p. 191. See our last Number, p. 103—112.

M. Dutrochet has received from the Academy of Sciences of Paris, one of the Gold Medals founded by M. Monthyon, for his discovery of *Endosmose.*—Ed.

demy of Sciences have clearly proved that Endosmose is not owing to capillary attraction. My new observations tend to demonstrate this fact, at the same time that they prove that this action is really the fundamental action of life.

It is known that hot liquids ascend less in capillary tubes than the same liquids when cold. Thus hot water does not ascend so high as cold water; it is the same with alcohol, &c. Hence it follows that increase of temperature diminishes the force of capillary attraction; but the experiments which I have repeated a great number of times have shown me that an increase of temperature augments, on the contrary, the force of endosmose.

It is therefore very evident that this does not at all depend upon the capillary attractions: it is produced by a particular state of electricity, as I have already announced; and this will be farther proved by the following experiments.

I have described in my work the instrument which I have called the *Endosmometer*. I made it with a small bladder, having a glass tube fixed into it. I have altered this instrument a little; and it is now made in the following manner:—

I prepared a tube of glass terminated at one end by a large brim similar to the mouth of a trumpet. I closed this orifice with a piece of bladder firmly fixed by means of a ligature. I filled the cavity of the trumpet mouth with the liquid with which I was to try the power of the endosmose, and I plunged the widened part into distilled water. The tube remaining empty, rose vertically above the water, and corresponded with a graduated plate. If the liquid contained in the endosmometer be of the kind to produce endosmose, it will soon rise in the tube, and with a degree of quickness proportional to the force of the endosmose.

If the liquid in the endosmometer is not of the kind to produce endosmose, there will be no ascent of the liquid in the tube; and besides, if by additional fluid the latter rises in the tube above the level of the water, it very soon falls; it filters through the bladder in virtue of its weight. I had attributed this descent of the fluid to the circumstance, that this last ought to have produced exosmose instead of endosmose. This is true in certain cases, but it is not so in the case under consideration. Thus, for example, when a weak solution of gum is put into the endosmometer, and the instrument is plunged into a strong solution of gum, there is exosmose in the endosmometer; the interior fluid descends in the tube, because the current of the exosmose is stronger than the current of the endosmose, owing to the greater density of the exterior fluid; but when pure water is the exterior fluid, and the fluid in the endosmometer descends in the tube, this is no more an effect of exosmose, but the simple result of a mechanical filtration. Thus when water charged with sulphuric acid is put into the endosmometer this liquid descends in the tube.

I had before admitted that sulphuric acid was an agent which produced exosmose, but it is not so, as can be ascertained by making the opposite experiment. If pure water is put into the endosmometer, and that instrument is plunged into water charged with sulphuric acid, the water even descends in the tube. These facts decidedly prove that there is no current of endosmose nor of the exosmose directed from the water towards the sulphuric acid, nor from the sulphuric acid towards the water. This acid, however, by its superior density to water, ought to produce endosmose when it is in the endosmometer. If no effect is produced, it shows that its chemical qualities render it completely incapable of producing endosmose or exosmose. We find also that it is hostile to this double action, for it has a tendency to destroy it when it does exist.

Thus, if a small quantity of sulphuric acid is mixed with a solution of gum which is introduced into the endosmometer, the fluid produces no endosmose, while the solution of gum employed alone strongly produces that effect; the gummy fluid mixed with sulphuric acid descends gradually in the tube of the endosmometer. If the quantity of sulphuric acid be very small, there still remains a slight power of endosmose in the gummy solution. We also sometimes see this acid solution which first descended in the tube of the endosmometer resume a slight ascending motion, when the prolonged immersion of the bladder in the water deprives the gummy solution of a part of the acid which it originally possessed. This very important fact proves that there are *inactive* fluids with respect to the property of producing the endosmose, and that these fluids can communicate their *inactive* state to those fluids which have contrary qualities, that is to say, which are *active* fluids.

I have found that the fluids of putrified animals are *inactive.* When put into the endosmometer surrounded by pure water, they descend in the tube notwithstanding their superiority of density to water. It may be established as a general fact, that all *active* fluids miscible in water, whether organic fluids or chemical fluids, act like fluids denser than pure water, when they are separated from the latter by a permeable membrane, that is, they are all agents producing endosmose. It is never towards the side occupied by the water that the strongest of the two currents is directed, and which constitute by their union the endosmose and exosmose. Thus every *active* fluid placed in affinity with pure water is not an agent producing exosmose. Whenever, then, we observe a fluid descend in the tube of the endosmometer when the bladder is plunged in pure water, we may conclude that this interior fluid is *inactive.* Its falling in the tube is the simple result of its filtration descending by the effect of its weight. Here I ought to mention an error into which I had fallen. Observing the manner in which sulphuric acid comports itself, I was led to think that the acids were the agents producing exosmose; but it is not so. Vinegar, nitric acid, hydrochloric acid, placed in the endosmometer surrounded by water, produce endosmose, hydrochloric acid, in particular, a very powerful endosmose.

We come now to observe, that, in relation to the property of producing endosmose and exosmose, there are *active* and *inactive* fluids. This fact, which is of the greatest importance, had escaped me in my first researches.

I have shown in my book that endosmose is produced by putting the pure water inside as well as outside of the endosmometer closed with an organic membrane, but making the interior water correspond with the negative pole of the voltaic pile, and the external water with the positive pole. It became necessary to determine if, by substituting any porous mineral plate whatever in this experiment for the organic membrane, the same result would be obtained. I have given an account in my book of experiments made with this view, which prove that we obtain no elevation of the water above its level, by means of the electricity of the pile, when the organic membrane is replaced in the endosmometer by porous plates of sandstone or carbonate of lime; but plates of baked white clay comport themselves in a very different manner. I shut the terminal mouth of an endosmometer with a plate of clay of three-eighths of an inch in thickness; I put distilled water into the interior of the endosmometer, which was itself plunged into distilled water; I then put the interior water in relation with the negative conjunctive wire of the pile, the exterior water being in contact with the positive conjunctive wire. The introduction of the water across the plate of clay became very rapid, the interior water soon gained the level of the exterior water; it entered the tube, and ascended with great quickness. The ascent of the water in the tube lasted as long as the action of the pile continued. This experiment convinced me that porous aluminous solids are apt, like the organic membranes, to cause the impulsion of the water under the influence of an electric current from the positive pole to the negative pole. Thus these solids present, like the organic membranes, the phenomenon of the endosmose by means of the electricity of the pile. It then became necessary to know if these various solid minerals are susceptible of presenting, like the organic membranes, the phenomenon of endosmose, by means of the contact of their opposite faces with homogeneous fluids. I luted to the endosmometer a plate of soft freestone one-sixth of an inch thick, and having put a solution of gum arabic into the interior, I plunged it into pure water. It did not show any endosmose; the interior gummy fluid did not ascend in the tube above the exterior level. I replaced the plate of freestone by a plate of porous calcareous carbonate of one-third of an inch in thickness. I obtained no effect of the endosmose from it. Thinking that this absence of the appearance of endosmose might proceed from the too great thickness of my porous plates, I placed upon my apparatus a plate of porous carbonate of lime, one-third of an inch in thickness. I did not obtain any appearance of endosmose. With the same want of success I made use of a plate of unbaked plaster, (calcareous sulphate of lime), a little more than one-sixth of an inch thick. I have employed for the same purpose, and with as little success, crystallized sulphate of lime, which, as is well known, divides into extremely thin plates; but here the want of the endosmose might be attributed to the plates of the crystallized substance not being permeable.

I was induced to believe that the negative results which I obtained from all these experiments proceeded from my porous plates being too thick. It was impossible to obtain these plates as thin as the organic membranes; and it appeared to me probable, that the electricity which produced endosmose was owing to the near approximation of the two heterogeneous fluids.

In this belief, I endeavoured to procure very thin and porous mineral plates. Slate appeared to me the most likely to answer my purpose. By means of a slight calcination slate is capable of being divided into extremely thin leaves. I obtained in this manner a plate of slate which was not more than one-fiftieth of an inch thick. I adapted it to my apparatus, and the experiment having been made as above described, I obtained a very evident, although very feeble, appearance of endosmose. The slight permeability of the slate to water was the cause of the weakness of the endosmose. Encouraged by this success, I prepared a plate of baked white clay of one twenty-fifth of an inch in thickness, and I adapted it to my apparatus; I obtained an endosmose sufficiently powerful, and but little different from that which I should have obtained in the same case with the organic membrane. Hence it is proved that certain inorganic bodies are susceptible of producing endosmose by means of heterogeneous fluids, in the same manner as the organic membranes. I tried to adapt a plate of white baked clay two-fifths of an inch in thickness to my apparatus; I again obtained an endosmose very quickly, which surprised me greatly. I adapted to my apparatus another plate of clay three-fifths of an inch in thickness; I obtained again the endosmose, but it was very weak or very slow. This ought to be attributed to the thickness of the porous plate having diminished its permeability. These facts entirely changed the opinion I had formed from my preceding experiments respecting the necessity of having the porous plates so extremely thin, in order to produce endosmose. They showed me that it did not arise from their being too thick, that the plates of freestone, of carbonate of lime, and sulphate of lime did not produce endosmose, but that it entirely depended upon the chemical nature of these porous plates. But it must be remarked, that these latter experiments agree perfectly with those we have described above relative to the property which the aluminous solids possess alone among the mineral solids, in producing endosmose by means of the electricity of the pile. These solids thus possess alone the power of causing endosmose by means of contact with heterogeneous fluids, for slate which creates it like clay, is itself an aluminous solid. This fact no longer leaves any doubt respecting the cause of the phenomenon of endosmose. This cause is undoubtedly electricity. Capillary attraction has evidently no connection with this phenomenon, since the porous plates with a siliceous base and a calcareous base cannot produce it, notwithstanding their capillarity. These last solids are in relation to the endosmose *inactive* solids. The aluminous solids and the organic solids are those only which we yet know as being *active* solids in relation to the endosmose. I have not tried with this view the effect of the magnesian solids, nor of the solids of barytes or of strontian. In general these experiments prove that the permeable membranes which separate heterogeneous fluids possess a particular action in the production of endosmose. These solids, which I denominate *active*, are alone fit to exercise this action which is not possessed by *inactive* solids. The organic membranes are eminently active in this point of view, but they do not enjoy this property in all its fulness, except in the *sound state*. I have shown that when these membranes putrify, they lose one part of their property of causing endosmose; they tend then towards the *inactive* state. We have seen above that in relation to endosmose fluids are divided also into *active* fluids and *inactive* fluids; we have seen that the organic fluids, eminently *active* in the sound state, become *inactive* when they putrify. Thus experiments prove, that, in relation to endosmose, there are *active* solids and *inactive* solids, and that the *active* solids may possess this property of *activity* in a degree more or less eminent, and that according to their chemical composition. Experience also proves that there are active fluids and inactive fluids, and that the *active* fluids may possess the property of activity in a greater or less degree, and that according to their density or their chemical composition. Thus the endosmose results from the reciprocal influence of *active* fluids upon *active* solids, and of *active* solids upon *active* fluids. It is sufficient that one only of these elements of action be inactive, that the endosmose may not take place.

Thus, for example, every thing being arranged conveniently for endosmose, this action will be suspended by the addition of a little sulphuric acid to the fluids, because this acid is an *inactive* fluid. It will be also in vain that the two heterogeneous fluids be *active.* If the permeable membrane which separates them is *inactive,* there will be no endosmose.

Thus it is demonstrated that this phenomenon results from two combined actions; 1st, the action of the fluid upon the solid; 2d, the action of the solid upon the fluid. These two actions, which are indubitably electrical actions, have evidently their seat in the thickness or in the substance itself of the permeable membrane which constitutes the *active* solid. It is a capillo-electrical phenomenon, or one of intra-capillary electricity. From this we may understand why this electricity does not appear in the galvanometer. It is not all exterior, it is in the capillary pores that the developement of this impulsive electricity is produced; and this state of electricity is given to the capillary pores in two manners; 1st, by the action of the two opposite poles of the pile upon the two opposite faces of the *active* permeable membrane; 2d, by the contact of two heterogeneous *active* fluids upon the two opposite faces of the membrane. Thus it is the influence of the contact of the fluids upon the solid which communicates to this last the state of *capillo-electricity,* and it is the influence of the *capillo-electrified* solid upon the fluids which communicates impulsion to them.

Art. XXIII.—*Observations on the Colour of Water, and on the Tints of the Ocean.* By Sir Humphry Davy, Bart.*

The purest water with which we are acquainted is undoubtedly that which falls from the atmosphere. Having touched air alone, it can contain nothing but what it gains from the atmos-

* From Sir Humphry's admirable volume entitled *Salmonia,* or *Days of Fly-fishing,* London, 1828, a work replete with scientific observation, good feeling, and unaffected piety.

phere, and it is distilled without the chance of those impurities which may exist in the vessels used in an artificial operation. We cannot well examine the water precipitated in the atmosphere as rain, without collecting it in vessels, and all artificial contact gives more or less of contamination; but in snow melted by the sunbeams that has fallen on glaciers, themselves formed from frozen snow, water may be regarded as in its state of greatest purity. Congelation expels both salts and air from water, whether existing below, or formed in the atmosphere; and in the high and uninhabited regions of glaciers, there can scarcely be any substances to contaminate,—removed from animal and vegetable life, they are even above the mineral kingdom; and though there are instances in which the rudest kind of vegetation (forms of the fungus or mucor kind) is even found upon snows, yet this is a rare occurrence; and red snow, which is occasioned by it, is an extraordinary, and not a common phenomenon towards the pole, and on the highest mountains of the globe.

Having examined the water formed from melted snows or glaciers in different parts of the Alps, and having always found it of the same quality, I shall consider it as pure water, and describe its character. Its colour, when it has any depth, or when a mass of it is seen through, is *bright blue*, and according to its greater or less depth of substance, it has more or less of this colour. As its insipidity and its other physical qualities are not at this moment objects of your inquiry, I shall not dwell upon them. In general, in examining lakes and masses of water in high mountains, their colour is of the same bright azure. And Captain Parry states that the water on the polar ice has the same beautiful tint. When vegetables grow in lakes, the colour becomes nearer sea-green, and as the quantity of impregnation from the decay increases, greener, yellowish green, and at length when the vegetable extract is large in quantity, as in countries where peat is found, yellow, and even brown.

To mention instances, the *Lake of Geneva*, fed from sources (particularly the higher Rhine), formed from melting snow, is *blue;* and the *Rhone* pours from it dyed of the *deepest azure*, and retains partially this colour till it is joined by the Soane, which gives to it a greener hue. The *Lake of Merat*, on the contrary, which is fed from a lower country, and from less pure sources, is *grass green*; and there is an illustrative instance in some small lakes fed from the same source in the road from Inspruck to Stutgard, which I observed in 1815 (as well as I recollect), between Nazareit and Reiti. The highest lake fed by melted snows in March when I saw it was *bright blue*. It discharged itself by a small stream into another, into which a number of large pines had been blown by a winter storm, or fell in from some other cause; in this lake its colour was *blue-green*. In a third lake in which there were not only pines and their branches, but likewise other decaying vegetable matter, it had a tint of *faded grass green*; and these changes had occurred in a space of not much more than a mile in length. These observations I made in 1815. On returning to the same spot *twelve* years after, in August and September, I found the character of the lakes entirely changed. The pine wood washed into the second lake had disappeared; a large quantity of stones and gravel washed down by torrents, or detached by an avalanche supplied their place; there was no perceptible difference of tints in the two upper lakes, but the lower one, where there was still some vegetable matter, seemed to possess a greener hue.

The same principle will apply to the Scotch and Irish rivers, which, when they rise or issue from pure rocky ravines, are *blue* or *bluish-green*, and when fed from peat-bogs or alluvial countries, yellow, or amber-coloured, or brown, even after they have deposited a part of their impurities in great lakes. Sometimes, though rarely, mineral impregnations give colour to water: small streams are sometimes *green* or *yellow* from ferruginous depositions. Calcareous matters seldom affect their colour, but often their transparency, when deposited, as is the case with the Velino at Terni, and the Anio at Tivoli; but I doubt if pure saline matters, which are in themselves white, ever change the tint of water.

The tint of the ocean probably depends on vegetable matters, and perhaps partially on two elementary principles, *iodine* and *brome*, which it certainly contains, though these are possibly the results of decayed marine vegetables. These give a *yellow* tint when dissolved in minute portions in water; and this mixed with the *blue* of pure water would occasion *sea-green.*

I made many years ago, being on the *Mer de Glace*, an experiment on this subject. I threw a small quantity of *iodine*, a substance then recently discovered, into one of those deep blue basins of water, which are so frequent on that glacier; and diffusing it as it dissolved with a stick, I saw the water change first to *sea-green* in colour, then to *grass-green*, and lastly, to *yellowish-green.* I do not, however, give this as a proof, but only as a fact favourable to my conjecture. It appears, however, to confirm the opinion, that snow and ice, which are merely pure crystallized water, are always blue when seen by transmitted light. I have often admired the deep azure in crevices in masses of snow in severe winters, and the same colour in the glaciers of Switzerland, particularly at the arch where the Arve issues in the valley of Chamouni.

Art. XXIV.—ZOOLOGICAL COLLECTIONS.

1. *On the Natural History of the Par.*

Our readers are doubtless aware that the par has been recently supposed, by very competent judges, to be the young of the salmon. The reason for this opinion we shall take an early opportunity of stating, and we shall be obliged to any of our correspondents who can give us any information on the subject. Sir Humphry Davy is of an opposite opinion, as appears from the following extract from his *Salmonia.*

"I think," says he, "the par, samlet, or brandling, common to most of our rivers which communicate with the sea, has a claim to be considered a distinct species; yet the history of this fish is so obscure, and so little understood, that I perhaps ought not to venture to give an account of it. I have seen this fish in the rivers of Wales and Herefordshire, and have heard it asserted, on what appeared good authority, that it was a mule—the offspring of a trout and a salmon. This opinion was supported by the fact, that it is found only in streams which are occasionally visited by salmon; yet I think it more probable, if it is a mixed race, that it is produced by the sea trout and common trout. In a small river which runs into the May near Ballina, in Ireland, I once caught in October a great number of small sea trout, which were generally of half a pound in weight, and which were all males, and unless it be supposed that the females were in the river likewise, and would not take the fly, these fish in which the spermatic system was fully developed, could only have impregnated the ova of the common river trout. The sea trout and river trout are indeed so like each other in character, that such a mixture seems exceedingly probable; but I know no reason why such mules should always continue small, except that it may be a mark of impregnation. The only difference between the par and the common small trout is in the colour, and in its possessing one or two spines more in the pectoral fin. The par has *large blue or olive-bluish marks* on the scales, as if they had been made by the impression of the fingers of a hand; and hence the fish is called in some places *Fingerlings.* The river and sea trout seem capable of changing permanently their places of residence; and sea trout seem often to become river trout. In this case they lose their silvery colour, and gain more spots; and in their offspring these changes are more distinct. Fish likewise which are ill fed remain small, and pars are exceedingly numerous in those rivers where they are found, which are never separated from the sea by impassable falls; from which I think it possible that they are produced by a cross between sea and river trout."—*Salmonia,* p. 66–69.

