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No. VI.

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ART. I.—*Abstract of Experiments on the Consolidation of the Strata of the Earth, made by* SIR JAMES HALL, Bart. F. R. S. Lond. and Edin., *with Notices of his former Writings on Geological Subjects.*

WE have great pleasure in presenting our readers with an abstract of a paper lately read to the Royal Society of Edinburgh by Sir James Hall, on the consolidation of the strata of the earth; and we recommend their attention to this notice with the more earnestness, because the volume in which the paper will be published at length, may perhaps not appear for some time, and is, moreover, by its nature, little calculated for that rapid and extensive circulation which the ardour of modern curiosity demands.

Sir James Hall is well known to the scientific world as a strenuous supporter of the Huttonian Theory, and as the philosopher who has most successfully attempted to rest the science of geology on the basis of experiment. As his discoveries, however, have been published at long intervals, and in a form not very accessible to the generality of readers, we conceive we shall be rendering a service to science, by giving a brief sketch of the principal results to which those investigations of our ingenious countryman have led.

Early in 1790, not long after Dr Hutton had announced his Theory of the Earth, Sir James Hall, who had declared himself friendly to the new doctrines, came forward to grapple with one of the most formidable difficulties which were urged against them. In the History of the Royal Society, Vol. iii. p. 8. *Edinburgh Transactions*, there is given a short abstract of two papers on the formation of granite. It is to be regretted, that these papers should not have been given at length. The abstract, however, is sufficiently curious, and well deserving of the attention of any experimentalist, who may be engaged in attempts to imitate nature in the formation of crystallised rocks. We have only room for a short extract:—

"In granites, which contain quartz and feldspar, it frequently occurs, that the feldspar is seen with the form of its crystals distinctly defined, whilst the quartz is a confused and irregular mass, being almost universally moulded on the crystals of feldspar. Now, were it true that all granite is formed by fusion, the very contrary, it would seem, ought always to take place, as feldspar is very easily melted, and quartz resists the greatest efforts of heat that have hitherto been applied to it.

"The difficulty is thus obviated: It is well known, that when quartz and feldspar are pounded and mixed together, the mixture may, with difficulty, be melted and run into a kind of glass, the feldspar serving as a flux to the quartz. The same may be stated in another way, by considering the feldspar, when melted, as a fluid, in which, as a menstruum, the quartz is dissolved; and in this view we may expect, by analogy, that phenomena, similar to those of the solution of salt in water, should take place. Now it is certain, that when excessive cold is applied to the salt water, the water is frozen to the exclusion of the salt, the ice obtained yielding fresh water when melted, and the salt, when the experiment is pushed to the utmost, separating from it in the form of sand. Why should not the same thing happen in the solution of quartz in liquid feldspar, when the mass is allowed to cool below the point of congelation of the menstruum? The feldspar may crystallise separately from the quartz, as we have seen pure ice formed separately from the salt; in both cases, the *congelation of the solvent* being *simultaneous* to that of the dissolved substance. Hence the crystals may mutually interfere with each others forms, and we may as naturally expect to see quartz moulded on crystals of feldspar, as the reverse."

Sir James then discusses the question, as to the effects of slow cooling, in preventing the return of the fused substance to a state of glass—and then advances the following very ingenious views, which are incapable of abridgement.

"If quartz, mica, feldspar, schorl, garnet, &c. happen to be melted together, the most fusible substance of them all may be considered as the menstruum in which all the rest are dissolved, and we may suppose, that these various dissolved substances may differ amongst themselves in their properties of solution, as salts differ from one another, so that some of them may be more soluble, when very much heated, than when it is comparatively cold, and others may be as soluble in it, when little warmer than its point of congelation, as when raised to a much higher temperature. If then we say, for example, that the congealing point of the solvent is 1000 degrees of Fahrenheit, and if the solution is at the temperature of 2000, we may conceive one portion of the matter dissolved as held by the simple dissolving power of the menstruum, and another portion as held by means of its elevated temperature. When, therefore, a mass of this kind is allowed to cool *very slowly*, as we may suppose must be the case with liquid granite in the bowels of the earth, those substances held in solution by the *heat* of the solvent, will first separate, and, being formed in a liquid, will assume their crystalline forms with perfect regularity; whereas those substances, which were held by the menstruum, simply as a fluid, will not separate till the congelation of the solvent itself takes place, when the crystals of the various substances will intermix and confound the regularity of form, which each would have assumed, if left to itself. In this manner, one of the most common kinds of granite will be produced, consisting of perfect crystals of schorl, mica, or garnet, inclosed in a confused mass of quartz and schorl."