2. *On the Generation and Migration of Eels.*

The problem of the generation of eels is the most abstruse and one of the most curious in natural history, and though it occupied the attention of Aristotle, and has been taken up by most distinguished naturalists since his time, it is still unsolved. Lacepede indeed asserts, in the most unqualified way, that they are viviparous, but he adduces no proofs of his assertion.

There are, it is certain, two migrations of eels,—one up and one down rivers, one from, and the other to the sea, the first in *spring* and *summer*, and the second in *autumn* or early winter. The first of very small eels, which are sometimes not more than 2 or 2½ inches long; the second of large eels, which are sometimes 3 or 4 feet long, and which weigh from 10 to 15, or even 20 lbs. There is great reason to believe that all eels found in fresh water are the results of the first migration: they appear in millions in April and May, and sometimes continue to rise as late even as July, and the beginning of August. I remember this was the case in Ireland in 1823. It had been a cold backward summer, and when I was at Ballyshannon about the end of July, the mouth of the river which had been in flood all this month under the fall was blackened by millions of little eels, about as long as the finger, which were constantly urging their way up the moist rocks by the side of the fall. Thousands died, but their bodies remaining moist served as the ladder for others to make their way; and I saw others ascending even perpendicular stones, making their road through wet moss, or adhering to some eels that had died in the attempt. Such is the energy of these little animals, that they continue to find their way in immense numbers to Loch Erne. The same thing happens at the fall of the Bann, and Loch Neagh is thus peopled with them: Even the mighty fall of Shaffhausen does not prevent them from making their way to the Lake of Constance, where I have seen many very large eels.

There are eels in the Lake of Neuchatel which communicate by a stream with the Rhine; but there are none in the Lake of Geneva, because the

Rhone makes a subterranean fall below Geneva; and though small eels can pass by moss or mount rocks, they cannot penetrate limestone rocks or move against a rapid descending current of water passing as it were through a pipe again: no eels mount the Danube from the Black Sea; and there are none found in the great extent of lakes, swamps, and rivers, communicating with the Danube,—though some of those lakes and morasses are wonderfully fitted for them,—and though they are found abundantly in the same countries in lakes and rivers connected with the ocean and the Mediterranean, yet, when brought into confined water in the Danube, they fatten and thrive there. As to the instinct which leads young eels to seek fresh water, it is difficult to reason:—probably they prefer warmth, and, swimming at the surface in the early summer, find the lighter water warmer, and likewise containing more insects, and so pursue the courses of fresh water, as the waters from the land at this season become warmer than those from the sea.

Mr J. Couch (*Lin. Trans.* Vol. xiv. p. 70,) says, the little eels, according to his observation, are produced within reach of the tide, and climb round falls to reach fresh water from the sea. I have sometimes seen them in spring, swimming in immense shoals in the Atlantic, in Mount Bay, making their way to the mouths of small brooks and rivers. When the cold water from the autumnal flood begins to swell the rivers, the fish tries to return to the sea; but numbers of the smaller ones hide themselves during the winter in the sand, and many of them form as it were masses together.

Various authors have recorded the migration of eels in a singular way, such as Dr Plot, who, in his *History of Staffordshire*, says they pass in the night across meadows from one pond to another; and Mr Arderon (*Phil. Trans.* 1747, vol. 44, p. 395.) gives a distinct account of small eels rising up the flood-gates and posts of the water-works of the city of Norwich; and they made their way to the water above, though the boards were smooth-planed, and five or six feet perpendicular. He says when they first rose out of the water upon the dry board they rested a little, which seemed to be till their slime was thrown out, and sufficiently glutinous, and then they rose up the perpendicular ascent with the same facility as if they had been moving on a plane surface. There can, I think, be no doubt that they are assisted by their small scales, which, placed like those of serpents, must facilitate their progressive motion; these scales have been microscopically observed by Lewenhoeck.

Eels migrate from the salt water of different sizes, but I believe never when they are above a foot long; and the great mass of them are only from 2½ to 4 inches. They feed, grow, and fatten in fresh water. In small rivers they seldom become very large, but in large deep lakes they become as thick as a man's arm or even leg; and all those of a considerable size attempt to return to the sea in October or November, probably when they experience the cold of the first autumnal rains. Those that are not of the largest size, as I said before, pass the winter in the deepest part of the mud of rivers and lakes, and do not seem to eat much, and remain, I believe, almost torpid. Their increase is not certainly known in any given time, but must depend upon the quantity of their food; but it is probable they do not become of the largest size from the smallest in one or even two seasons; but this, as well as many other particulars, can only be ascertained by new observations and experiments. Bloch states that they grow slowly, and mentions that some had been kept in the same pond for *fifteen* years.

As very large eels after having migrated never return to the river again, they must (for it cannot be supposed that they all die immediately in the sea) remain in salt water; and there is great probability that they are then confounded with the conger, which is found of different colours and sizes, from the smallest to the largest, from a few ounces to one hundred pounds in weight. The colour of the conger is generally paler than that of the eel; but in the Atlantic, it is said that pale congers are found on one side of the Wolf Rock, and dark ones on the other. The conger has breathing tubes, which are said not to be found in the other eel. Both the common and the conger eel have fringes along the air bladder, which are probably the ovaria; and Sir E. Home thinks them hermaphrodite, and that the seminal vessels are close to the kidneys; but this circumstance demands confirmation from new dissections, and some chemical researches on the nature of the fringes, and the supposed melt. If viviparous, and the fringes contain the ova, one mother must produce tens of thousands, the ova being remarkably small; and it appears more probable that they are oviparous, and that they deposit their ova in parts of the sea near deep basins which remain warm in winter. This might be ascertained by experiment, particularly on the coasts of the Mediterranean. I cannot find that they haunt the Arctic Ocean, which is probably of too low a temperature to suit their feelings or habits; and the Caspian and Black Sea are probably without them, from their not being found in the Volga or Danube: these being shallow seas are perhaps too cold for them in winter. From the time that small eels begin to migrate (April) it is probable that they are generated in winter; and the pregnant eels ought to be looked for in November, December, and January. I opened one in December, in which the fringes were abundant, but I did not examine them under the microscope or chemically. I hope this curious problem will not remain much longer unsolved.—*Salmonia.*

3. *On the Luminous Appearance of the Ocean.* By Lieut. R. Ingalls.

While bathing at night, in a southern latitude, I had noticed and admired the beautiful sparkling of the water when agitated or resisted; but the myriads of bodies of whatsoever sort which emitted these coruscations were alike invisible and impalpable. On one occasion, however, I struck my arm against a small soft mass, which immediately emitted a flash of two or three inches in diameter. But the mass eluded my attempts to secure it, as it was invisible the moment it parted from its accidental contact with my arm. This occurred several times afterwards, and I began to think I perceived a sensation of warmth whenever I struck one of these bodies, though aware how liable I was to be deceived by the almost irresistible association of light and heat in the mind. A very large one ultimately convinced me I was not deceived, the sensation being on this occasion perfectly distinct, grateful, and continuing for a minute or two after the touch.

The masses of marine ovula, left by the tide to heat and hatch on the beach, I had long before observed during the whole process of vivification. First, a transparent mass of jelly,—next marked by a white opaque speck, a little distance from the centre,—third, this spot fringed with a red border, of the colour of arterial blood,—next, a kind of irregular pulsation, accompanied by the developement of certain white contractile fibres, and the extension of several large red lines in radial directions from the focal opaque speck. The appearance of a black speck, ultimately a defined head,—and finally, I have seen the rising tide shake out from the mass the perfect animal, apparently in the full possession of life; certainly exercising the important function of apprehension of danger.

The identity of this ovulum, with the luminous bodies I encountered in the water, appeared probable from their size, consistency, and abounding in the same regions. It was soon after ascertained; for on a night when the sea was somewhat agitated, I observed the same coruscations in the waves, breaking on the beach, and succeeded in obtaining several of the illuminating bodies by the light of their own flashes. They appeared, as I expected, identical.

When examined by candle to overcome the glare of their brilliancy, and at the same time observe their action more clearly, the power of illumination appeared to reside in a similar focal point to that described as the place of the first phenomena of vivification; and the flashes, which could be procured by irritating the mass with the end of a pencil, diverged from this point in lines, similar in magnitude and direction to the large red ones mentioned in that process. I regret that it did not occur to me to electrically insulate one of these bodies, and endeavour to obtain shocks; but I was too much occupied with the question above stated, to avail myself of the means in my hands, of making some interesting experiments on the theory of life.—From the *Transactions of the Albany Institute*, vol. i. No. 1.

4. *Circumstances relative to the Economy of Bees.* By T. A. Knight, Esq.

In a former paper the author stated his having observed that, several days previous to the settling of a swarm of bees in the cavity of a hollow tree adapted to their reception, a considerable number of those insects were incessantly employed in examining the state of the tree, and particularly of every dead knot above the cavity which appeared likely to admit water. He has since had an opportunity of noticing, that the bees who performed this task of inspection, instead of being the same individuals, as he had formerly imagined, were, in fact, a continual succession of different bees: the whole number in the course of three days being such as to warrant the inference, that not a single labouring bee ever emigrates in a swarm without having seen its proposed future habitation. He finds that the same remark applies not only to the permanent place of settlement, but also to the place where the bees rest temporarily, soon after swarming, in order to collect their numbers.

The swarms which were the subjects of Mr Knight's experiments showed a remarkable disposition to unite under the same queen. On one occasion, a swarm which had arisen from one of his hives settled upon a bush, at a distance of about twenty-five yards; but instead of collecting together into a compact mass, as they usually do, they remained thinly dispersed for nearly half an hour, after which, as if tired of waiting, they singly, and one after the other, and not in obedience to any signal, arose and returned home. The next morning a swarm issued from a neighbouring hive, and proceeded to the same bush upon which the other bees had settled on the preceding day, collecting themselves into a mass, as they usually do when their queen is present. In a few minutes afterwards a very large assemblage of bees rushed from the hive from which the former swarm had issued, and proceeded directly to the one which had just settled, and instantly united with them.—The author is led from these and other facts to conclude, that such unions of swarms are generally, if not always, the result of previous concert and arrangement.

He next proceeds to mention some circumstances which induce him to believe that sex is not given to the eggs of birds, or to the spawn of fishes or insects, at any very early period of their growth. Female ducks, kept apart from any male bird till the period of laying eggs approached, when a musk drake was put into company with them, produced a numerous offspring, six out of seven of which proved to be males.

The mule-fishes found in many rivers where the common trout abounds, and where a solitary salmon is present, are uniformly of the male sex: hence the spawn must have been without sex at the time it was deposited by the female.

Mr Knight states that he has also met with analogous circumstances in the vegetable world, respecting the sexes of the blossoms of monœcious plants. When the heat is excessive, compared with the quantity of light which the plant receives, only male flowers appear: but if the light be in excess, female flowers alone are produced.—*Proceedings of Royal Society, Phil. Mag.* p. 60.

Art. XXV.—HISTORY OF MECHANICAL INVENTIONS AND OF PROCESSES AND MATERIALS USED IN THE FINE AND USEFUL ARTS.

1. *Description of the Winch Bridge, the oldest Suspension Bridge in England.* Communicated by W. C. Trevelyan, Esq.

Having, along with my brother, lately made a short excursion in the upper part of Teesdale, where there is some very beautiful scenery, I took the opportunity of examining the Winch Bridge, which is the oldest chain-bridge in Britain and probably in Europe. As all the accounts of it I have seen are very incorrect in regard to its dimensions, and as I think it interesting to preserve an account of it, I send you the measurements which we took.

The Winch Bridge is formed of two chains, composed of links *six* inches in length, the iron of which is 1½ inch in circumference. The floor, which is laid on the chains, is *eighteen* inches wide, and has a hand-rail on each side. The chains are fixed by bolts into the rocks at each end. The lengths of the chains are as follow :—

	Feet.	Inches.
Length of chain between the rocks, -	59	4
——— supported by the rock on N. side,	12	0
——————— S. side,		

not visible, being covered with rubbish.

The centre of the bridge, which is about three feet lower than the ends, was, on the 2d July 1828, *twenty-one* feet above the level of the water, the depth of which was 8½ feet. This measure is very different from that given in all the printed accounts of it I have seen, which vary in making it from fifty to sixty feet high.

The bridge, which is in a decayed state, and not pleasant to pass over, is steadied by two chains, which are passed round the floor, and fixed in the basalt rocks on the west side.

2. *On Lithochromy, or the Art of multiplying Oil Coloured Lithographic Paintings.*

The art of lithography, in which designs are executed with one tint, has been carried to great perfection. In Germany, M. Boisserée has long ago succeeded, by the successive application of several plates, to give to lithographic drawings executed under his direction by M. Strixner, all the effect of a design coloured with several tints. More recently, however, M. Malapeau has attempted to obtain oil pictures by means of the mechanical process used in lithography. After painting on the stone the general designs, no fewer than twenty-seven rollers are then in succession passed over the stone in order to communicate to it all the colours which enter into the picture. An impression is then taken in the usual manner, and of course this impression will be a picture coloured with the twenty-seven tints which have been employed. This art is most perfect when the painting is on a large scale. M. Malapeau has executed a Christ larger than life, the effect of which is said to be surprising.—See the *Revue Encyclopedique*, June 1828, p. 818.

3. *On the Grass Oil of Nemaur.* By J. Forsyth, Esq. From the *Calcutta Transactions*, vol. iii. p. 213.

The grass oil of Nemaur (*Roosaka Tel,*) is in high repute among the natives of India as a specific for rheumatism. The method of using it is by rubbing about two drachms of the undiluted oil over the pained part in the heat of the sun, or before a fire twice a day. It causes a strong sense of heat and pricking, which usually lasts for two hours or longer. The grass is met with in frequent distinct patches, in the jungle throughout the province of Nemaur, but in greatest abundance along the foot of the *Vindhya* range of hills in the vicinity of Jaum Ghat, and thirty miles further west on the table land of the same range, near Nalcha, at which two places only I believe it is prepared, at least to any amount. About the latter end of August, it begins to bud, and continues to flower in tolerable vigour till the end of October, during which period alone it gives out the oil in sufficient quantity to cover the expence and trouble of its preparation, as after this it speedily dries up, and what little oil it does yield is extremely acrid, and unfit for use.

The oil is obtained from the grass by distillation, by means of an apparatus simple enough in its construction, some little improvement on which, it is probable, might give it more power. A wrought iron boiler is fitted over an earthen fireplace, and surmounted with a capital, from which two straight tubes, from five to six feet in length, and two inches in diameter, conduct the vapour into a couple of large copper receivers, immersed in cold water. At the conclusion of the process, the condensed fluid is poured into a large wide-mouthed vessel, and permitted to stand for some time, when the oil may be skimmed off the surface with a small shallow spoon. The plant is cut across where it begins to give out its flower, and bound up into small bundles or maniples, 250 or 300 of which are placed in the boiler, and so much water poured over them as to leave a sufficient space for ebullition, which is immediately promoted, without any previous maceration. The process occupies about six hours; and as there is a succession of attendants, it suffers little interruption, being usually accomplished four times in twenty-four hours, in which time about one seer of the oil is obtained. It is volatile, and extremely pungent, of a very light straw colour, and beautifully transparent, giving out a peculiarly rich and grateful odour, which diffuses itself very widely, if the vessel containing it is left unstopped. The price set upon it by the distiller is altogether disproportionate to the actual expence incurred in its preparation, as on calculating the cost of labour and materials, at rates even admitted by the Jaum manufacturer, I conceive that an average price of $\frac{1}{4}$ per quart would cover all his expences, and allow him an equitable recompense for his trouble. But there is no hope of being able to effect so considerable a reduction, while he can realize so much more by disposing of it elsewhere.

4. *Theory of Sir H. Davy's Safety Lamp.* By G. Libri.

An interesting paper on the nature and properties of flame was read by G. Libri, at the Society of Georgofili (Florence) on the 3d of December 1826. The author was led to doubt the correctness of the theory or explanation given by Sir H. Davy, in order to account for the phenomenon of his safety lamp. The distinguished inventor ascribes the security which the lamp affords to the conducting power of the metallic gauze, by which it is supposed the temperature of the flame is so much lowered as to be insufficient to ignite the inflammable mixture on the outside. Some facts known to the author were at variance with this hypothesis; and he found upon trial, that when single rods were made to approach a flame, the latter was always inflected on all sides from the rod, as if repelled by it, and that this effect was independent of the conducting power of the rod, whether good or bad. The amount of inflection or repulsion was directly as the mass, and inversely as the distance from the flame. It was not diminished by increasing the temperature of the rod, even to such a degree as to render it scarcely possible for it to abstract any of the caloric. In fact, when two flames are made to approach each other, there is a mutual repulsion, although their proximity increases the temperature of each instead of diminishing it.

"From these principles," says the author, "the theory of the safety lamp is easily deduced. A metallic wire, exerting, according to its diameter and its own nature, a constant repulsion upon flame, it is evident that two parallel wires, so near each other as not to exceed the distance of twice the radius of the sphere of repulsion, will not permit a flame to insinuate itself between them, unless it be impelled by a force superior to the intensity of repulsion. If to these two wires others be added, a tissue is formed impenetrable to flame, especially when the conducting power of the wires adds its influence to that of the repulsion."

The author conceives, that, from the views above stated, the number of cross or horizontal wires in the Davy lamp is unnecessarily large, and that by rejecting all of these excepting a number sufficient to secure the firmness of the tissue, the lamp would afford as great a security as at present, and at the same time diffuse a much greater light. This opinion he has verified by actual experiment.—*Bibliotheque Universelle de Geneve, Mars,* 1827.

5. *Protection against Damp, Rust, &c.* By JOHN MURRAY, F S. A. F. L. S. &c. Communicated by the Author.

I find that if linen or woollen cloth be immersed in water, saturated with *quick-lime and sulphate of soda,* and then carefully dried, delicate steel instruments folded up in it, even if themselves damp, are effectually preserved from rust or oxidation. The rust of iron is found to contain a carbonate of that metal, and the aqueous particles of "wet" and "damp" are, it is proved, decomposed by the contact of iron at all temperatures, and with increased effect at an elevated one, hence the formation of rust or oxidation, &c. It is probable that the caustic lime not merely absorbs any minute quantity of carbonic acid present in the air, and by damp brought into more immediate contact with the iron or steel, but also absorbs the first portions of present damp, perhaps too caustic lime may even take up *oxygen.*

The efflorescent sulphate of soda does not attract humidity, but rather casts it off even its own water of crystallization.

It is evident that an envelope of cotton or woollen cloth, saturated as described, would not only be a protection against damp in the case of steel, plate, &c. but also of equal value for the preservation of deeds, &c. whether on paper or parchment.

Steel articles, &c. may be very well preserved if buried in powdered quick-lime.

From a number of experiments I have made by suspending, by means of a silk, &c. thread, finely polished and magnetized steel bars in *lime water,* so as to float freely in this medium from the point of suspension, I have concluded that it points out an admirable method by which the magnetic virtue may be preserved for an indefinite period. A ring of iron, inclining to the "angle of no attraction" pointed out in Mr Barlow's Researches, might surround the phial or little glass globe, and the cardinal points be engraved by a diamond on a circular line externally. Under these circumstances, poised in an uniform medium of unvarying density, no atmospheric mutations would disturb it, and the finely polished steel needle would be preserved even free from oxidation, the fatal antagonist to magnetism.

6. *Improvement of Candles.* By JOHN MURRAY, F. L. S. and Lecturer on Chemistry. Communicated by the Author.

I steep the cotton wick in lime water, in which I have dissolved a considerable quantity of *nitrate of potassa,* (*chlorate of potassa* answers still better, but is too expensive for common practice,) by this means I secure a purer flame, and superior light;—a more perfect combustion is insured,—snuffing is rendered nearly as superfluous as in wax candles, and the candles thus treated do not "*run.*" The wicks must be thoroughly dry before the tallow is put to them.

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

I.—*A Brief Account of Microscopical Observations on the Particles contained in the Pollen of Plants; and on the general Existence of Active Molecules in Organic and Inorganic Bodies.* By ROBERT BROWN, F. R. S., Hon. M. R. S. E. & R. I. Acad., V. P. L. S., &c.

THE very able pamphlet, of which the above is the title, though printed by its distinguished author, is not published, and has been circulated only among his scientific friends. We proposed at first to lay before our readers only an analysis of it; but this we find to be impracticable, both from the nature of the subject, and from the mutual dependence of its parts. We have therefore printed the whole of it, and we doubt not that the scientific reader will look forward with the same impatience that we do to the more minute details which Mr Brown has promised in a future work.

"The following observations have all been made with a simple microscope, and indeed with one and the same lens; the focal length of which is about $\frac{1}{32}$d of an inch.*

* This double convex lens, which has been several years in my possession, I obtained from Mr Bancks, optician, in the Strand. After I had made considerable progress in the inquiry, I explained the nature of my subject to Mr Dollond, who ob-

The examination of the unimpregnated vegetable Ovulum, an account of which was published early in 1826,* led me to attend more minutely than I had before done to the structure of the Pollen, and to inquire into its mode of action on the Pistillum in Phænogamous plants.

In the essay referred to, it was shown that the apex of the nucleus of the ovulum, the point which is universally the seat of the future embryo, was very generally brought into contact with the terminations of the probable channels of fecundation; these being either the surface of the placenta, the extremity of the descending processes of the style, or more rarely, a part of the surface of the umbilical cord. It also appeared, however, from some of the facts noticed in the same essay, that there were cases in which the particles contained in the grains of pollen could hardly be conveyed to that point of the ovulum through the vessels or cellular tissue of the ovarium; and the knowledge of these cases, as well as of the structure and economy of the antheræ in Asclepiadeæ, had led me to doubt the correctness of observations made by Stiles and Gleichen upwards of sixty years ago, as well as of some very recent statements, respecting the mode of action of the pollen in the process of impregnation.

It was not until late in the autumn of 1826 that I could attend to this subject; and the season was too far advanced to enable me to pursue the investigation. Finding, however, in one of the few plants then examined, the figure of the particles contained in the grains of pollen clearly discernible, and that figure not spherical but oblong, I expected, with some confidence, to meet with plants in other respects more favourable to the inquiry, in which these particles, from peculiarity of form, might be traced through their whole course: and thus, perhaps, the question determined whether they in any case reach the apex of the ovulum, or whether their direct action is limited to other parts of the female organ.

My inquiry on this point was commenced in June 1827, and the first plant examined proved in some respects remarkably well adapted to the object in view.

This plant was *Clarckia pulchella*, of which the grains of pollen, taken from antheræ full grown, but before bursting, were filled with particles or granules of unusually large size, varying from nearly $\frac{1}{4000}$th to about $\frac{1}{5000}$th of an inch in length, and of a figure between cylindrical and oblong, perhaps slightly flattened, and having rounded and equal extremities. While examining the form of these particles immersed in water, I observed many of them very evidently in motion; their motion consisting not

ligingly made for me a simple pocket microscope, having very delicate adjustment and furnished with excellent lenses, two of which are of much higher power than that above-mentioned. To these I have often had recourse and with great advantage, in investigating several minute points. But to give greater consistency to my satements, and to bring the subject as much as possible within the reach of general observation, I continued to employ throughout the whole of the inquiry the same lens with which it was commenced.

* In the Botanical Appendix to Captain King's *Voyages to Australia*, vol. ii. p. 534. *et seq.*

only of a change of place in the fluid, manifested by alterations in their relative positions, but also not unfrequently of a change of form in the particle itself; a contraction or curvature taking place repeatedly about the middle of one side, accompanied by a corresponding swelling or convexity on the opposite side of the particle. In a few instances the particle was seen to turn on its longer axis. These motions were such as to satisfy me, after frequently repeated observation, that they arose neither from currents in the fluid, nor from its gradual evaporation, but belonged to the particle itself.

Grains of pollen of the same plant taken from antheræ immediately after bursting, contained similar subcylindrical particles, in reduced numbers, however, and mixed with other particles, at least as numerous, of much smaller size, apparently spherical, and in rapid oscillatory motion.

These smaller particles, or molecules as I shall term them, when first seen, I considered to be some of the cylindrical particles swimming vertically in the fluid. But frequent and careful examination lessened my confidence in this supposition; and on continuing to observe them until the water had entirely evaporated, both the cylindrical particles and spherical molecules were found on the stage of the microscope.

In extending my observations to many other plants of the same natural family, namely *Onagrariæ,* the same general form and similar motions of particles were ascertained to exist, especially in the various species of Œnothera, which I examined. I found also in their grains of pollen taken from the antheræ immediately after bursting, a manifest reduction in the proportion of the cylindrical or oblong particles, and a corresponding increase in that of the molecules, in a less remarkable degree, however, than in Clarckia.

This appearance, or rather the great increase in the number of the molecules, and the reduction in that of the cylindrical particles, before the grain of pollen could possibly have come in contact with the stigma,—were perplexing circumstances in this stage of the inquiry, and certainly not favourable to the supposition of the cylindrical particles acting directly on the ovulum; an opinion which I was inclined to adopt when I first saw them in motion. These circumstances, however, induced me to multiply my observations, and I accordingly examined numerous species of many of the more important and remarkable families of the two great primary divisions of Phænogamous plants.

In all these plants particles were found, which in the different families or genera varied in form from oblong to spherical, having manifest motions similar to those already described; except that the change of form in the oval and oblong particles was generally less obvious than in Onagrariæ, and in the spherical particle was in no degree observable*. In a great proportion of these plants I also remarked the same reduction of the larger particles, and a corresponding increase of the molecules after the bursting

* In *Lolium perenne*, however, which I have more recently examined, though the particle was oval and of smaller size than in Onagrariæ, this change of form was at least as remarkable, consisting in an equal contraction in the middle of each side, so as to divide it into two nearly orbicular portions.

of the Antheræ: the molecule, of apparently uniform size and form, being then always present; and in some cases, indeed, no other particles were observed, either in this or in any earlier stage of the secreting organ.

In many plants belonging to several different families, but especially to Gramineæ, the membrane of the grain of pollen is so transparent that the motion of the larger particles within the entire grain was distinctly visible; and it was manifest also at the more transparent angles, and in some cases even in the body of the grain in Onagrariæ.

In *Asclepiadeæ*, strictly so called, the mass of pollen filling each cell of the anthera is in no stage separable into distinct grains; but within, its tesselated or cellular membrane is filled with spherical particles, commonly of two sizes. Both these kinds of particles when immersed in water are generally seen in vivid motion; but the apparent motions of the larger particle might in these cases perhaps be caused by the rapid oscillation of the more numerous molecules. The mass of pollen in this tribe of plants never bursts, but merely connects itself by a determinate point, which is not unfrequently semitransparent, to a process of nearly similar consistence, derived from the gland of the corresponding angle of the stigma.

In *Periploceæ*, and in a few *Apocineæ*, the pollen, which in these plants is separable into compound grains filled with spherical moving particles, is applied to processes of the stigma, analogous to those of Asclepiadeæ. A similar economy exists in *Orchideæ*, in which the pollen masses are always, at least in the early stage, granular; the grains, whether simple or compound, containing minute, nearly spherical particles, but the whole mass being, with very few exceptions, connected by a determinate point of its surface with the stigma, or a glandular process of that organ.

Having found motion in the particles of the pollen of all the living plants which I had examined, I was led next to inquire whether this property continued after the death of the plant, and for what length of time it was retained.

In plants, either dried or immersed in spirit for a few days only, the particles of pollen of both kinds were found in motion equally evident with that observed in the living plant; specimens of several plants, some of which had been dried and preserved in an herbarium for upwards of twenty years, and others not less than a century, still exhibited the molecules or smaller spherical particles in considerable numbers, and in evident motion, along with a few of the larger particles, whose motions were much less manifest, and in some cases not observable *.

* While this sheet was passing through the press, I have examined the pollen of several flowers which have been immersed in weak spirit about eleven months, particularly of *Viola tricolor*, *Zizania aquatica*, and *Zea Mays*; and in all these plants the peculiar particles of the pollen, which are oval or short oblong, though somewhat reduced in number, retain their form perfectly, and exhibit evident motion, though I think not so vivid as in those belonging to the living plant. In *Viola tricolor*, in which, as well as in other species of the same natural section of the genus, the pollen has a very remarkable form, the grain on immersion in nitric acid still discharged its contents by its four angles, though with less force than in the recent plant.

In this stage of the investigation having found, as I believed, a peculiar character in the motions of the particles of pollen in water, it occurred to me to appeal to this peculiarity as a test in certain families of cryptogamous plants, namely Mosses, and the genus Equisetum, in which the existence of sexual organs had not been universally admitted.

In the supposed stamina of both these families, namely, in the cylindrical antheræ or pollen of Mosses, and on the surface of the four spathulate bodies surrounding the naked ovulum, as it may be considered, of Equisetum, I found minute spherical particles, apparently of the same size with the molecule described in Onagrariæ, and having equally vivid motion on immersion in water; and this motion was still observable in specimens both of Mosses and of Equiseta, which had been dried upwards of one hundred years.

The very unexpected fact of seeming vitality retained by these minute particles so long after the death of the plant, would not perhaps have materially lessened my confidence in the supposed peculiarity. But I at the same time observed, that on bruising the ovula or seeds of Equisetum, which at first happened accidentally, I so greatly increased the number of moving particles, that the source of the added quantity could not be doubted. I found also that on bruising first the floral leaves of Mosses, and then all other parts of those plants, that I readily obtained similar particles, not in equal quantity indeed, but equally in motion. My supposed test of the male organ was therefore necessarily abandoned.

Reflecting on all the facts with which I had now become acquainted, I was disposed to believe that the minute spherical particles or molecules of apparently uniform size, first seen in the advanced state of the pollen of Onagrariæ, and most other phænogamous plants,—then in the antheræ of Mosses, and on the surface of the bodies regarded as the stamina of Equisetum,—and lastly, in bruised portions of other parts of the same plants, were in reality the supposed constituent or elementary molecules of organic bodies, first so considered by Buffon and Needham, then by Wrisberg with greater precision, soon after and still more particularly by Müller, and very recently by Dr Milne Edwards, who has revived the doctrine, and supported it with much interesting detail. I now, therefore, expected to find these molecules in all organic bodies: and, accordingly, on examining the various animal and vegetable tissues, whether living or dead, they were always found to exist; and merely by bruising these substances in water, I never failed to disengage the molecules in sufficient numbers to ascertain their apparent identity in size, form, and motion, with the smaller particles of the grains of pollen.

I examined also various products of organic bodies, particularly the gum resins, and substances of vegetable origin, extending my inquiry even to pit-coal; and in all these bodies molecules were found in abundance. I remark here also, partly as a caution to those who may hereafter engage in the same inquiry, that the dust or soot deposited on all bodies in such quantity, especially in London, is entirely composed of these molecules.

One of the substances examined was a specimen of fossil wood, found in Wiltshire oolite, in a state to burn with flame; and as I found these molecules abundantly, and in motion in this specimen, I supposed that their existence, though in smaller quantity, might be ascertained in mineralized vegetable remains. With this view a minute portion of silicified wood, which exhibited the structure of coniferæ, was bruised, and spherical particles, or molecules in all respects like those so frequently mentioned, were readily obtained from it; in such quantity, however, that the whole substance of the petrifaction seemed to be formed of them. But hence I inferred that these molecules were not limited to organic bodies, nor even to their products.

To establish the correctness of the inference, and to ascertain to what extent the molecules existed in mineral bodies, became the next object of inquiry. The first substance examined was a minute fragment of window-glass, from which, when merely bruised on the stage of the microscope, I readily and copiously obtained molecules agreeing in size, form, and motion with those which I had already seen.

I then proceeded to examine, and with similar results, such minerals as I either had at hand or could readily obtain, including several of the simple earths and metals, with many of their combinations.

Rocks of all ages, including those in which organic remains have never been found, yielded the molecules in abundance. Their existence was ascertained in each of the constituent minerals of granite, a fragment of the sphinx being one of the specimens examined.

To mention all the mineral substances in which I have found these molecules would be tedious; and I shall confine myself in this summary to an enumeration of a few of the most remarkable. These were both of aqueous and igneous origin, as travertine, stalactites, lava, obsidian, pumice, volcanic ashes, and meteorites from various localities *. Of metals I may mention manganese, nickel, plumbago, bismuth, antimony, and arsenic. In a word, in every mineral which I could reduce to a powder, sufficiently fine to be temporarily suspended in water, I found these molecules more or less copiously; and in some cases, more particularly in siliceous crystals, the whole body submitted to examination appeared to be composed of them.

In many of the substances examined, especially those of a fibrous structure, as asbestus, actinolite, tremolite, zeolite, and even steatite, along with the spherical molecules, other corpuscles were found, like short fibres somewhat moniliform, whose transverse diameter appeared not to exceed that of the molecule, of which they seemed to be primary combinations. These fibrils, when of such length as to be probably composed of not more than four or five molecules, and still more evidently when formed of two or three only, were generally in motion, at least as vivid as that of the simple molecule itself; and which, from the fibril often changing its position in the fluid, and from its occasional bending, might be said to be somewhat vermicular.

In other bodies which did not exhibit these fibrils, oval particles of a size about equal to two molecules, and which were also conjectured to be

* I have since found the molecules in the sand-tubes, formed by lightning, from Drig in Cumberland.

primary combinations of these, were not unfrequently met with, and in motion generally more vivid than that of the simple molecule, their motion consisting in turning usually on their longer axis, and then often appearing to be flattened. Such oval particles were found to be numerous and extremely active in white arsenic.

As mineral bodies which had been fused contained the moving molecules as abundantly as those of alluvial deposits, I was desirous of ascertaining whether the mobility of the particles existing in organic bodies was in any degree affected by the application of intense heat to the containing substance. With this view small portions of wood, both living and dead, linen, paper, cotton, wool, silk, hair, and muscular fibres, were exposed to the flame of a candle, or burned in platina forceps, heated by the blowpipe; and in all these bodies so heated, quenched in water, and immediately submitted to examination, the molecules were found, and in as evident motion as those obtained from the same substances as before burning.

In some of the vegetable bodies burned in this manner, in addition to the simple molecules, primary combinations of these were observed, consisting of fibrils having transverse contractions, corresponding in number, as I conjectured, with that of the molecules composing them; and those fibrils, when not consisting of a greater number than four or five molecules, exhibited motion resembling in kind and vivacity that of the mineral fibrils already described, while longer fibrils of the same apparent diameter were at rest.

The substance found to yield these active fibrils in the largest proportion and in the most vivid motion, was the mucous coat interposed between the skin and muscles of the haddock, especially after coagulation by heat.

The fine powder produced on the under surface of the fronds of several ferns, particularly of *Acrostichum calomelanos,* and the species nearly related to it, was found to be entirely composed of simple molecules and their primary fibre-like compounds, both of them being evidently in motion.

There are three points of great importance which I was anxious to ascertain respecting these molecules, namely, their form, whether they are of uniform size, and their absolute magnitude. I am not, however, entirely satisfied with what I have been able to determine on any of these points.

As to form, I have stated the molecule to be spherical, and this I have done with some confidence; the apparent exceptions which occurred admitting, as it seems to me, of being explained by supposing such particles to be compounds. This supposition in some of the cases is indeed hardly reconcileable with their apparent size, and requires for its support the further admission, that, in combination, the figure of the molecule may be altered. In the particles formerly considered as primary combinations of molecules, a certain change of form must also be allowed; and even the simple molecule itself has sometimes appeared to me when in motion to have been slightly modified in this respect.

My manner of estimating the absolute magnitude and uniformity in size of the molecules, found in the various bodies submitted to examination, was by placing them on a micrometer divided to five thousandths of an inch, the lines of which were very distinct; or more rarely on one divided to ten thousandths, with fainter lines, not readily visible without the application of plumbago, as employed by Dr Wollaston, but which in my subject was inadmissible.

The results so obtained can only be regarded as approximations, on which perhaps, for an obvious reason, much reliance will not be placed. From the number and degree of accordance of my observations, however, I am upon the whole disposed to believe the simple molecule to be of uniform size, though as existing in various substances and examined in circumstances more or less favourable, it is necessary to state that its diameter appeared to vary from $\frac{1}{15000}$th to $\frac{1}{20000}$th of an inch *.

I shall not at present enter into additional details, nor shall I hazard any conjectures whatever respecting these molecules, which appear to be of such general existence in inorganic as well as in organic bodies; and it is only further necessary to mention the principal substances from which I have not been able to obtain them. These are oil, resin, wax, and sulphur, such of the metals as I could not reduce to that minute state of division necessary for their separation, and finally, bodies soluble in water.

In returning to the subject with which my investigation commenced, and which was indeed the only object I originally had in view, I had still to examine into the probable mode of action of the larger or peculiar particles of the pollen, which, though in many cases diminished in number before the grain could possibly have been applied to the stigma, and particularly in Clarckia, the plant first examined, were yet in many other plants found in less diminished proportion, and might in nearly all cases be supposed to exist in sufficient quantity to form the essential agents in the process of fecundation.

I was now therefore to inquire, whether their action was confined to the external organ, or whether it were possible to follow them to the nucleus of the ovulum itself. My endeavours, however, to trace them through the tissue of the style in plants well suited for this investigation, both from the size and form of the particles, and the developement of the female parts, particularly Onagrariæ, was not attended with success; and neither in this nor in any other tribe examined, have I ever been able to find them in any part of the female organ, except the stigma. Even in those families in which I have supposed the ovulum to be naked, namely, Cycadeæ and Coniferæ, I am inclined to think that the direct action of these particles, or of the pollen containing them, is exerted rather on the orifice of the proper membrane than on the apex of the included nucleus; an opinion

* While this sheet was passing through the press, Mr Dollond, at my request, obligingly examined the supposed pollen of *Equisetum virgatum* with his compound achromatic microscope, having in its focus a glass divided into 10,000ths of an inch, upon which the object was placed; and although the greater number of particles or molecules seen were about $\frac{1}{20000}$, yet the smallest did not exceed $\frac{1}{30000}$th of an inch.

which is in part founded on the partial withering confined to one side of the orifice of that membrane in the larch,—an appearance which I have remarked for several years.

To observers not aware of the existence of the elementary active molecules, so easily separated by pressure from all vegetable tissues, and which are disengaged and become more or less manifest in the incipient decay of semitransparent parts, it would not be difficult to trace granules through the whole length of the style: and as these granules are not always visible in the early and entire state of the organ, they would naturally be supposed to be derived from the pollen, in those cases at least in which its contained particles are not remarkably different in size and form from the molecule.

It is necessary also to observe that in many, perhaps I might say in most plants, in addition to the molecules separable from the stigma and style before the application of the pollen, other granules of greater size are obtained by pressure, which in some cases closely resemble the particles of the pollen in the same plants, and in a few cases even exceed them in size: these particles may be considered as primary combinations of the molecules, analogous to those already noticed in mineral bodies and in various organic tissues.