These theoretical views, whether just or otherwise, it must be admitted, are highly curious and philosophical, and are well deserving of being put to those experimental tests, which no man knows better how to devise than Sir James himself: And as very slow cooling, or, which is the same thing, a perfect command of the nicest regulation of high heats, is indispensable to their success, we are rejoiced to hear that he has invented an instrument, which, we are told, accomplishes this great desideratum completely. We look very anxiously, therefore, to his publishing some account of it, even though he should not have any very decisive results, as to its power of producing imitations of crystallised rocks. Such an instrument, on many other accounts, is a desideratum in practical chemistry, and the scientific world are entitled to be put in possession of it forthwith.

In the *Edinburgh Transactions* for 1798 (vol. v. p. 23.) was given an account of a series of experiments, completely establishing the identity of whinstone and lava. By this analogy the most important aid was afforded to the Huttonian Theory.

It had been stated, that, whinstone, like the granite above mentioned, when melted and allowed to cool again, always became glass, and did not return to stone as Dr Hutton's Theory required. Sir James Hall, however, conceived that nature would operate in this case by slow degrees, and that the temperature of the melted stone, when occurring in vast quantities, would be gradually, and not suddenly reduced. He imagined that the effect of this would be, to allow the fused mass to remain for a sufficient length of time, during its descent through the various stages of heat, *in that particular pitch of temperature required by its nature for its assuming a crystalline texture.* His experiments fully proved the justice of these ingenious ideas; and we believe there is, in consequence, now but one opinion as to the igneous origin of the whole of this class of rocks.

The most formidable objection, however, to the Huttonian Theory still remained, until Sir James Hall removed it by the same philosophical line of inquiry. Dr Hutton had asserted, that calcareous rocks, like every other, had been subjected to the action of heat. But it was well known that when heat was applied to this class of rocks, the carbonic acid was driven off in the shape of gas, and the remaining quicklime became infusible. Dr Hutton, indeed, had answered this, by suggesting that the pressure of the superincumbent ocean was sufficient to confine the carbonic acid, and to cause it to act as a flux on the quicklime. This theory, however ingenious, was so abundantly gratuitous, that it by no means satisfied even his own disciples. During his lifetime he discouraged the experimental investigation of the subject; but no sooner was all delicacy on the subject at an end by Dr Hutton's death, than Sir James Hall commenced a series of experiments, which in the end set the question completely at rest. He ascertained, by numerous experiments, that carbonate of lime might readily be fused when exposed to heat, if it were at the same time under a pressure not greater than Dr Hutton's Theory required, or about a mile and a half of sea. These experiments, in which the subject is treated in a very masterly way, will be found in the sixth volume of the *Edinburgh Transactions.* In the words of Mr Playfair, it may be truly said of them, "that, independently of all theory, they have narrowed the circle of prejudice and error."

So far Sir James had confined himself to the illustration of doctrines purely Huttonian; but we should be doing injustice to his sagacity and originality, were we to omit stating that he by no means followed Dr Hutton in all his ideas. On the contrary, he always considered Dr Hutton's explanation of the formation of valleys, and of the present appearance of the earth's surface generally, as quite incomplete. To account for these by the *diurnal* action of the elements, he thought altogether untenable. Sir James's theory, which is at once bold and original, is published in the *Edinburgh Transactions* for 1812, vol. vii. p. 139, 169, in two papers "on the Revolutions of the Earth's Surface," to which we call the attention of our readers. Valleys he conceives to have been formed at various times by a succession of heaves from below, which could not fail to rend and dislocate the solid crust of the globe in a thousand shapes, and to leave it as to the general features, in the rugged and irregular form it at present retains, an appearance totally inexplicable upon any view of diurnal action. But as it must be admitted that most mountains, valleys, plains, lakes, and other parts of the earth's surface, are evidently no longer in the precise state which they would have been left in by those violent heaves alluded to, he was led to inquire what other causes could be supposed to have reduced them to their present appearance. It was not long before he saw that a vast and overwhelming torrent or *debacle* (perhaps many more than one) must have passed over all those parts of the globe which he had an opportunity of examining. A little further reflection made it also evident to him, that if the Huttonian Theory were supposed to be true, such waves became a necessary consequence. For if great masses of strata be suddenly elevated to the surface from the bottom of a deep sea, waves proportionate in size must be produced, which, in their transient, but overwhelming course, would produce all the well known phenomena of a diluvian character. Professor Buckland's recent speculations on the same subject form a valuable addition to this most interesting theory.

The consolidation of sandstone was another very knotty point amongst the geologists—no theorist of either party, as far as we know, having attempted to account for it by any rational hypothesis. The present paper, which we shall now proceed to analyse, goes far to supply this deficiency.

Sir James Hall commences by some general observations on the nature of geological inquiries, and on the spirit in which experiments should be conducted, which have for their object to advance the boundaries of this science. These remarks we recommend strongly to any one engaged in similar pursuits; and we must be permitted to say, that the time is now surely come when it is incumbent on the supporters of the *aqueous* doctrine to show, *experimentally*, that their theory is equally capable of representing artificially the rocks which we see in nature, so many of which the Huttonians have successfully imitated.

Our author proceeds to say, it had often been urged, and apparently with good reason, against this branch of the Huttonian Theory, that no amount of heat applied to loose sand, gravel, or shingle, would occasion the parts to consolidate into a compact stone. And as all his experience led to the same conclusion, he saw that, unless, along with heat, some flux were introduced amongst the materials, no agglutination of the particles would take place. A striking circumstance, which he describes as occurring near Dunglass in East Lothian, having suggested to him the idea that the salt of the ocean might possibly have been the agent in causing the requisite degree of fusion, he instituted a series of experiments, the details of which he now brings before the Society. By these he shows, that this material, under various modifications, is fully adequate to explain the consolidation of the strata, and perhaps many other effects which we see on the surface of the Earth.

His success, from the first, was such as to promise the most satisfactory results; but various circumstances occurred to retard his progress.

"Whoever," he judiciously remarks, "has had any experience in the prosecution of new subjects of experimental inquiry, knows that, owing to his ignorance of the requisite adjustment of the proportions of the ingredients, and of other similar arrangements, he must depend, in a great degree, upon chance for the success of his first results, and that he must often submit to spend much time and labour upon a subject, even after it has been made out to his own satisfaction, before he has acquired sufficient command over its details to answer for the result of any particular experiment, so as to be able to produce it with confidence to the public."—pp. 5, 6.

The scene alluded to as having first excited Sir James' attention to this subject was on the borders of Lammermuir, "where

"A set of horizontal beds occur, consisting of a loose assemblage of rounded stones, intermixed with sand and gravel, which bear every appearance of having been deposited by water, and which, as to their general history, seem to have undergone no change since the overwhelming, though transient, agitations of water, of which I have frequently had occasion to speak in this Society.

"In the summer of 1812, as I was returning from visiting the granitic range which occurs in the water of Fasnet, in the hills of Lammermuir, and riding down the little valley of Aikengaw, which deeply indents this loose collection of gravel and shingle, about two miles above the village of Oldhamstocks, and at the distance of eight or ten miles from the sea, I was struck with astonishment on seeing one of these gravel banks, formed, as above described, of perfectly loose materials, traversed vertically by a dyke, which, in its middle, consisted of whinstone, and was flanked by solid conglomerate; but this solidity abated gradually till the conglutination of the rounded masses diminishing by degrees, the state of loose shingle and gravel was entirely restored on both sides. The agglutinated mass adjacent to the dyke bore no resemblance to the result of calcareous petrifaction; scarcely ever gave effervescence with acid; and, by its gradual termination, differed from any whinstone-dyke I have seen to penetrate the strata; for, in the ordinary case, the termination of the crystallite against the adjoining aggregate through which it passes, is almost always quite abrupt.

" About a hundred yards higher up the valley of Aikengaw, there occurs an agglutination similar to the last, though without any whin-dyke, and sufficiently strong to resist the elements, by which the surrounding matters had been washed away, leaving the pudding-stone, or agglutinated shingle, to stand up by itself, in a manner remarkable enough to have attracted the notice of the peasantry as something supernatural, since they have bestowed upon it the name of the Fairy's Castle.

" Farther up the stream, other agglutinations occur frequently, as we could see in little narrow glens cutting through the mass; and higher still, they are so numerous as to meet and convert the whole into one unbroken mass of pudding-stone, occupying all that is exposed to view.