From the account formerly given of Asclepiadeæ, Periploceæ, and Orchideæ, and particularly from what was observed of Asclepiadeæ, it is difficult to imagine, in this family at least, that there can be an actual transmission of particles from the mass of pollen, which does not burst, through the processes of the stigma; and even in these processes I have never been able to observe them, though they are in general sufficiently transparent to show the particles were they present. But if this be a correct statement of the structure of the sexual organs in Asclepiadeæ, the question respecting this family would no longer be, whether the particles in the pollen were transmitted through the stigma and style to the ovula, but rather whether even actual contact of these particles with the surface of the stigma were necessary to impregnation.

Finally, it may be remarked that those cases already adverted to, in which the apex of the nucleus of the ovulum, the supposed point of impregnation, is never brought into contact with the probable channels of fecundation, are more unfavourable to the opinion of the transmission of the particles of the pollen to the ovulum, than to that which considers the direct action of these particles as confined to the external parts of the female organ.

The observations, of which I have now given a brief account, were made in the months of June, July, and August 1827.

The facts ascertained respecting the motion of the particles of the pollen were never considered by me as wholly original; this motion having, as I knew, been obscurely seen by Needham, and distinctly by Gleichen, who not only observed the motion of the particles in water after the bursting of the pollen, but in several cases remarked their change of place within the entire grain. He has not, however, given any satisfactory account either of the forms or of the motions of these particles, and in some cases appears to have confounded them with the elementary molecule, whose existence he was not aware of.

Before I engaged in the inquiry in 1827, I was acquainted only with the abstract given by M. Adolphe Brongniart himself, of a very elaborate and valuable memoir, entitled " *Recherches sur le Génération et le Développement del Embryon dans les Végétaux Phanerogames,*" which he had then read before the Academy of Sciences of Paris, and has since published in the *Annales des Sciences Naturelles.*

Neither in the abstract referred to, nor in the body of the memoir, which M. Brongniart has with great candour given in its original state, are there any observations, appearing of importance even to the author himself, on the motion or form of the particles ; and the attempt to trace these particles to the ovulum with so imperfect a knowledge of their distinguishing characters, could hardly be expected to prove satisfactory. Late in the autumn of 1827, however, M. Brongniart having at his command a microscope constructed by Amici, the celebrated professor of Modena, he was enabled to ascertain many important facts on both these points, the result of which he has given in the notes annexed to his memoir. On the general accuracy of his observations on the motions, form, and size of the granules, as he terms the particles, I place great reliance. But in attempting to trace these particles through their whole course, he has overlooked two points of the greatest importance in the investigation.

For, in the *first* place, he was evidently unacquainted with the fact, that the active spherical molecules generally exist in the grain of pollen along with its proper particles ; nor does it appear from any part of his memoir that he was aware of the existence of molecules having spontaneous or inherent motion, and distinct from the peculiar particles of the pollen, though he has doubtless seen them, and in some cases, as it seems to me, described them as those particles.

Secondly, he has been satisfied with the external appearance of the parts in coming to his conclusion, that no particles capable of motion exist in the style or stigma before impregnation.

That both simple molecules and larger particles of different form, and equally capable of motion, do exist in these parts, before the application of the pollen to the stigma can possibly take place, in many of the plants submitted by him to examination, may easily be ascertained ; particularly in *Antirrhinum majus,* of which he has given a figure in a more advanced state, representing these molecules or particles, which he supposes to have been derived from the grains of pollen, adhering to the stigma.

There are some other points respecting the grains of pollen and their contained particles in which I also differ from M. Brongniart, namely, in his supposition that the particles are not formed in the grain itself, but in the cavity of the anthera ; in his assertion respecting the presence of pores on the surface of the grain in its early state through which the particles formed in the anthera, pass into its cavity ; and lastly, on the existence of a membrane forming the coat of his boyau or mass of cylindrical form ejected from the grain of pollen.

I reserve, however, my observations on these and several other topics connected with the subject of the present inquiry for the more detailed account, which it is my intention to give.

July 30, 1828.

II.—*Transactions of the Royal Society of Edinburgh*, Vol. xi. First Part, pp. 234. 9 Plates.

This volume, of which we propose to give a brief analysis, contains *fourteen* papers on the subjects of *Mineralogy, Geology, Optics, Chemistry, Botany*, and the *Mechanical Arts*.

1. *Description of Sternbergite.* By W. Haidinger, Esq.—A very copious abstract of this paper has already been published by Mr Haidinger in this Journal, vol. vii. or No. xiv. p. 242—247.

2. *Description of some remarkable effects of unequal refraction.* By the Rev. W. Scoresby.—An abstract of this paper we have already given in vol. vi. No. xii. p. 213,

3. *On a new combustible gas.* By Dr Thomas Thomson.—The composition of this gas we have already given in No. xiii. p. 182.

The gas is obtained by the following process :—Put into a flask a mixture of 1½ oz. of muriatic acid, ½ oz. of the nitric acid of commerce, and ½ oz. of pyroxylic spirit, all by measure. By means of a perforated cork insert very tightly a bent glass-tube into the mouth of the flask. Heat the mixture over a spirit lamp till it begin to effervesce, and till the colour of the liquid changes to red. The flask must then be withdrawn, and the extremity of the bent tube plunged into a mercurial trough. The gas issues in torrents for five or six minutes, and may be collected in any quantity, in glass jars, previously filled with mercury, and inverted on the trough. From the quantity of materials stated above, at least 200 cubic inches of the gas are extricated.

The gas, as it comes over, acts with considerable energy on the mercury; both calomel and corrosive sublimate being formed in abundance. But this is owing to the presence of some chlorine, with which the gas, as it issues from the flask is mixed. For when we transfer the gas into a clean jar, it may be left for any length of time on the trough, without acting in the least on the mercury, or changing its volume.

The gas thus obtained possesses the following characters :—

1. It is transparent and colourless, and has the mechanical properties of common air.

2. Its smell is exceedingly pungent and disagreeable; but quite peculiar. It acts with considerable energy upon the eyes and nose, occasioning a flow of tears, and exciting considerable pain in the eyes.

3. It burns with a lively bluish-white flame.

4. Water absorbs it pretty rapidly: one volume of water absorbing five volumes of the gas. The water acquires a pungent taste, and the peculiar smell of the gas. But it does not alter the colour of litmus or cudbear paper.

5. One volume of oil of turpentine absorbs thirty volumes of the gas; the oil assumes a light-green colour, and resembles cajeput; but still retains its peculiar odour.

6. The gas is neither absorbed by acids nor alkalies. Hence it possesses neither acid nor alkaline properties.

7. When common air or oxygen gas is mixed with this gas, the usual red fumes of nitrous acid appear, and the volume of the mixture is diminished. It is not therefore homogeneous, but contains a considerable proportion of nitrous gas. I endeavoured to determine the proportion of nitrous gas in 100 volumes, by mixing it with determinate quantities of oxygen gas over mercury. The diminution of volume was noted, and two-thirds of that diminution reckoned as nitrous gas. A mean of some experiments gave the amount of nitrous gas in 100 volumes of the new gas, 63 volumes, or rather more than three-fifths of the whole.

100 volumes of the gas, after being washed in water, and in a solution of protosulphate of iron, left 8 per cent. of azotic gas.

Hence the gas extricated from a mixture of *aqua regia* and pyroxylic spirit, consists of

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

The specific gravity of the gas was taken in a flask which had been twice exhausted and filled each time with hydrogen gas. It was 1.945, the specific gravity of common air being reckoned unity.

The calculated specific gravity of the pure inflammable gas in this mixture is 4.1757, which considerably exceeds the specific gravity of chloro-carbonic acid, or the phosgene gas of Dr Davy, which is 3.4722.

The gas seems to be a compound of

$1\frac{1}{3}$ volume carbon vapour,	condensed into one volume.
$1\frac{1}{3}$ volume hydrogen gas,	These added together make
$1\frac{1}{3}$ volume chlorine gas,	a specific gravity of 3.9814.

This is lighter than the gas was found by experiment by about one twenty-first part. But there is some uncertainty about the actual specific gravity, as it depends upon the proportion of nitrous gas,—a proportion not determined with perfect accuracy.

I am disposed to consider it as not unlikely that the proportion of nitrous gas may have been rather underrated. On that supposition, I think it very probable, that the true constituents of a volume of the gas are,

1 volume carbon vapour,	0.4166
1 volume hydrogen gas,	0.0694
$1\frac{1}{2}$ volume chlorine gas,	3.7500
	4.2361

This would make the specific gravity of the gas 4.2361, which only exceeds the specific gravity found by about one seventieth part,—a difference certainly not greater than might be looked for in determining the quantity of nitrous gas mixed with it.

The gas, then, is a compound of

1 atom hydrogen,	0.125
1 atom carbon,	0.750
$1\frac{1}{2}$ atom chlorine,	6.750
	7.625

and its atomic weight is 7.625

The discovery of this gas was gratifying to Dr Thomson, for the following reason :—In the *First Principles of Chemistry*, vol i. p. 249, he pointed out a remarkable property of the compound of one atom carbon and one atom hydrogen. This compound he distinguishes by the name *carbo-hydrogen*, since the appropriate term *carburetted hydrogen* has been unluckily applied to a different combination. Carbo-hydrogen has the property of forming a variety of gases and vapours, differing from each other in the number of integrant particles of carbo-hydrogen, which a single volume of the gas or vapour contains. The gas described in this paper (abstracting the chlorine) contains only one integrant particle of carbo-hydrogen in a volume; olefiant gas contains two integrant particles. One of the oleaginous liquids obtained by condensing oil-gas, which has been examined by Mr Faraday in an insulated state, but which had been previously detected in oil-gas, in the state of vapour, by Mr Dalton, contains three integrant particles. Sulphuric ether vapour (abstracting the water) contains four integrant particles; while the vapour of Naphtha contains six integrant particles. The following table exhibits the atomic weights and specific gravities of these gases and vapours.

	Atomic Weight.	Spec.Gr.
Simple carbo-hydrogen gas, - -	0.875	0.4861
Olefiant gas, or deuto-carbo-hydrogen, -	1.75	0.9722
Oil-gas vapour, or trito-carbo-hydrogen, -	2.625	1.4583
Ether vapour, or tetarto-carbo-hydrogen,	3.5	1.9444
Naphtha vapour of hexa-carbo-hydrogen, -	5.25	2.9166

The existence of the simple carbo-hydrogen was merely hypothetic, till the discovery of sesqui-carbo-hydrogen has given us an example of its actual existence. Thus the only doubtful part of this reasoning has been shown to be actually correct. This circumstance gives an importance to the discovery of sesqui-carbo-hydrogen, to which it would not otherwise be entitled.

4. *Some experiments on Gold.* By Dr Thomas Thomson.—A brief notice of this paper will be found in this *Journal*, No. xiii. p. 183.

5. *On the Construction of Polyzonal Lenses and their combinations with Plane Mirrors, for the purpose of Illumination in Lighthouses.* By Dr

Brewster.—In a subsequent number of this *Journal* we shall direct the attention of our readers very fully to the contrivances described in this paper, which require numerous figures for their illustration.

6. *On the parasitic formation of Mineral species.*—In this number, p. 275. and in No. xiii. p. 126, the reader will find the whole of this curious and important paper.

7. *On the influence of the air in determining the crystallization of Saline Solutions.* By Mr Thomas Graham.—When a phial is filled with a boiling saturated solution of Glauber's Salt, and its mouth immediately stopped by a piece of bladder tied tightly over it while it is hot, the solution will cool without crystallizing, and will continue entirely liquid for hours and even days, although it contains a great excess of salt. If the bladder, however, is punctured, and the air admitted, the solution is immediately resolved into a spongy crystalline mass, with the evolution of much heat. This fact, which has long puzzled chemists, has been ingeniously and satisfactorily explained by Mr Graham, who concludes from several experiments and facts, *that air determines the crystallization of supersaturated saline solutions by dissolving in the water, and thereby giving a shock to the feeble power by which the excess of salt is held in solution.*

The expansion of the whole mass when it becomes solid is shown by Mr Graham to be entirely a momentary dilatation of the whole contents of the phial, both liquid and solid, by the evolution of heat, which occurs at the instant of crystallizing, and which always amounts to 20° or 30° Fahr.

8. *Mineralogical account of the ores of Manganese.* By W. Haidinger, Esq.—In an article *On the crystalline forms and properties of the Manganese ores,* which Mr Haidinger published in this *Journal,* vol. iv. No. vii. p. 41—51, he had previously published the principal facts contained in the present paper, He has added, however, under the head of Prismatic Manganese Ore, the description of Pyrolusite, which, in order to complete the article in our seventh number, we have published in p. 304 of this number.

9. *Chemical Examination of the oxides of Manganese.* By Dr Edward Turner.—Dr Turner's able and elaborate Paper is divided into two parts viz.

Part. I. On the Atomic Weight of Manganese.—Analysis of the Carbonate of Manganese.

II. On the composition of the Ores of Manganese, described by Mr Haidinger.

The following are the leading results of Dr Turner's analyses.

1. *Carbonate of Manganese* consists of

Protoxide of manganese, - -	56.853
Carbonic acid, - - - -	34.720
Water, - - - - -	8.427
	100.00

2. *Prismatoidal Manganese Ore* or *Manganite* consists of

Protoxide of manganese, - -	80.92
Oxygen, - - - - -	8.98
Water, - - - - -	10.10
	100.00

3. *Brachytypous Manganese Ore* or *Braunite* consists of

Protoxide, - - -	86.94
Oxygen, - - -	9.851
Water, - - - -	0.949
Baryta, - - - -	2.260
Silica, - - - -	a trace
	100.00

4. *Pyramidal Manganese Ore* or *Hausmannite* consists of

Red oxide, - - -	98.098
Oxygen, - - -	0.215
Water, - - - -	0.435
Baryta, - - -	0.111
Silica, - - -	0.337
	100.00

5. *Uncleavable Manganese Ore* or *Psilomelane* consists of

Red oxide, - - -	69.795
Oxygen, - - -	7.364
Baryta, - - -	16.365
Silica, - - - -	0.260
Water, - - -	6.216
	100.000

6. *Prismatic Manganese Ore* or *Pyrolusite* consists of

Red oxide, - - -	85.617
Oxygen, - - -	11.599
Water, - - -	1.566
Silica, - - -	0.553
Baryta, - - -	0.665
Lime, - - - -	a trace
	100.000

7. *Manganese Oxidé noir Barytifere* of Hauy, from Romaneche.—Its specific gravity is 4.365. It consists of

Red oxide, - - -	70.967
Oxygen, - - -	7.260
Baryta, - - -	16.690
Silica, - - -	0.953
Water, - - -	4.130
	100.000

10. *An Account of the Formation of Alcoates.* By Mr THOMAS GRAHAM.—The bodies described in this paper are definite solid compounds of salts and alcohol, analogous to the hydrates, and are imperfectly crystallizable. Those which Mr Graham succeeded in forming are not numerous. They were obtained simply by dissolving the salts, previously rendered anhydrous, in absolute alcohol, with the aid of heat. Upon cooling, the alcoates were deposited in the solid state. The crystallization was generally compound, but in some cases singular crystalline forms appeared. The crystals are transparent, decidedly soft, and easily fusible by heat in their alcohol of crystallization, which is generally considerable, amounting in one instance to nearly three-fourths of the weight of the crystals.

The following are the alcoates obtained:—

1. *Alcoate of Chloride of Calcium.*—This alcoate crystallizes in thin transparent plates, which have the form of isosceles triangles, which form compound crystals. They consist of

2 atoms chloride of calcium, -	14
7 atoms alcohol, - - -	20.125
	34.125

2. *Alcoate of Nitrate of Magnesia.*—This alcoate is obtained in crystals much smaller and less distinct than the former, but without any regular form. It consists of

1 atom nitrate of magnesia, -	9.25
9 atoms alcohol, - - -	25.875
	35.125

3. *Alcoate of the Nitrate of Lime.*—This salt is obtained sometimes in irregular crystals. It consists of

2 atoms nitrate of lime, - -	20.5
5 atoms of alcohol, - - -	14.375
	34.875

4. *Alcoate of Proto-chloride of Manganese.*—This alcoate is obtained in plates with ragged edges. It consists of

1 atom protochloride of manganese, -	8
3 atoms alcohol, - - - -	8.625
	16.625

5. *Alcoate of Chloride of Zinc.*—This alcoate, when concentrated so as to be viscid, deposits small separate crystals of a regular shape. It consists of

2 atoms of chloride of zinc -	17.5
1 atom of alcohol - - -	2.875
	20.375

Mr Graham considers it probable that many more alcoates of salts may be formed, particularly of the metallic chlorides; but the great obstacle to their formation is the difficulty and frequently the impossibility of rendering the salts perfectly anhydrous before their solution in alcohol is attempted.

11. *An Account of the Tracks and Footmarks of Animals found Impressed in Sandstone in the Quarry of Corncockle Muir.* By the REV. Dr HENRY DUNCAN.—A full abstract of this very curious paper has already been given in this *Journal*, No. xvi. p. 305. See also No. xv. p. 130.

12. *On the Combination of Chlorine with the Prussiate of Potash, and the presence of such a Compound as an Impurity in Prussian Blue.* By Mr JAMES F. W. JOHNSTON, A. M.—The new compound described in this paper is considered as a chloro-ferro-cyanide of potassium, and consists of

$$\left.\begin{array}{ll}\text{1 atom chloro-ferro-cyanic acid} & = 31 \\ \text{4 potassium} & = 20\end{array}\right\} 51$$

This new acid may be obtained in a separate state by various processes, which Mr Johnston promises to explain in a future paper. When pure, it forms beautiful red four-sided needles, not differing in appearance from those of any of its salts.

Mr Johnston has formed the various salts resulting from the union of this acid with the base; and he gives the following account of their general properties. :—

1. They are all of a deep red colour, crystallizing in four-sided pyramids and rhomboidal prisms. In minute needles their colour is golden-yellow.

2. In the moist state the crystals are liable to decompose by light and heat, becoming externally of a greenish colour, and in solutions depositing a green sediment.

3. They are very soluble in water, but insoluble in alcohol, unless considerably diluted.

4. Their solutions, when hot and concentrated, have a peculiar smell, approaching to that of weak chlorine; and, with the exception of the salt of lead, they have all a bitterish taste; that of lead having the sweet taste of its other salts.

5. These solutions are decomposed by sulphuretted hydrogen becoming green and depositing sulphur. Some of the hydro-sulphurets have a similar effect, but they are not changed by hydrogen gas.

6. Treated in powder with sulphuric acid, they give off chlorine gas. From the salts of barytes, strontian, and lead, it is also partially driven off by a gentle heat.

7. Their solutions are also decomposed by metallic mercury being changed into green, becoming greenish-yellow, and letting fall a blue precipitate; the solutions no longer giving a *red*, but a *white*, with nitrate of silver. They have likewise a strong action upon metallic iron, coating it immediately with Prussian blue.

8. They all give similar precipitates with the metallic oxides.

9. When dry they undergo no change by exposure to the air, the salt of cadmium excepted, which deliquesces.

10. Most of them decrepitate when heated, and in the flame of a candle are combustible, throwing out bright white sparks, and leaving a dark brown residue. The salt of barytes melts without sensibly burning; and that of lead burns silently like tinder, giving minute globules of metallic lead.