" These very remarkable, and, to me at least, novel appearances, were the first which suggested the idea, that the consolidation not only of this class of conglomerates, but of sandstone in general, had been occasioned by the influence of some substance in a gaseous or aëriform state, driven by heat into the interstices between the loose particles of sand and gravel, where it had acted as a flux on the contiguous parts. On considering what this penetrating substance might be, and from whence it could have come, the following circumstance presented itself to my recollection at the moment, and promised to afford some assistance to these conjectures.

" A few miles lower down the valley in which the above facts were observed, at the distance of more than a mile from the sea, and between two and three hundred feet perpendicularly above it, there occurs a crag of sandstone, in which a numerous succession of strata are distinctly visible. Several of these beds have yielded much to the action of the air, and, in dry weather, exhibit a considerable white efflorescence, which has completely the taste of common salt; and so remarkable is this circumstance, that the rock has acquired, in the country, the name of Salt-Heugh.

" Here, then, it immediately occurred to me, was probably the source of an abundant supply of the elastic substance or fumigator, whose action as a flux had been pointed out by the agglutinations in Aikengaw above described.

" I conceived, that, if there were at the bottom of the sea a bed of sand and gravel, drenched with brine of full saturation, and that heat were applied to it from beneath, according to Dr Hutton's hypothesis, the first effect would be, to drive the water from the lowest portion of the sand, and to convert the salt which remained amongst it, together with the sand, into a dry cake. During this operation, or until the cake became quite dry, the absorption of latent heat would prevent the temperature from surpass-ing the boiling point of brine. But no sooner was this dryness accomplished, than, I imagined, the temperature of the mass would begin to rise above that pitch; the portion of it next the fire would gradually acquire a red-heat; that then the salt, being made by the heat in part to assume an elastic form, would be sent in fumes through the dry cake just described, and thus, by partially melting the contiguous particles, produce an agglutination.

"Such being my theoretical views, no time was lost in submitting them to the test of experiment. Taking it for granted that a quantity of sea-salt must frequently be formed and deposited, along with sand and gravel, at the bottom of the ocean, (in the manner I shall have occasion to describe at another stage of this paper), where the water has been collected by its superior specific gravity, in the form of brine, I proceeded to make the following experiments:—

"Dry salt was placed along with sand, sometimes in a separate layer, at the bottom of the crucible, and sometimes mixed throughout the experiment: the whole was then exposed to heat from below. I found that the salt was invariably sent in fumes through the loose mass, and by its action produced solid stone in a manner completely satisfactory, as illustrative of the facts in Aikengaw; and so as to give a good explanation of the production of sandstone in general.

"These artificial stones are of various degrees of durability and hardness;—some of them do not stand exposure to the elements, and crumble when immersed in water;—some resist exposure for years;—others are so soft as not to preserve their form for any length of time;—while some bear to be dressed by the chisel; and, it may be remarked generally, that, as far as the results of my experiments have been compared with natural sandstone, the same boundless variety exists in both cases. A striking instance of this resemblance occurs in the case of the Salt-heugh, the sandstone of which, when immersed in water, crumbles down, exactly in the same manner as those results of my experiments which taste much of salt.

"The fumes of the salt, no doubt, act, in all these cases, as a flux on the siliceous matter, and thus cement the adjacent particles together. The Society are, doubtless, well aware of the power of salt fumes in glazing pottery; and the analogy, I conceive, is complete. It is the application alone that is new.

"So far the results were satisfactory. But it next occurred, that it might be plausibly objected, that the presence of the superincumbent cool ocean would interfere with the process, on the principles of latent heat. To put this to the test, I proceeded to expose a quantity of sand, covered to the depth of several inches with common salt-water, to the heat of a furnace, and, as the liquid boiled away, replenished it from time to time by additions from the sea. Of course it gradually approached to a state of brine. But this proved a very tedious operation, requiring a continued ebullition, during three weeks, without ceasing, before it became sufficiently saturated with salt by the discharge of the fresh-water; and I thought it much easier, and no less satisfactory, to employ brine from the first, formed at once by loading the water with as much salt as it could dissolve, amounting to about one-third of its weight.