13. *On a Mass of Native Iron from the desert of Atamaca in Peru.* By Mr Allan.—This paper is reprinted in this Number, p. 259.

14. *Observations on the Structure of the Fruit in the Cucurbitaceæ.* By Dr Francis Hamilton.—As this paper is entirely the description of numerous figures, it will not admit of any abstract.

Art. XXVII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Remarkable Double Stars in the Southern Hemisphere.*—Mr James Dunlop communicated to the Astronomical Society on the 9th of May last a valuable memoir on the approximate places of double stars in the southern hemisphere for 1827, as observed at Paramatta. The following are a few of the most remarkable:—

α *Crucis.* This double star resembles *Castor* both in the magnitudes of the two stars, and in their mutual distance.

α *Centauri.* This star consists of one of the *first* magnitude, accompanied by one of the *fourth*,—a combination which does not occur in our hemisphere. Their distance is about 20″.

ι *k Argus.* This star consists of stars of the *sixth* and *eighth* magnitudes, the large star being *blue*, and the small one dusky *red*. This is the only instance known of a combination of two considerably bright stars differing decidedly in magnitude, where a marked excess of the less refrangible rays appears in the light of the smaller star, and of the more refrangible rays in the larger one. Its R. Asc. is $8^h\ 4^m$, and its declination 42° 7′ south.

Another double star, unnamed, has a deep red purple colour, which occurs also in our hemisphere. It is of the seventh magnitude, and is situated in right ascension $1^h\ 19^m\ 43^s$ and declination 33° 31 south. See *Phil. Mag.* July 1828.

2. *Curious Phenomenon in Saturn's Ring.*—On the 21st December 1827, M. Schwabe observed that the dark space between the body of Saturn and his ring appeared larger on the eastern side of the planet than on the western side. Mr Herschel and others were also of opinion that the eastern space was the largest; but from his observations and those of Mr South's, it appears that there is no difference. Thus,

$$\left.\begin{array}{lcr} \text{Western space,} & - & 3''532 \\ \text{Eastern space,} & - & 3\ 607 \end{array}\right\} \begin{array}{c}\text{1st Set}\\ \text{of}\\ \text{35 Obs.}\end{array}$$

Western space, -	3″472	2d Set of 20 Obs.
Eastern space, -	3 472	

Of the last set *ten* were made by Mr Herschel, and gave

Western space, -	3″612
Eastern space, -	3 442

and *ten* by Mr South, which gave

Western space, -	3″331
Eastern space, -	3 502

Hence it follows that the phenomenon is an optical deception.

Prof. Struve, however, is decidedly of opinion, from observations with his splendid achromatic telescope, that Saturn is not in the centre of his ring. From a mean of 15 measurements he makes the apparent distance on the east side 11″.272, and on the west side 11″.390, making a difference of 0″.215. The probable error of his mean measurements he regards as 0″.024, the ninth part of the difference above found.

3. *Reappearance of the new Variable Star in the Serpent.*—This variable star, which we have mentioned in No. xv. p. 167, has, according to Professor Harding, now became visible, and has attained the 8th or 9th magnitude. Its position the beginning of this year is, R. Asc. $15^h 46^m 45^s$. N. Decl. 15° 39′ 30″.

4. *Length of the Seconds Pendulum at Paramatta.*—From a mean of 41 experiments, the length of the pendulum vibrating seconds at Paramatta, *in vacuo* at the freezing point, and at the level of the sea, is 39.071618 English inches, or 992.412801 millimetres.

METEOROLOGY.

5. *Shower of Ice in Staffordshire.*—On Saturday the 9th of August there was a fall of *solid* ice at Horsley in Staffordshire. Some of the pieces were *three inches long* by *one inch broad,* and others were about *three inches in circumference,* and quite solid. One gentleman in Dudley had L. 70 worth of glass broken in his own house, and at Mr York's house near the Horsley Iron Works, about 150 panes of glass were broken. About 100 panes were broken at the iron works. The storm was accompanied with very heavy thunder, but no lightning. The crops upon which the ice fell are said to be completely ruined.

6. *Meteor of a Green Colour.*—On the night of the 11th of February, between eleven and twelve o'clock, as I was crossing the East River, between this city and Long Island, I observed a beautiful meteor which was visible for about the space of two seconds. Its course was from a point perhaps 5° below the zenith, toward the horizon in a N.E. direction. It described an arc of perhaps 20°, when it apparently exploded, but without any report that I could hear. Its colour was a singularly pure grass green, of a light shade; the trail which it left was of the same colour, and so were the scintillations which accompanied its apparent explosion. The lat-

ter were distinct, like those accompanying the bursting of a rocket, but by no means so numerous.—Two gentlemen who were in the boat with me at the time also saw it.—*Silliman's Journal.*

ELECTRICITY.

7. *Influence of Electricity on the Emanation of Odours.*—When a continued current of electricity traverses an odoriferous body, camphor for example, the odour of this substance becomes more and more feeble, and at last entirely disappears. When this has taken place, and when the body withdrawn from all electrical influence, is put in communication with the ground, it will remain without odour for some time. The camphor, however, resumes its former properties gradually and slowly. M. Libri of Florence, the author of this curious experiment, has promised to describe it with more detail.

8. *On the production of Fulminary Tubes by Electricity.*—Our readers will no doubt have heard of the long tubes produced by the passage of lightning through beds of sand. Dr Fiedler has collected many of these tubes from different localities, and specimens of them have already found their way into several collections of minerals. These tubes are formed by the agglutination of the particles of sand by the action of the electric fluid.

The idea occurred to M. Hachette of attempting to make similar tubes with an electrical battery. He and M. Savart, and M. Beudant accordingly placed a quantity of pounded glass in a hole made in a brick, and having made the discharge of the battery pass through the pounded glass, they obtained tubes similar to those found in nature. One of these was an inch long, its exterior diameter varied from one-eighth of an inch to one-sixteenth, and the inner diameter was the fiftieth of an inch.

In another experiment in which the pounded glass was mixed with a little chloride of sodium, the tube was $1\frac{1}{7}$th inch long, and of equal diameter throughout. Its mean exterior diameter was one-fifth of an inch, and its interior diameter one-twelfth.

They could not produce the tubes by using powder of felspar or pounded quartz.—*Ann. de Chim.* Tom. xxvii p. 319. March 1828.

II. CHEMISTRY.

9. *Sulphuret of Aluminium.*—Sulphur may be distilled from aluminium without any combination taking place. But if a piece of sulphur is dropped on aluminium when strongly incandescent, so that it may be enveloped in an atmosphere of the vapour of sulphur, the union is effected with vivid emission of light. The resulting sulphuret is a partially vitrified, semi-metallic mass, which acquires an iron-black metallic lustre when burnished. On exposure to the air it smells strongly of sulphuretted hydrogen, swells up gradually, and falls into a gray powder. Applied to the tongue it excites a pricking warm taste of sulphuretted hydrogen gas. In pure water sulphuretted hydrogen gas is rapidly disengaged, and gray alumina is separated.

The sulphuret of aluminium cannot be generated by exposing sulphate of alumina to hydrogen gas at a red heat; for in that case all the acid is expelled without the aluminous earth being reduced.

10. *Phosphuret of Aluminium.*—When aluminium is heated to redness in contact with the vapour of phosphorus, it takes fire, and burns with considerable brilliancy. The product is a blackish-gray pulverulent mass, which by rubbing acquires a dark gray metallic lustre, and smells constantly of phosphuretted hydrogen. Thrown into water a phosphuretted hydrogen gas, which does not ignite spontaneously in the air, is disengaged. The effervescence is less rapid than with the sulphuret; but is increased by heat.

11. *Seleniuret of Aluminium.*—This compound is formed with emission of light by heating to redness a mixture of selenium and aluminium. The product is black, pulverulent, and assumes a dark metallic lustre when rubbed. In the air it emits a strong odour of seleniuretted hydrogen; and this gas is rapidly disengaged by the action of water, which is speedily reddened by the separation of selenium.

12. *Arseniuret of Aluminium.*—When arsenic in powder and aluminium are heated to redness, combination takes place, though with less intense light and heat than in the preceding compounds. The arseniuret is dark gray, pulverulent, acquires metallic lustre by friction, and smells feebly of arseniuretted hydrogen. In water no action ensues; but in a short time a slow disengagement of arseniuretted hydrogen occurs, and the effervescence becomes rapid by the aid of heat.

13. *Alloy of Tellurium and Aluminium.*—When a mixture of these metals are heated to redness, they unite with such violence that the whole mass is projected from the vessel as if shot from a gun. This inconvenience may be avoided by adding the tellurium in mass.

The telluriet of aluminium is a black, metallic, brittle substance, rendered coherent by partial fusion. In the air it smells intolerably of tellureted hydrogen, and this gas is rapidly disengaged by the action of water, which quickly becomes red, then brown, and lastly opaque, from deposition of tellurium. The destruction of this compound in water takes place even more easily than the sulphuret of aluminium.

Antimony, when heated to a strong red heat with aluminium, did not combine with it.

14. *On the presence of Uric Acid in the urine of the Lion and Tiger.*—We are informed by a letter from Professor Stromeyer, that he has lately had an opportunity of examining the urine of the lion, tiger, leopard, and hyena. The urine of all these animals was found to contain uric acid. When quite recent it also had an acid reaction, but speedily became neutral and then alkaline.

15. *On a Gaseous Fluoride of Manganese.* By Dr Wöhler. (*Poggen-*

dorff's An. ix. 619.)—On adding sulphuric acid to a mixture of the common mineral chameleon with half its weight of fluor-spar in powder, a violent action ensues, and a beautiful purple coloured vapour is disengaged. On performing this experiment with fuming sulphuric acid in a vessel of platinum, the vessel became filled with a greenish yellow gas, of a more intensely yellow tint than chlorine. When this gas was mixed with common atmospheric air, it instantly acquired the purple-red colour. By water it was freely absorbed, and the solution was of a purplish red colour, and had an acid reaction. The yellow gas acted instantly on glass; fluo-silicic gas was formed, and a brown matter deposited, which became of a deep purple-red colour on the addition of water.

From the experiments of Dr Wöhler it may be inferred, that the yellow gas is a fluoride of manganese; that when mixed with water both compounds are decomposed, and fluoric and manganesic acids are formed, which are dissolved; that a similar formation of the two acids ensues from the admixture of the yellow gas with atmospheric air, owing to the moisture contained in the latter; and that by contact with glass fluo-silicic gas is generated, and anhydrous manganesic acid deposited. Dr Wöhler has not been able to ascertain any other of its properties, nor is it certain whether it is the vapour of a volatile liquid, or a gas permanent at moderate temperatures.

This is obviously the same compound which M. Dumas noticed in his experiments on the volatile chloride of manganese. (See the Number of this *Journal* for January, p. 179.) The fluoride must doubtless contain as many equivalents of fluorine as the manganesic acid does of oxygen.

16. *Preparation of Pure Malate of Lead.* (*Poggendorff, Ibid.*)—Dr Wöhler states that a perfectly pure malate of lead is readily obtained by the following process: The juice of the berries of the service tree, before they are quite ripe, is diluted with three or four parts of water, filtered, and heated; and while boiling a solution of acetate of lead is added as long as any turbidity appears. The solution is then quickly filtered. At first a small quantity of dark-coloured salt subsides; but on decanting the hot liquid, the malate of lead is deposited on cooling in groups of brilliant white crystals.

17. *Decomposition of Selenious Acid by Metals.* By Professor Fischer of Breslau. (*Poggendorff,* x. 152.)—Berzelius had observed that the selenious acid in solution is reduced to the state of selenium by the action of metallic zinc. Professor Fischer has remarked, that the whole list of metals from zinc to silver inclusive, possesses the same property. Silver is even an exceedingly delicate reagent for selenious acid, and detected its presence when purposely mixed with 50,000 parts of sulphuric acid. Selenious acid has been thus discovered in three kinds of sulphuric acid of commerce. The procedure consists simply in placing a rod of silver in the acid or solution to be tested; and after a longer or shorter period the metal acquires a dark film on its surface, like that produced by sulphuretted hydrogen. The compound thus formed is seleniuret of silver.

Our readers will remember that since M. Mitscherlich's discovery of a new selenic acid proportional to sulphuric acid, the term *selenious acid* is applied to the acid discovered by Berzelius, and which consists of one equivalent of selenium to two equivalents of oxygen, or it corresponds to sulphurous acid.

18. *Bromine in the Water of the Baltic.*—This substance has been discovered in the water of the Baltic by Dr Wöhler and M. Kindt. (*Poggendorff, Ibid.*)

19. *On a New Sulphate of Potash.* By Mr R. Phillips.—The new salt discovered by Mr Phillips is a sesquisulphate of potash, and was obtained from the bisulphate of potash, formed in the process of preparing nitric acid by the decomposition of one equivalent of nitre by two equivalents of concentrated sulphuric acid. The following is the history and analysis of the salt as given by Mr R. Phillips in the *Philosophical Magazine and Annals* for December 1827.

"To the supersulphate of potash remaining in the retort, I added nearly an equal weight of water; by the application of heat, the salt was readily dissolved, without ebullition, and consequently with but little diminution of the water. The salt obtained by the cooling of the solution consisted of extremely minute filaments resembling asbestos in appearance; a part of the residual solution was so retained by the capillary attraction of the crystals, that it could not be separated by draining, and it was necessary to absorb it by filtering paper.

"The primary form of bisulphate of potash is either a right rhombic prism, or an octahedron with a rhombic base, and the crystals are usually so flat as to be tabular; it appeared to be improbable that the acicular crystals which I have now described, should be a variety of either of the primary forms above-mentioned. I thought they might, however, be bisulphate of potash containing more or less than the two atoms of water, which are known to exist in it in its common form. To determine this point I made the following experiments: 100 grains of the filamentous salt, which had been dried by exposure to the air in a moderately warm room, were dissolved in water, and solution of muriate of barytes was added as long as precipitation took place; the sulphate of barytes after washing and igniting, taking the mean of two experiments, weighed 154.75 grains, equivalent to 52.45 of sulphuric acid.

To expel the water of crystallization, as well as the excess of acid, 100 grains of the filamentous salt were heated to redness in a platina crucible; the neutral sulphate of potash remaining weighed 78.4 grains, and consequently 21.6 of sulphuric acid and water were expelled. Now as 88 of sulphate of potash contain 40 of sulphuric acid, 78.4 contain 35.6, which deducted from 52.45, the whole quantity contained in 100 grains of the salt, leave 16.85 as the sulphuric acid expelled by heat, with 4.75 of water of crystallization. It will be observed that the quantity of sulphuric acid separated by heat from the supersulphate, is as near one-half that remaining in the neutral salt, as 16.85 to 17.8. The salt in question appears therefore to be sesquisulphate of potash, or to consist of

		Theory.	Experiment.
3 atoms sulphuric acid -	120	53.33	52.45
2 atoms potash - -	96	42.66	42.80
1 atom water - -	9	4.00	4.75
	225	99.99	100·00

Or it may be regarded as constituted of

2 atoms of sulphate of potash - -	176
1 atom of liquid sulphuric acid - -	49
	225

"It is extremely difficult to procure the sesquisulphate of potash free from bisulphate; and on repeating an attempt to prepare it, as nearly as possible in the mode already described, I procured a large quantity of bisulphate and a small proportion of sesquisulphate. I am well aware that different salts are obtainable by using different quantities of water, for the same proportions of acid and base will yield either sulphate, sesquisulphate, or bisulphate of potash; and I have found that in order to procure bisulphate, the solution must be much concentrated. But I am unacquainted with the precise circumstance to which the production of sesquisulphate is to be ascribed; it may perhaps be referrible to some peculiarity of temperature in influencing the time of cooling.

"In the sesquisulphate subjected to analysis, minute crystals of bisulphate of potash could occasionally be detected; and very pure bisulphate was obtained by evaporating the residual solution after separating the acicular salt; and eventually the solution became extremely acid and ceased to afford crystals of any kind.

"When a mixture of crystallized bisulphate and sesquisulphate of potash is exposed to the air, while it retains some of the solution from which it was crystallized, a formation of arborescent crystals occurs at the surface. I have not yet collected a sufficient quantity of this salt for examination, but it is probably only sesquisulphate."

20. *Preparation of Pure Oxide of Zinc.* By M. Hermann.—It is by no means easy to obtain this substance perfectly pure. The following is M. Hermann's process. Oxide of zinc, or metallic zinc, is to be dissolved in excess of sulphuric acid, and the solution being filtered, sulphuretted hydrogen is to be passed through so long as a brown or yellow precipitate is formed. Cadmium, lead, or copper being thus separated, and the solution filtered, it is to be treated with solution of the chloride of lime (bleaching powder) by which the iron and manganese will be separated. The solution, again filtered, is then to be crystallized in porcelain vessels, by which sulphate of lime is rejected, and another liquor separated, which usually contains cobalt and nickel. The crystals of sulphate of zinc are to be dissolved in a small quantity of cold water, and the

sulphate of lime filtered out. The solution, being diluted with water, is decomposed by carbonate of soda in slight excess, and the precipitate well washed, dried, and heated to redness. It is then a perfectly pure and beautifully white oxide.—*Quarterly Journal of Science for October* 1827.

III. NATURAL HISTORY.

MINERALOGY.

21. *On Herderite, a New Mineral Species.* By W. HAIDINGER, Esq. F. R. S. E.—1. *General Description.* Fundamental form, a scalene four-sided pyramid, P = 141° 16′, 77° 20′, 116° 3′. (Plate IV. Fig. 8.) Ratio of the axes $a : b : c = 1 : \sqrt{2.55} : \sqrt{0.46}$.

Simple forms. $(\breve{P}-2)^4$ (o) = , 149° 50′, ; $(\frac{4}{3}\breve{P}-2)^3$ (n) = , 134° 35′, ; P (p); $(\breve{P}r+\infty)^5$ (t) = 115° 7′; $(\breve{P}+\infty)^6$ (s) = 42° 58′; $\breve{P}r$ (M) = 115° 53′; $\breve{P}r+\infty$ (r); $\bar{P}r+\infty$ (P.)

Combinations observed. 1. $\breve{P}r . P . (\breve{P}r+\infty)^5 . \bar{P}r+\infty$. (Fig. 9.)
2. $\breve{P}r . (\breve{P}-2)^4 . (\frac{4}{3}\breve{P}-2)^3 . P . (\breve{P}r+\infty)^5 . (\breve{P}+\infty)^6 . \breve{P}r+\infty . \bar{P}r+\infty$.

Cleavage distinct, parallel to the faces M, but interrupted; also perpendicular to the axis, the latter only in detached portions of very bright and even faces, and faint indications parallel to P. Fracture small conchoidal.

Surface, M very smooth, and delicately streaked parallel to its edges of combination with P, and resembling in this respect all the faces of the pyramids, *n*, *o*, and *p*, situated between them.

The faces *r* and *s* are very narrow, and somewhat curved. Those marked *t* and P, have a peculiar granulated aspect, but they are at the same time pretty smooth, particularly the latter.

Lustre, vitreous, slightly inclining to resinous. Colour several shades of yellowish and greenish-white; streak white, strongly translucent.

Very brittle. Hardness = 5.0, equal to that of apatite. Specific gravity = 2.985.

2. *Observations.*—1. The only specimen of herderite, at present known, is in the Wernerian Museum at Freiberg. It was pointed out to me by M. Von Weissenbach, then keeper of the museum, as containing crystals, whose forms he could not exactly refer to those of apatite, among the varieties of which it was exhibited. The different aspect of the faces *p* and *t*, the former being smooth or but faintly streaked parallel to their intersections with P, while the latter are granulated, showed that the forms did not belong to the rhombohedral but to the prismatic system; and I did not hesitate in pronouncing the mineral to be a new species, which I requested permission to examine more minutely. This permission was very liberally conceded. Mr Breithaupt, who was then present, and had himself at a former period placed the specimen in the cabinet of Werner, likewise concurred in acknowledging the species to be a new one.

Through the kind intercession of Mr Reich, now keeper of the museum, I was favoured, during my stay at Berlin in the winter of 1825, with some fragments of the specimen for analysis, by Baron Von Herder, the present Ober-Berghauptmann, or director of every thing connected with mining proceedings in Saxony. It is in compliment to that nobleman, that I propose the name of *Herderite* for the species.

2. Herderite occurs imbedded in fluor, in the tin mines of Ehrenfriedersdorf, in Saxony. It resembles apatite, with which it was formerly confounded, in a remarkable degree; particularly some of those named asparagus-stone: such as the variety from Zillerthal, in Salzburg, and that from Hof in Gastein in the same country, which is found accompanying the axotomous iron-ore of Mohs, and still more so certain pale greenish-white masses of the same species, which occur, though in small quantity, along with the zoisite from the Saualpe in Carinthia. The resemblance among those species is sufficient to class the Herderite in the genus *Fluor-haloide* of Mohs, in which it may be henceforth included as the "*prismatic Fluor-haloide*."—*Ann. of Phil. July* 1828, p. 1.

22. *Fahlunite.*—Count Trolle-Wachtmeister, (*Kongl. Vetensk. Acad. Handl. for* 1827,) has given the results of an examination of three varieties of this mineral.

	1.	2.	3.
Silica, -	43.51	44.60	44.95
Alumina, - -	25.81	30.10	30.70
Oxide of iron, -	6.35	Protox. 3.86	7.22
Magnesia, -	6.53	6.75	6.04
Protoxide of manganese,	——	——	1.90
mixed with oxide of iron,	1.72	2.24	——
Soda, - -	4.45	} 1.98	——
Potash, - -	0.94		1.38
Fluoric acid with silica,	0.16	——	——
Lime, - -	——	1.35	0.95
Water, - -	11.66	9.35	8.05

The first variety is uncrystallized, has a black colour, a brown streak, a spec. gr. = 2.68. The second variety is crystallized, in forms like the topaz, has a gray colour, a white streak, and a spec. gr. = 2.74. The third variety blackish gray in colour, white in streak, and the spec. gr. = 2.79. The general formula of this combination of isomorphous bodies is = $MS^2 + 3\ AS + 2\ Aq$. All these varieties are found in the Fahlun Mine.

23. *Diallage.*—Dr Köhler of Cassel (Poggendorff's *Annalen der Physik und Chemie,* vol. xii. p. 101, &c.) has examined several varieties of diallage, and infers from this examination, that metalloidal diallage, bronzite, and hypersthene, are subspecies of the pyroxene, (paratomous augite spar) and not like the Schiller spar and antophyllite species of the Schiller spar family.

1. *Metalloidal Diallage from the Baste, near Harzburg, on the Harz.*—This mineral forms a constituent of the great granular gabbro or euphotide, and has a highly perfect cleavage parallel to one direction. The lustre is pearly and metallic, the colour olive and leek-green, brown, and gray; the hardness = 3.75 ... 4.0, the spec. gr. = 3.22 ... 3.23. Like the sma-

ragdite, this variety is in regular composition with hornblende. It consists of

Silica, - - -	52.064
Lime. - - -	17.743
Magnesia, - - -	17.810
Protoxide of iron and protoxide of manganese,	8.734
Alumina, - - -	2.571
Water, - - -	1.078
	100.000

The mineralogical formula is $\left.\begin{array}{r} C \\ M \\ f \\ mn \end{array}\right\} S^2$

2. *Metalloidal Diallage from Salzburg.*—Colour pale greenish-gray; hardness = 3. 75; spec. gr. = 3.21 . . . 3.23. Composition:

Silica, - -	51.338
Lime, - -	18.284
Magnesia, - -	15.692
Protoxide of iron and manganese,	8.230
Alumina, - -	4.388
Water, - - -	2.107
	100.039

Formula: $\left.\begin{array}{r} C \\ M \\ f \\ mn \end{array}\right\} S^2$

3. *Metalloidal Diallage from Florence.*—Colour, hardness, &c. like the foregoing varieties; spec. gr. = 3.25. Composition:

Silica, - -	53.200
Lime, - -	19.088
Magnesia, - -	14.909
Protoxide of iron, -	8.611
Protoxide of Manganese, -	0.308
Alumina, - -	2.470
Water, - -	1.773
	100.491

Formula: $\left.\begin{array}{r} C \\ M \\ f \\ mn \end{array}\right\} S^2$

4. *Crystallized Diallage from the Baste.*—Form like that of the augite; the crystals are little, indistinct, and surrounded by the matrix; spec. gr. = 3.054. Composition:

Silica,	53.739
Magnesia,	25.093
Lime,	4.729
Protoxide of iron,	11.501
Protoxide of manganese,	0.233
Alumina,	1.335
Water,	3.758
	100.397

$$\text{Formula: } \left.\begin{matrix} M \\ f \\ C \\ mn \end{matrix}\right\} S^2$$

5. *Bronzite from the Stempel, near Marburgh.*—This mineral is found in Olivine, in small cleavable masses. The most distinct cleavage has a pearly lustre and greenish bronze yellow colour. Two other cleavages, less distinct, forms with the first an angle of 134°: It has a resinous lustre, and deep greenish-brown colour. The hardness of this bronzite is = 5.75 . . . 6.0; it is brittle, the streak white; the spec. gr.= 3.241. It consists of

Silica,	57.193
Magnesia,	32.669
Lime,	1.299
Protoxide of iron,	7.461
Protoxide of manganese,	0.349
Alumina,	0.698
Water,	0.631
	100.300

$$\text{Formula: } \left.\begin{matrix} M \\ f \\ C \\ mn \end{matrix}\right\} S_2$$

6. *Bronzite from the Ulten valley in the Tyrol.*—Cleavage, lustre, colour like the foregoing variety: hardness = 5.25; spec. gr. = 3.258. Composition:

Silica,	56.813
Magnesia,	29.677
Lime,	2.195
Protoxide of iron,	8.464
Protoxide of manganese,	0.616
Alumina,	2.068
Water,	0.217

$$\text{Formula: } \left.\begin{matrix} M \\ f \\ C \\ mn \end{matrix}\right\} S^2$$

7. The *Hypersthene* from Paul's Island on the coast of Labrador is in com-

plete accordance with the bronzite of Marburg. The mineralogical formula, according to the analysis of Klaproth is:

$$\left.\begin{matrix} f \\ M \\ C \end{matrix}\right\} S^2$$

24. *Nickel-glance.*—This uncrystallized mineral, which Berzelius represents by the formula Ni S^2 + Ni As, and has till now been found only in the cobalt mines of Loo in Helsingland in Sweden, has been discovered by Mr Zincken, mining director of the Duke of Anhalt, Bernburgh, among the old ores from the mine Albertine near Harzgerode on the Harz. According to the examination of Prof. G. Rose of Berlin, the crystals are hexahedrons with the faces of the octahedron. Cleavage highly perfect, parallel to the faces of the hexahedron; lustre metallic; colour like that of arsenical pyrites; hardness = 5.5; spec. gr. = 6. 097. It is found in a vein with carbonate of iron, carbonate of lime, fluor spar, quartz, lead glance, blende, sulphur and copper pyrites.—(Poggendorff's *Annalen*, vol. xiii. p. 165.)

25. *Pektolite.*—Under this name Prof. von Kobell of Munich (Kastner's *Archiv. fur Naturlehre*, vol. xiii. p. 385,) describes a mineral which is found on Natrolite (a variety of Mesotype) on Monte Baldo in South Tyrol. Spheroidal shapes, composition columnar, consisting of delicate divergent individuals radiating from a centre; lustre pearly; colour grayish; on the surface generally dull; hardness between that of fluor spar and feldspar; spec. gr. = 2.69.

Before the blowpipe it yields a white translucent glass. It consists of

51.30	Silica,	1.57	Potassa,
33.77	Lime,	8.89	Water,
8.26	Soda,	0.90	Alumina and oxide of iron.

The mineralogical formula is:

$$4\ C\ S^2 + 3 \left.\begin{matrix} N \\ K \end{matrix}\right\} S_3 + 6\ Aq.$$

26. *Mineralogical Literature.*—1. Dr Naumann, professor in the Mining Academy of Freiberg, has published "*Lehrbuch der Mineralogie*"—*Treatise on Mineralogy*, Berlin, 1828, by A. Rucker, in 8vo. This treatise, by a scholar of the celebrated Prof. Mohs of Vienna, is one of the best on that science. The crystallographic method of Prof. Naumann is eclectic in reference to those of Mohs and Weiss, and is very good; the system is established according to the physical and chemical characters of minerals. He describes a multitude of varieties of crystals with the assistance of 556 figures. In general the work is very classical, and deserves to be recommended to mineralogists.

2. Dr Charles Hartmann, Mining-officer in the service of his Highness the Duke of Brunswick, has published *Worterbuch der Mineralogie und Geognosie,—Dictionary of Mineralogy and Geology*. Leipsic, by Brockhaus, 8vo. This work gives a description of all known minerals and rocks in alphabetical order, and contains an introduction to mineralogy and geolo-

gy, with the history and literature of the sciences in systematical arrangement. In reference to the crystallography, Dr Hartmann pursues the methods of Prof. Mohs and of Prof. Weiss. This work merits the particular notice of all mineralogists, and also travellers, because the size of the book is not great, and the type very small. A German, an English, a French, and an Italian index facilitate the use of the book, and 312 figures illustrate the forms of the crystals.

3. Dr Hartmann has also published *Vorlesungen über Mineralogie, &c., Lectures on Mineralogy, particularly for Schools, &c.* Ilmenau, by Voigt, 8vo. This elementary treatise is strongly recommended to young men who study the natural history of minerals, and to lecturers in schools. As in the elementary introduction of Mr Phillips, the crystalline forms of minerals are illustrated with wood-cuts printed along with the text.

27. *Chloropheite discovered in Northumberland.*—Mr William Hutton of Newcastle-upon-Tyne has discovered that rare and curious mineral called chloropheite, in a basaltic dike near Coquet Water in Northumberland, about two miles north-east of Felton. It exists in the form of small nodules, which, from a specimen kindly sent to us by W. C. Trevelyan, Esq. has exactly the same appearance and properties as those of the chloropheite which Major Paterson brought from Faro. Mr Hutton has also observed the same substance at Coaley Hill near Newcastle, but in the earthy form.

28. *Two New Minerals consisting of Biseleniuret of Zinc and Sulphuret of Mercury.*—These new minerals were found at Culebras, in Mexico, by Mr J. M. Herrera, in the limestone which overlies the red sandstone.

The red mineral burns with a beautiful violet coloured flame. Its specific gravity is 5.66. It is a biseleniuret of zinc, but the mercury will be in the state of a bisulphuret. Its formula is $\ddot{Z}n\,\ddot{S}e^4+Hg\,S^2$.

The gray mineral is like light gray silver ore, but yields a blacker powder. Its specific gravity is 5.56. It is composed of

Selenium, - -	49
Zinc, - -	24
Mercury, - -	19
Sulphur, - -	1.5
	93.5

which, with the addition of six grains of lime obtained, will amount to 99.5. The lime, however, is mechanically mixed with it. Hence the mineral is a biseleniuret of zinc united to a protosulphuret of mercury, and its formula is $\ddot{Z}n\,\ddot{S}e^4+HgS$.—*Phil. Mag. Aug.* 1828, p. 113.

BOTANY.

29. *Flora Danica.*—In the course of last summer (1827) Professor Hornemann of Copenhagen published the thirty-second Fasciculus of *Flora*

Danica, which brings that valuable work down to plate 1920. About the same time he published "*Nomenclatura Floræ Danicæ emendata cum indice Systematico et Alphabetico,*" in 8vo, pp. xxviii. 214, containing indexes of the plants; 1. according to their order of publication; 2. according to the Linnæan system; 3. alphabetical.

The preface contains an interesting account of the origin and progress of that work, (published principally at the expence of the King,) which was commenced by George Christian Oeder of Anspach, who, in 1752, was appointed Professor of Botany in Copenhagen; and in 1761, published a prospectus and specimen of the *Flora Danica*, which, between that time and 1771, (when he received an appointment in Norway, which took him from this work,) was followed by ten fasciculi, containing 600 plates. Those in the early parts are drawn and engraved by the Roeslers, father and son, and are much superior to those in the later parts, where he employed inferior artists. Oeder was succeeded in 1772 by the celebrated zoologist, Otto Frederick Müller, who published Fasciculi xi.–xv. plates 601–900.

He attended more particularly to the lower orders of plants, Confervæ and Fungi, hitherto much neglected; though it appears he had scarcely determined in what part of the system of nature Fungi should be included, as he about the same time published *Clavaria militaris* in his *Zoologia Danica* as an animal, and in the *Flora* as a plant. The plates were during Muller's editorship executed by a brother of his, and are much inferior to those of the Roeslers.

To him succeeded in 1783 a worthy pupil of Linnæus, (under whom he studied for several years at Upsal) Martin Vahl, by whom the work was much improved, both in accuracy and in execution, though the mosses are frequently so imperfectly represented in their most essential characters, that it is difficult to refer them to their species or even genus. He published Fasciculi xvi.–xxi. plates 901–1260.

The present editor, Jens Wilken Hornemann, succeeded in 1805, and had last year continued the work to Fasciculus xxxii. plate 1920; and is zealously proceeding in his labours to which the botanical world is so much indebted. He calculates, that, reckoning the Cotyledonous plants of Denmark at 1600, and the Acotyledonous at 3200, about ¾ of the former or 1200, and little more than ¼ of the latter or 900, are published.

30. *Epilobium Alpinum found in England.*—This plant was lately discovered by W. C. Trevelyan, Esq. near Caldron Snout Teesdale Durham.

IV. GENERAL SCIENCE.

31. *On the pressure of the Sea at great depths on Empty Bottles.* By Dr Jacob Green.—Our readers are well aware, that at great depths the sea water forces itself into tightly corked bottles. The Reverend Mr Campbell,* and others were of opinion that the water forced itself through the

* *Travels in Africa.* p. 335. See also Edinburgh Encyclopædia, Art. Hydrodynamics, vol. xi. p. 483.

pores of the glass. This opinion is contradicted by the following experiments made by Dr Green of Philadelphia.

" A hollow glass globe hermetically sealed, which I had previously prepared in Philadelphia, was then fastened to a line, and sunk, with a heavy mass of lead, to the depth of 230 fathoms, or 1380 feet. On the same line, and 30 fathoms above the glass globe, was fastened a small bottle with an air-tight glass stopper ; 50 fathoms above this, a stout glass bottle with a long neck was tied ; a good cork was previously driven into the mouth of this bottle, which was then sealed over with pitch, and a piece of linen dipped in melted pitch was placed over this ; and when cool, another piece of linen treated in the same way was fastened over the first. Twenty fathoms above this bottle, another was attached to the line, much stouter, and corked and sealed like the first, except that it had but one covering of pitched sail-cloth. Thirty fathoms above this was a small thin bottle filled with fresh water closely corked ; and twenty fathoms from this last there was a thin empty bottle corked tight and sealed, a sail-needle being passed through and through the cork, so as to project on either side of the neck.

" Upon drawing in the line, thus furnished with its vessels, and which appeared to have sunk in a perpendicular direction, the following was the result :

" The empty bottle with the sail-needle through the cork, and which came up the first, was about half full of water, and the cork and sealing as perfect as when it first entered the sea.

" The cork of the second bottle, which had been previously filled with *fresh water*, was loosened and a little raised, and the water was *brackish*.

" The third bottle, which was sealed and covered with a single piece of sail-cloth, came up empty, and in all respects as it descended.

" The fourth bottle, with a long neck, and the cork of which was secured with two layers of linen, was crushed to pieces, all except that part of the neck round which the line was tied ; the neck of the bottle both above and below the place where the line was fastened had disappeared, and the intermediate portion remained embraced by the line. This I thought a little remarkable ; and perhaps may be explained by supposing that the bottle was first filled by the superincumbent pressure with dense sea-water, which expanded on being drawn up near the surface. Had the vessel been broken by external pressure, that part surrounded with the line ought to have been crushed with the rest.

" The fifth bottle, which had been made for the purpose of containing French perfumery or ether, and which was therefore furnished with a long close glass-stopper, came up about one-fourth filled with water.

" The hollow glass-globe, hermetically sealed, which was the last and had been sunk the deepest of all, was found perfectly empty, not having suffered the smallest change. It is therefore concluded, that at the depth of 230 fathoms the water enters glass vessels through the stoppers and coverings which surround them, and not through the pores of the glass.

What effect a pressure of 400 fathoms or more will have on the glass-globe above mentioned, Captain Dixey has engaged to ascertain for me on his return to America, if opportunity shall offer."—*Phil. Mag. July* 1828, p. 37.

32. *Account of the Earthquake at Bogota, and in the Cordillera, between Bogota and Popayan, 16th November* 1827. By Colonel P. Campbell. The following is an abstract of the paper read before the Royal Society of London on the 8th May.—The earthquake is described by the narrator as occurring suddenly, at half-past six o'clock in the evening, whilst he was at dinner. It was announced by a loud rumbling noise; the whole house shook with violence; the decanters and glasses on the table being thrown down. The family ran for shelter under the door-way of the principal floor, which they had no sooner reached than they witnessed the fall of the towers of the cathedral opposite to them, with a dreadful crash. The whole tremor lasted about a minute. The first shock consisted of a long, undulating motion; the next was quick and violent; and the party found it difficult to preserve their balance, and were affected as if from sea-sickness. The damage sustained by the town of Bogota is immense, and has been estimated at about two millions of dollars, independently of the destruction of the cathedral, which had been completed about nine years ago, and the building of which cost 800,000 dollars. The government palace, and almost all the public offices and barracks, have either been rendered useless, or severely shattered. Of the churches, only those of the Capuchins, Carmelites, and the chapel of the convent "de la Ensenanza," can be said to have escaped without injury. Few of the houses above one story high are habitable, and even many of the low houses have been thrown down. The whole of the upper part of the Barrio del Rosorio, consisting of buildings of this latter description, now presents nothing but a heap of ruins. Many habitations which had withstood the first shocks have given way under those which followed, although incomparably less violent. The injury to dwellings has been remarkably unequal in different parts of the town—some streets having only partially suffered, while others are totally destroyed. Amidst this widely spreading destruction, it is fortunate that the loss of lives has been very inconsiderable, being, in the city of Bogota, limited to only five or six persons.