"The vessels employed in these early experiments, were the large black-lead crucibles used by the brass-founders. I filled the vessel, which was 18 inches high and 10 broad, nearly to the brim with brine of full saturation, the lower portion being occupied, to the depth of about 15 inches, with loose sand from the sea-shore, and thoroughly drenched with the brine. In order to have a view of the progress of the experiment, I placed an earthen-ware tube, about the size and shape of a gun-barrel, closed at bottom, and open at the top, in a vertical position, having its lower extremity immersed in the sand, and reaching to within about an inch of the bottom of the pot, while the other end rose a foot above the surface of the brine, and could be looked into without inconvenience.

"After a great number of experiments, furnishing an unbounded variety of results, I at length obtained a confirmation of the main object in view. I observed that the bottom of the porcelain barrel, and of course the sand in which it rested, became red-hot, whilst the brine, which, during the experiment, had been constantly replenished from a separate vessel, continued merely in a state of ebullition: the upper portion of the sand, drenched with the liquid, remained permanently quite loose, but the lower portion of the sand had formed itself into a solid cake.

"On allowing the whole to cool, after it had been exposed to a high heat for many hours, and breaking up the mass, I was delighted to find the result, occupying the lower part of the pot, possessed of all the qualities of a perfect sandstone, as may be seen in the specimens now presented to the Society. Whenever the heat was not maintained so long, the sandstone which resulted was less perfect in its structure, tasted strongly of salt, and sometimes crumbled to sand when placed in water.

"Many of these early experiments were accomplished with tolerable success. But still the result was somewhat precarious, and could not be announced with the confidence that I felt in presenting my former experiments to this Society.

"The cause of this uncertainty I traced to the chemical operation of the salt, acting as a flux upon the porcelain vessels employed. This very action, I was well aware, was the main agent and cause of our success, when kept within proper bounds; but, on being allowed to pass those limits, and to act on the containing vessel as well as on the experiment, it destroyed the vessel, and converted the whole into a confused mass of slag.

"After numberless unsuccessful attempts, and after returning again and again to the charge, with an interval sometimes of years, I at last met with a quality in some of the materials to me altogether unlooked for, by means of which may be obtained successful results, with scarcely any risk of failure.

"I found that the action of the salt upon the substances of the crucibles of clay, did not exert itself in the same manner upon iron; but that a large vessel of cast-iron, 18 inches deep by 10 wide, and a common gun-barrel welded up at the breech, and open at the top, enabled me to work with the heat of melting gold, without injuring the vessels, and at any time to produce a perfect freestone; thus satisfying our theoretical expectations.

"Similar results, in all respects, were produced by exposing pure pounded quartz to the action of the salt fumes,—and also when gravel, or any other mass of loose materials, was used instead of sand." pp. 6—12.

Sir James next proceeds to show, that if this theory of the consolidation of sandstone be admitted as sound, there is an adequate supply of salt to be looked for in nature, or at least of brine, which is nearly the same thing. He conceives, that in the Mediterranean, and other similar seas, where there is a greater evaporation from the surface than supply of fresh water by the rivers, rains, &c., the sea, at the bottom, will gradually approach to a state of brine. And even, without entering into any such theoretical explanation of how this supply of salt is formed, he thinks it sufficient that there are known to exist in the world many large districts of rock-salt, lakes and rivers of salt water, and numerous brine-springs in this and other countries.

It was objected, as Sir James tells us, to his Theory, by a member of the Royal Society, that the influence of the superincumbent ocean would, in all cases, counteract, by its coolness, the effect of the heat, and prevent the formation of stone: but these experiments most distinctly prove, that this effect, however probable it certainly was, would not take place, since it was easy, by means of his device of the gun-barrel, to look into the heart of the experiment, and discover the red-hot sand under the water, while, at the same time, the temperature of the brine on the top was so low that the hand could be plunged into it without injury. But whenever the same experiment was tried with *fresh* water instead of brine, no exertion of heat ever produced a red heat. Nothing, certainly, in the history of chemical experiment, is more satisfactory than this; and the extreme simplicity of the contrivance by which so important a fact has been established, instead of diminishing, only adds to our admiration of that ingenuity which seems always to come to the assistance of some men just at the moment of need.

Sir James concludes his Paper by adverting to some other speculations which are not yet fully matured, but which he is in hopes, ere long, to lay before the public. "A simple allusion to one or two of these," he says, "may perhaps be received with indulgence."