It appears that the earthquake was not felt much to the north of Bogota; but to the south the devastation has been most extensive. Throughout the whole of the plain of Bogota, as far as the towns of Purificacion and Neiva, there remains no church or public edifice of importance that has not been either overthrown or materially damaged. In the towns of Purificacion and Ibogué, the shock was so powerful as to throw down many houses constructed of cane, with thatched roofs. In Neiva, not only were all the public buildings destroyed by the earthquake, but torrents of rain conspired to increase the havoc. Even straw-huts were levelled with the ground; and the roofs of some of them taking fire, added to the horror of the scene, and to the extent of the calamity. Great part of the plain of Neiva was inundated: this was productive of considerable loss of lives, particularly on the banks of the Magdalena, the current of which was at first considerably lessened; but a great flood succeeded, and swept down vast quantities of mud and other substances, emitting a strongly sulphureous vapour, and attended with a general destruction of the fish.

These and other facts render it probable that some volcanic eruption took place in Tolima, an old volcano of Tocaima, from the mouth of which it is reported, that of late dense columns of smoke have been seen to arise, and more remarkably so on the day of the earthquake; as also from the ridge of mountains of Santa Anna in Maraquita, and the Paramo of Ruiz, which is a part of the same Cordillera, and contiguous to that of Tolima.

Popayan, which is 200 geographical miles S. S. W. of Bogota, has also suffered much from the same earthquake, many houses having fallen in consequence of the violent shocks that continued to succeed each other every six hours down to the evening of the 18th, which is the date of the latest intelligence from that place. The torrents of rain with which they were accompanied have proved a great aggravation to the misery they have created. At Patea, still further to the S. S. W. the devastation has been still greater; some of the largest trees having been thrown down by the concussions. It is hence inferred, that eruptions have taken place at the same period in the volcano of Pasto; and the wide crevices which have appeared in the road of Guanacas, leave no doubt that the whole of the Cordillera has sustained a powerful shock.

In the plains of Bogota considerable crevices have also opened, and the river Tunza has already begun to flow through those which have appeared near Costa. In other parts of the Cordillera, although the earth has continued in motion for a quarter of an hour without intermission, the movement has been nearly insensible, and observable only by means of the compass or the pendulum.—*Phil. Mag. Id.*

33. *Medal adjudged to Miss Caroline Herschel*.—The Astronomical Society of London has adjudged a medal to Miss C. Herschel, " for her reduction to January 1800 of the nebulæ discovered by her illustrious brother."

34. *Medal adjudged to Mr Dunlop*.—The Astronomical Society has adjudged a medal to Mr Dunlop, for his valuable astronomical labours while assistant to Sir Thomas Brisbane at Paramatta.

Art. XXVIII.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE JUNE 20, 1828.

20. June 20. For certain Improvements on Anchors. To William Rodger, county of Middlesex.

21. June 20. For an Improvement in Boiling or Evaporating Solutions of Sugar and other Liquids. To John Davis, county of Middlesex.

22. July 11. For certain Combinations of Machinery for generating and communicating Power and Motion applicable to the propelling fixed Machinery, as also Floating Bodies, Carriages, and other Locomotive Machines and Instruments. To Thomas Stanope Hollond, city of London.

23. July 16. For certain Improvements in the Method or Apparatus for generating Carburetted Hydrogen Gas and in purifying the same. To Henry Pinkus, Parish of St James's, Westminster.

24. August 5. For an Improvement or Improvements in Machines adapted for Spinning, Doubling, Twisting, Roving, or preparing Cotton and other Fibrous Substances. To Maurice de Jongh, county of Lancaster.

Art. XXIX.—CELESTIAL PHENOMENA,

From October 1st, 1828, to January 1st, 1829. 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.	
3	3	14	58	☽ ☌ 1 α ♋ ☽ 39′ N.
3	4	32	43	☽ ☌ 2 α ♋ ☽ 17′ N.
4	12	28	43	☽ ☌ π ♌ 8′ S.
5				♅ Stationary.
6	14	56	51	☽ ☌ υ ♌ ☽ 66′ N.
7				♀ Greatest Elong.
8	12	18		● New Moon.

Sun Eclipsed (Invisible at Greenwich.) ☌ at 12h 18′ 45″ in Long. 6s 15° 40′ 15″. ☽'s Lat. 6½′ N. The Sun will be centrally eclipsed in the Meridian at 12h 23′ 30″ in E. Long. 174° 6′ 30″, and South Lat. 13° 7½′.

D.	H.	M.	S.	
9	23	11	5	☽ ☌ λ ♍ ☽ 66′ N.
11	8	42	41	☽ ☌ 4 ζ ♎ ☽ 51′ N.
11	17	54	7	☽ ☌ θ ♎ ☽ 2′ S.
12	10	2	48	☽ ☌ φ Oph. ☽ 72′ S.
13	5			♀ ☌ ε ♌
15	18	47		☽ First Quarter.
16	9	50	39	☽ ☌ β ♑ ☽ 30′ N.
18	11	14	1	☽ ☌ θ ♒ ☽ 65′ N.
21	9	15		♅ □ ☉
21	11	54	2	☽ ☌ ι ♓ ☽ 55′ S.
21	16	36	24	☽ ☌ ζ ♓ ☽ 9′ N.
22	6	27	14	☽ ☌ ο ♓ ☽ 51′ N.
22	13	12		○ Full Moon.
22	22	32		☉ enters ♏
23				☿ Greatest Elong.
25	2			♀ ☌ σ ♌ ☽
25	2	59	4	☽ ☌ 1 δ ♉ ☽ 5′ N.
25	3	29	48	☽ ☌ 2 δ ♉ ☽ 13′ N.
26	17			♀ ☌ τ ♌
26	23			♄ □ ☉
30	4	34		☾ Last Quarter.
30	11	12	9	☽ ☌ 1 α ♋ ☽ 41′ N.
30	12	29	47	☽ ☌ 2 α ♋ ☽ 14′ N.
31	10	30	56	☽ ☌ ο ♌ ☽ 32′ S.
31	20	27	58	☽ ☌ π ♌ ☽ 6′ S.

NOVEMBER.

D.	H.	M.	S.	
1	4			♀ ☌ β ♍
2				☿ Stationary.
5	10	15		♂ □ ☉
6	7	0	33	☽ ☌ λ ♍ ☽ 66′ N.
7	3	4		● New Moon.
7	15	57	4	☽ ☌ 4 ζ ♎ ☽ 49′ N.
7	23			♀ ☌ η ♍
8	0	56	58	☽ ☌ θ ♎ 4′ S.
10	4			☿ ☌ κ ♎
12	15	10	34	☽ ☌ β ♑ ☽ 24′ N.
13	0			♀ ☌ γ ♍
13	9			☿ Inf. ☌ ☉
14	1	48		☽ First Quarter.
14	17			♂ ☌ γ ♍
14	17	7	14	☽ ☌ θ ♒ ☽ 59′ N.
15				♄ Stationary.
16	20	45		♃ ☌ ☉
17	8			♂ ☌ δ ♑
17	19	44	10	☽ ☌ ι ♓ ☽ 58′ S.
18	0	34	6	☽ ☌ ζ ♓ ☽ 7′ N.
18	14	45	33	☽ ☌ ο ♓ ☽ 49′ N.
19	12			♀ ☌ θ ♍
21	2	40		○ Full Moon.

D.	H.	M.	S.	
21	12	8	3	☽ ☌ 1 δ ♉ ☽ 8′ N.
21	12	38	48	☽ ☌ 2 δ ♉ ☽ 16′ N.
23				☿ Stationary.
26	19	17	3	☽ ☌ 1 α ♋ ☽ 51′ N.
26	20	34	17	☽ ☌ 2 α ♋ ☽ 28′ N.
27	13	44	8	☽ ☌ ξ ♌ ☽ 66′ S.
27	18	32	19	☽ ☌ ο ♌ ☽ 22′ S.
28	4	30	8	☽ ☌ π ♌ ☽ 4′ N.
29	1	44		☾ Last Quarter.
30	7	34	20	☽ ☌ ν ♌ ☽ 63′ N.
30	7			♃ λ ♎

DECEMBER.

D.	H.	M.	S.	
1				☿ Greatest Elong.
3	13			♀ ☌ κ ♍
3	13			☽ ☌ ♀
4	6			☿ ☌ 4 ζ ♎
5	3			☽ ☌ ☿
5	1	6	0	☽ ☌ 4 ζ ♎ ☽ 50′ N.
5	10	0	24	☽ ☌ θ ♎ ☽ 4′ S.
6	16	14		● New Moon.
9	17			☿ ☌ ♃
9	20	25	29	☽ ☌ β ♑ ☽ 14′ N.
10	6			☿ ☌ 1 β ♏
10	6			☿ ☌ 2 β ♏
11	10			☿ ☌ ν ♏
11	22	18	50	☽ ☌ θ ♒ ☽ 46′ N.
12	12			♂ ☌ λ ♒
13	9	39		☽ First Quarter.
13	11			♃ 1 β ♏
13	12			♃ 2 β ♏
15	1	12	56	☽ ☌ ι ♓ ☽ 69′ N.
18	19	27	6	☽ ☌ 1 δ ♉ ☽ 7′ N.
18	19	58	21	☽ ☌ 2 δ ♉ ☽ 14′ N.
20	6			♀ ☌ 4 ζ ♎
20	7			♃ ☌ ν ♏
20	18	28		○ Full Moon.
21	1			♂ ☌ φ ♒
21	7	22		☉ enters ♑
23	6			☿ B Oph.
24	2	49	24	☽ ☌ 1 α ♋ ☽ 63′ N.
24	4	6	12	☽ ☌ 2 α ♋ ☽ 41′ N.
25	11	54	57	☽ ☌ π ♌ ☽ 19′ N.
26	17			♀ ☌ 1 β ♏
26	17			♀ ☌ 2 β ♏
28	0			♀ ☌ ν ♏

Times of the Planets passing the Meridian.

OCTOBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	h.	′	h	′	h	′	h	′	h	′	h	′
1	1	4	21	6	7	5	2	21	19	46	7	31
7	1	14	21	7	6	58	2	4	19	26	7	9
13	1	23	21	9	6	51	1	46	19	6	6	47
19	1	30	21	11	6	44	1	29	18	45	6	24
25	1	32	21	13	6	36	1	11	18	23	6	2

NOVEMBER.

1	1	22	21	15	6	28	0	51	17	57	5	36
7	0	53	21	17	6	20	0	32	17	33	5	12
13	0	4	21	18	6	11	0	13	17	9	4	49
19	23	9	21	19	6	2	23	51	16	44	4	25
25	22	44	21	21	5	53	23	31	16	19	4	1

DECEMBER.

1	22	38	21	22	5	43	23	10	15	52	3	36
7	22	42	21	23	5	32	22	50	15	26	3	12
13	22	50	21	25	5	21	22	29	14	58	2	47
19	23	0	21	28	5	10	22	7	14	30	2	20
25	23	13	21	31	4	59	21	46	14	2	1	56

Declination of the Planets.

OCTOBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	°	′	°	′	°	′	°	′	°	′	°	′
1	10	46 S.	12	34N.	24	54 S.	15	33 S.	19	48N.	21	5 S.
7	14	29	11	16	24	6	15	54	19	42	21	4
13	17	42	9	42	23	11	16	16	19	38	21	4
19	20	18	7	52	22	11	16	38	19	34	21	3
25	22	7	5	50	21	4	16	59	19	31	21	2

D.	° ′	° ′	° ′	° ′	° ′	° ′
			NOVEMBER.			
1	22 50 S.	3 14 N.	19 39 S.	17 24 S.	19 29 N.	21 1 S.
7	21 34	0 50 N.	18 21	17 45	19 28	20 59
13	18 7	1 39 S.	16 57	18 5	19 27	20 58
19	14 35	4 12	15 29	18 25	19 28	20 55
25	13 46	6 45	13 56	18 44	19 30	20 52
			DECEMBER.			
1	15 15 S.	9 16 S.	12 20 S.	19 2 S.	19 33 N.	20 48 S.
7	17 39	11 43	10 40	19 19	19 37	20 44
13	20 6	14 1	8 57	19 36	19 42	20 41
19	22 12	16 9	7 13	19 52	19 47	20 37
25	23 43	18 4	5 27	20 6	19 53	20 33

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a celestial globe, and to determine their times of rising and setting.

Art. XXX.—*Summary of Meteorological Observations made at Kendal in June, July, and August* 1828. By Mr Samuel Marshall. Communicated by the Author.

State of the Barometer, Thermometer, &c. in Kendal for June 1828.

	Inches.
Barometer.	
Maximum on the 26th, - - - -	30.09
Minimum on the 5th, - - - -	29.08
Mean height, - - - -	29.78
Thermometer.	
Maximum on the 28th, - - -	81.5°
Minimum on the 7th, - - - -	44°
Mean height, - - - - -	59.07°

Quantity of rain, 3.078 inches.
Number of rainy days, 11.
Prevalent wind, west.

The weather in this month has been mostly sultry, and we have had more thunder than usual in June. The wind from the east has prevailed more than is generally the case in summer, and has been very sultry. The barometer has experienced considerable fluctuations, and the average temperature is greater than that of the corresponding month in the last year, and the prevalent wind in the same quarter. There have been 22.308 inches of rain taken during the present year, and in the first six months last year there were 30.304. To the end of June last year we had 87 wet days, and this year to the same period 92.

July.

	Inches.
Barometer.	
Maximum on the 31st, - - -	29.83
Minimum on the 14th, - -	29.12
Mean height, - - - -	29.50

Thermometer.	
Maximum on the 1st, - - - -	76°
Minimum on the 16th, - - - -	40°
Mean height, - - - -	58.62°

Quantity of rain, 3.502 inches.
Number of rainy days, 12.
Prevalent wind, west.

The steadiness of the barometer during this month has been very remarkable, when it is recollected that the weather has been changeable. The variations have scarcely equalled ¾ inch. The temperature for the month is much less than usual in July. The heat has not been equal to that of last month, the thermometer having never been so high as 70°, except on the 1st and 2d, and the mean for the month is less than that of June, which was 59.07°. It has happened through the month that we have generally had an alternation of three days wet, and four or five fine weather. We have had frequent thunder storms, the most severe of which happened on the 12th, and 1.104 inch of rain was measured the following morning. The winds have been mostly gentle, and frequently in the N. N.E. and N.W. about the middle of the month, though that from the west prevailed for nine days during the month. The wind was from the N.W. six days, N.E. five, N. four, from S.W. six, and S. one day.

August.

Barometer.	Inches.
Maximum on the 26th, - - -	30.14
Minimum on the 10th, - - -	28.89
Mean height, - - -	29.65
Thermometer.	
Maximum on the 30th, - - -	73°
Minimum on the 16th, - - - -	40°
Mean height, - - - -	58.25°

Quantity of rain, 5.581 inches
Number of rainy days, 17.
Prevalent wind, west.

Since the 23d of the month, the weather has been as favourable for the labours of the harvest as could be wished, uniformly clear and fine without rain, and the thermometer and barometer both high. From the beginning of the month to the 23d, the weather was mostly cold and rainy, though we have by no means had the heavy rains or floods so prevalent through most of the nation, and the grain cannot be said to have suffered materially. We had thunder storms about the beginning of the month, and the most violent on the 8th, when three horses in a stage coach, a few miles from this town, were killed, and a passenger seriously injured. The W. and S.W. winds have prevailed during twenty-three days, that from the W. thirteen, and from the S.W. ten days. The quantity of rain for the past eight months in this year is 31.391 inches, which is about an inch above the average quantity for the eight months ending in August, calculating from the quantity for the last four years.

ART. XXXI.—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 1828.

D. of Week.	Day of Month.	Thermometer. Morn.	Thermometer. Even.	Thermometer. Mean.	Register Therm. Min.	Register Therm. Max.	Register Therm. Mean.	Barometer. Morn.	Barometer. Even.	Rain.
S.	1	60	53	56.5	48	63	55.5	29.58	29.54	.09
M.	2	57	49	53	45	61	53	29.37	29.51	
T.	3	57	51	54	46	59	52.5	29.57	29.25	
W	4	57	47	52	44	60	52	29.07	28.98	.32
T.	5	54	47	50.5	44	54	49	29.08	29.25	.09
F.	6	52	48	50	42	54	48	29.36	29.57	
S.	7	57	46	51.5	45	59	52	29.74	29.82	
S.	8	57	50	53.5	43	64	53.5	29.88	29.93	
M.	9	60	54	57	48	62	55	29.95	29.92	
T.	10	63	53	58	51	64	57.5	29.92	29.86	
W	11	58	54	56	52	64	58	29.90	29.91	
T.	12	62	56	59	51	65	58	29.95	30.00	
F.	13	64	54	59	49	67	58	29.98	30.06	
S.	14	60	47	53.5	47	66	56.5	30.11	30.11	
S.	15	50	50	50	44	53	48.5	30.01	29.95	.13
M.	16	54	52	53	48	61	54.5	29.81	29.73	.16
T.	17	52	52	52	48	57	52.5	29.60	29.38	
W.	18	62	56	59	50	66	58	29.38	29.45	
T.	19	67	58	62.5	52	68	60	29.50	29.60	
F.	20	65	57	61	54	70	62	29.61	29.57	
S	21	63	54	58.5	52	67	59.5	29.54	29.52	.02
S.	22	67	65	66	50	71	60.5	29.62	29.77	
M.	23	60	54	57	49	67	58	29.89	30.00	
T.	24	67	50	58.5	46	74	60	30.05	30.05	
W.	25	76	60	68	49	74	61.5	29.99	30.01	
T.	26	70	60	65	54	73	63.5	30.05	30.02	
F.	27	68	64	66	57	75	66	30.01	29.98	
S.	28	72	60	66	51	75	63	29.93	29.92	
S.	29	60	56	58	54	64	59	29.91	29.88	
M.	30	63	55	59	53	69	61	29.86	29.75	
	Sum,	1834	1612	1732	1466	1946	1706	89222	89147	.81
	Mean.	61.13	53.73	57.73	48.87	64.87	56.87	29.741	29.716	

JULY 1828.

D. of Week.	D. of Mon.	Thermometer. Morn.	Thermometer. Even	Thermometer. Mean.	Register Therm. Min.	Register Therm. Max.	Register Therm. Mean.	Barometer. Morn.	Barometer. Even.	Rain.
T.	1	58	56	57	53	61	57	29.65	29.55	.43
W.	2	64	62	63	51	67	59	29.45	29.41	.18
T.	3	68	61	64.5	56	72	64	29.52	29.55	
F.	4	70	60	65	55	71	63	29.37	29.45	
S.	5	68	54	61	56	71	63.5	29.38	29.42	.07
S.	6	64	54	59	50	67	58.5	29.44	29.57	
M.	7	64	55	59.5	47	63	55	29.63	29.68	.06
T.	8	64	58	61	49	66	57.5	29.67	29.64	
W.	9	62	56	59	55	64	59.5	29.60	29.52	
T.	10	65	60	62.5	44	70	57	29.55	29.62	
F.	11	64	60	62	54	72	63	29.63	29.55	2.00
S.	12	54	57	55.5	52	60	56	29.38	29.24	.63
S.	13	54	56	55	51	59	55	29.16	29.11	.13
M.	14	56	55	55.5	53	58	55.5	29.05	29.32	
T.	15	62	50	56	50	64	57	29.51	29.58	
W.	16	67	56	61.5	46	70	58	29.53	29.48	
T.	17	67	59	63	50	69	59.5	29.42	29.43	
F.	18	66	59	62.5	57	67	62	29.28	29.28	.05
S.	19	62	54	58	52	69	60.5	29.21	29.25	
S.	20	67	53	60	50	70	60	29.29	29.23	
M.	21	61	58	59.5	49	61	55	29.28	29.28	.44
T.	22	67	55	61	53	67	60	29.29	29.36	.08
W.	23	62	58	60	50	65	57.5	29.40	29.40	.04
T.	24	63	56	59.5	52	63	57.5	29.41	29.48	
F.	25	60	56	58	53	62	57.5	29.42	29.49	
S.	26	58	52	55	45	58	51.5	29.58	29.65	
S.	27	58	51	54.5	47	60	53.5	29.75	29.86	
M.	28	60	50	55	45	63	54	29.90	29.78	.41
T.	29	57	52	54.5	42	59	50.5	29.68	29.72	.05
W.	30	59	53	56	47	63	55	29.74	29.79	
T.	31	58	54	56	46	62	54	29.74	29.68	
		1929	1730	1829.5	1560	2013	1786.5	913.94	914.37	4.57
		62.22	55.80	59·0	50.32	64.93	57.63	29.48	29.50	

AUGUST 1828.

D. of Week.	D. of Mon.	Thermometer. Morn.	Thermometer. Even.	Thermometer. Mean.	Register Therm. Min.	Register Therm. Max.	Register Therm. Mean.	Barometer. Morn.	Barometer. Even.	Rain.
F.	1	60	58	59	48	62	55	29.52	29.47	.07
S.	2	63	53	58	53	64	58.5	29.40	29.25	.15
S.	3	60	55	57.5	45	64	54.5	29.21	29.15	.50
M.	4	61	53	57	51	66	58.5	29.16	29.15	
T.	5	64	56	60	47	66	56.5	29.20	29.27	.06
W.	6	59	54	56.5	49	65	57	29.28	29.29	.26
T.	7	59	52	55.5	51	63	57	29.33	29.36	
F.	8	60	56	58	48	62	55	29.23	29.34	.43
S.	9	59	57	58	49	65	57	29.05	28.87	.59
S.	10	60	56	58	53	63	58	29.02	29.16	.12
M.	11	62	54	58	52	64	58	29.25	29.33	.21
T.	12	65	54	59.5	46	65	55.5	29·42	29.57	.35
W.	13	56	53	54.5	49	58	53.5	29.66	29.67	
T.	14	56	51	53.5	48	58	53	29.67	29.69	
F.	15	55	52	53.5	45	58	51.5	29.69	29.69	
S.	16	61	60	60.5	38	65	51.5	29.65	29.45	.17
S.	17	63	56	59.5	38	65	51.5	29.45	29.40	.10
M.	18	62	53	57.5	50	67	58.5	29.43	29.73	·15
T.	19	61	59	60	50	60	55	29.82	29.70	
W.	20	63	53	58	54	65	59.5	29.59	29.55	.18
T.	21	61	53	57	47	64	55.5	29.49	29.33	
F.	22	62	54	58	50	65	57.5	29.47	29.77	
S.	23	63	54	58.5	47	66	56.5	29.81	29.85	
S.	24	65	56	60.5	50	68	59	29.80	29.96	
M.	25	63	56	59.5	47	69	58	30.10	30.13	
T.	26	76	62	66	51	75	63	30.07	30.09	
W.	27	71	61	66	53	76	64.5	30:07	30.05	
T.	28	70	58	64	49	74	61.5	30.02	30.05	
F.	29	69	58	63.5	49	74	61.5	30.08	30.16	
S.	30	63	55	59	52	63	57.5	30.20	30.16	.09
S.	31	59	54	56.5	50	64	57	30.14	30.03	
		1925	1716	1820.5	1509	2023	1766	917.26	928.61	3.43
		62.10	55.35	58.67	48.68	65.26	56.97	29.59	29.38	

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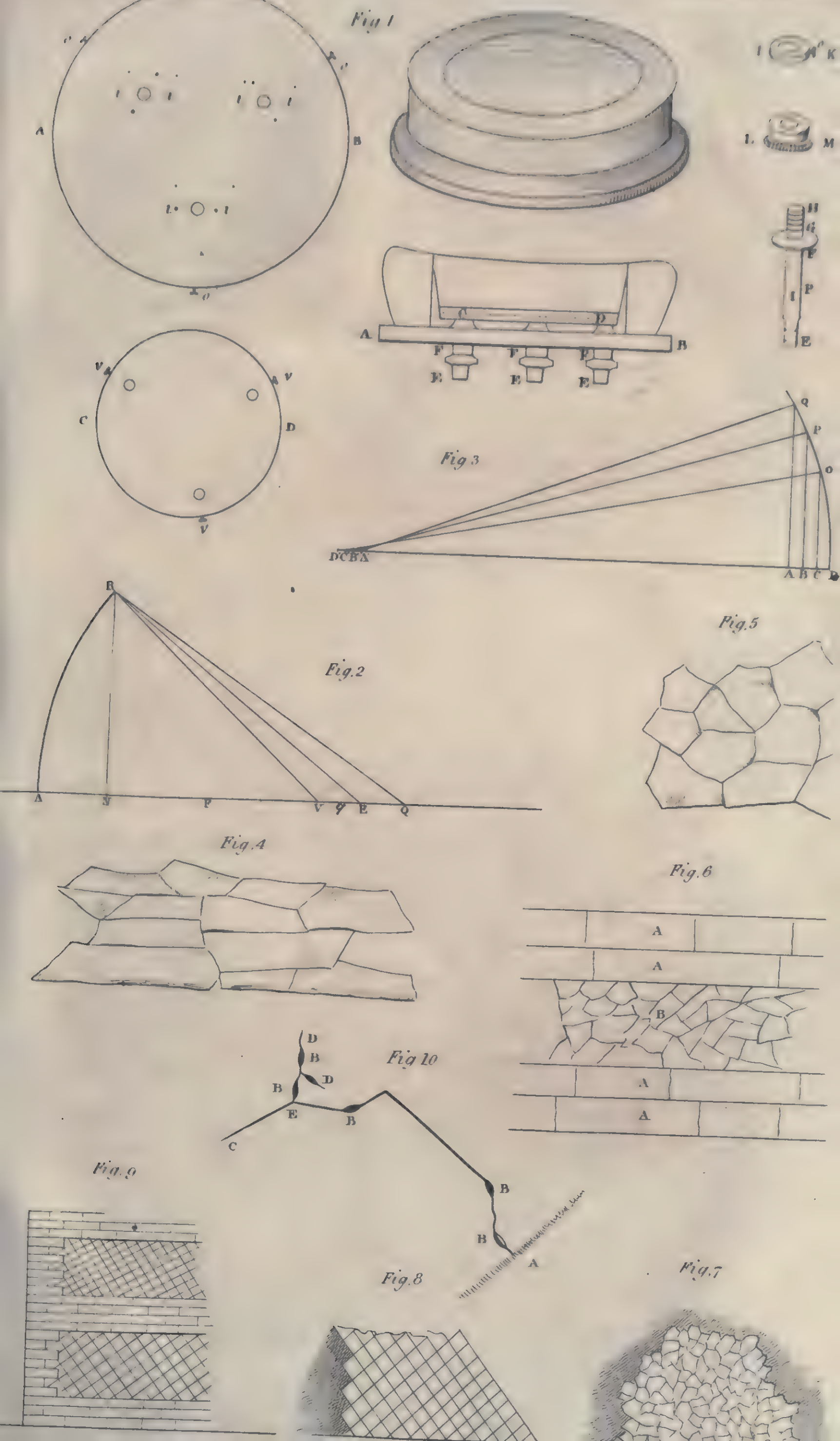
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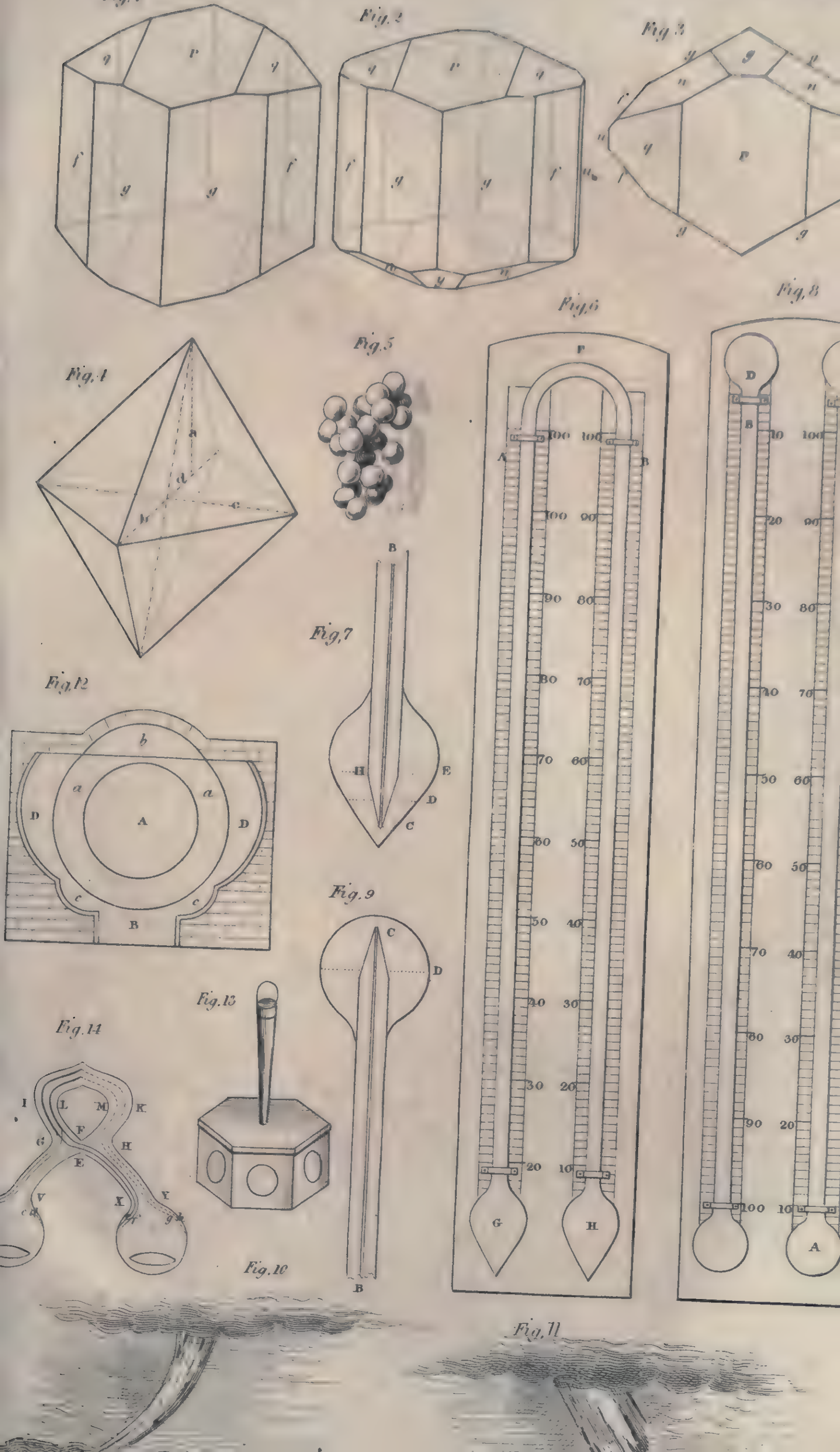

Fig. 1
Fig. 2
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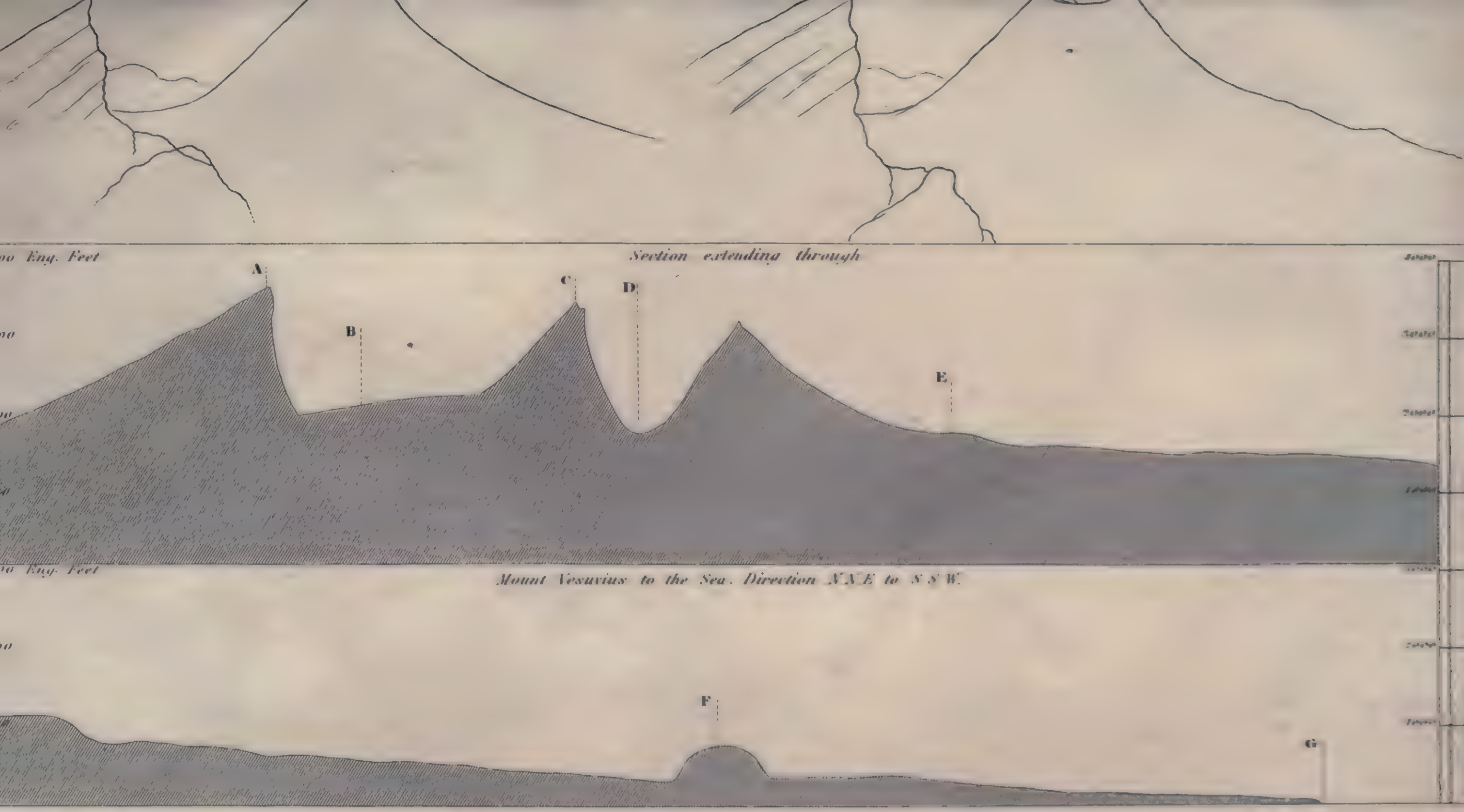

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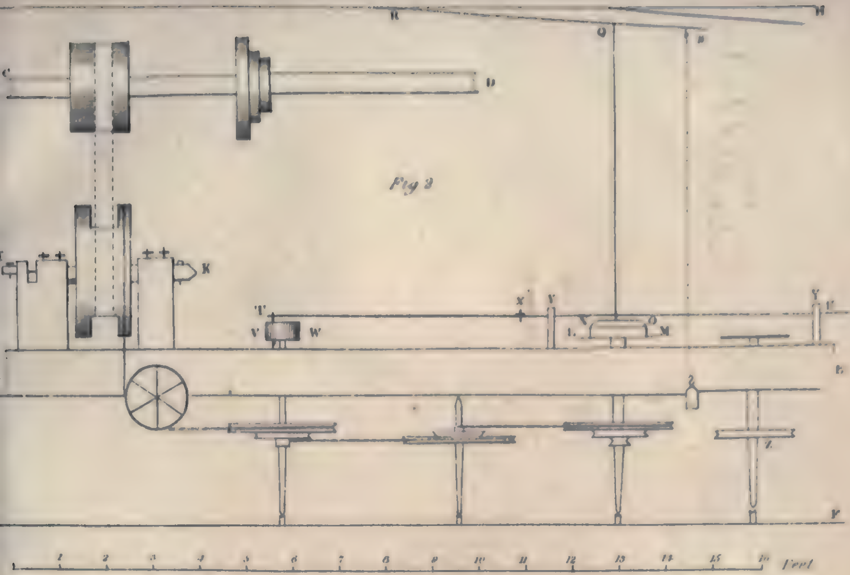

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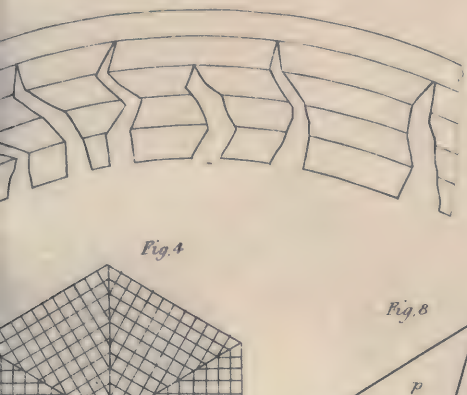

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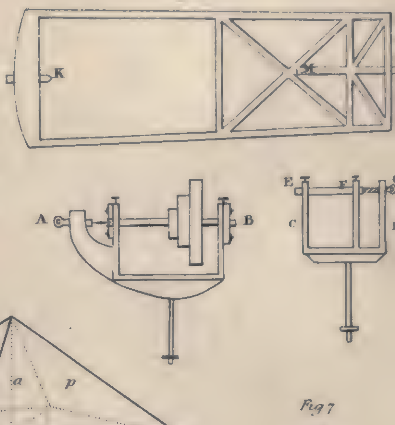

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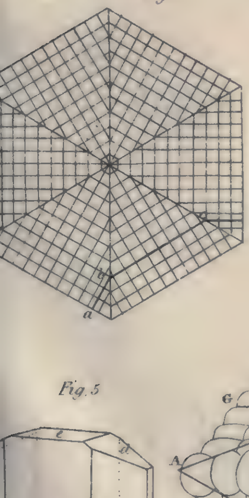

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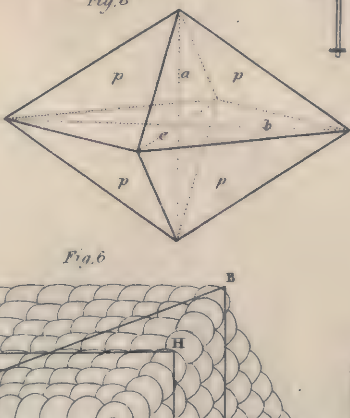

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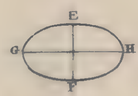

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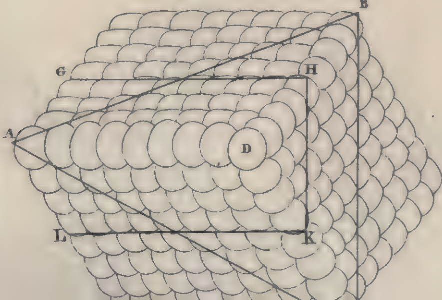

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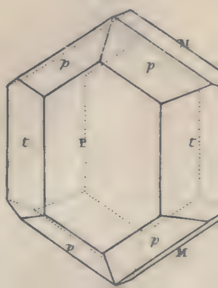

Fig.5

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