"I conceive, that salt, in the state of fumes, and urged by a powerful heat, possibly also modified by pressure, or perhaps combined with other substances, may have penetrated a great variety of rocks, acting as a flux on some, as in basalt, granite, &c.; agglutinating others, as in the case of sandstone, pudding-stone, &c.; softening others, as in the case of contorted strata of greywacke. In many cases, too, I conceive that these fumes may have had the power of carrying along with them various other materials, such as metals in a sublimed state, which would in this way be introduced into rents, veins, and cavities, or may even have entered into the solid mass of the rocks, which I imagine these fumes may have had power to penetrate. I have already tried some experiments in pursuit of these ideas. Salt, for instance, has been mixed with oxide of iron, reduced to fine powder, and then exposed to heat along with quartzose sand. The iron, I found, was borne up along with the salt fumes. The sandstone, formed in this way, was deeply stained with iron, and other most curious appearances presented themselves.

"Every one who has seen a sandstone quarry, must have noticed evident traces of iron, the rock being stained in a great variety of ways; sometimes in parallel layers,—sometimes in concentric circles, or rather in portions of concentric spheres, like the coats of an onion,—and, generally speaking, disposed in a way not accountable by deposition from water. All these appearances I would account for, by supposing the rock, either at the moment of its agglutination into sandstone, or at some subsequent period, to have been penetrated by the fumes of salt, charged with iron, also in a state of vapour.

"I may mention one very curious result of my experiments with salt and iron, acting upon sand, namely, that, upon breaking up the specimen of artificial sandstone, an appearance often presents itself of incipient crystallisation, if I may use this term; a number of large, shining, parallel faces pervade the whole mass, and, by holding the specimen at the proper angle to the light, this appearance becomes very obvious. What the nature of these crystals is, I have not investigated; but as they very much resemble what we see in different kinds of sandstone, I am of opinion that they hold out a fair expectation, of our being able to produce many of the crystalline appearances with which we are familiar in nature.

"Common sea-salt, such as I have used, as is well known, is not pure muriate of soda; and, in my experiments, I have mixed various other substances with it. In Nature, we must suppose that various contaminating substances would in like manner occur, to diversify the phenomena; and, accordingly, we do find a boundless variety, in the aspect not only of sandstone, but of almost every kind of rock; and I am by no means without expectation, that, in the course of time, we shall be able to imitate in our laboratory as many of these varieties as we choose to exhibit.

I have long been engaged also in a series of experiments on the formation of *Crystallites,* the name by which, as I have before stated, every crystallised rock might, perhaps, be usefully distinguished in contradistinction to *Aggregates,* or those formed of fragments. This great object in experimental geology, I hope to accomplish by means of an instrument which I have long had in use, for the regulation of high heats, a description of which may probably soon be laid before the Society, together with some further results in support of the Huttonian Theory of the Earth."—pp. 15, 16.

We again repeat our earnest solicitation to Sir James Hall to make this invention known to the public. There is, we believe, at this moment, more than one chemist on the Continent,* if not in this country, engaged in the formation of crystals in imitation of nature; and as we know that the regulation of high heats is by far the most difficult part of the process, we trust that Sir James may be induced to lend the assistance of this valuable instrument to a subject which, it may be fairly presumed, he has as sincerely at heart as any man in the field.

Sir James Hall stands so high as an experimental geologist, if we may be allowed the expression, and his authority is now a-days so often quoted, that we think a reprint of all his papers, in a separate form, would be gratefully received by the scientific world.

Art. II.—*On some Phenomena of Vertical and of Lateral Mirage, observed at King George's Bastion, Leith.* An Extract of a Letter to the Editor, from Henry Home Blackadder, Esq. Surgeon, Med. Staff, H. P.

Close along the sea shore, to the north-east of the new Docks at Leith, there is an extensive bulwark, the central part of which is named King George's Bastion. This bulwark is

* See this *Journal,* vol. i. p. 375, and vol. ii. p. 129.

formed of huge blocks of cut sand-stone, and was intended both as a protection against the sea, and, if need should be, against the attacks of an enemy. When the weather is favourable, this bulwark affords an opportunity of witnessing most of the interesting phenomena, connected with what has been termed unusual atmospheric refraction. Near the centre of the range there is a solid stone tower, and from this to the eastern extremity, the appearances are observed to most advantage.

From the tower eastward, the bulwark forms a straight line to the distance of about 498 feet. It is eight feet in height, on the side next to the land, and has a foot-way upwards of two feet in breadth, and about three feet from the ground. At the top, the parapet is three feet wide, and has a slight inclination towards the sea.

When the weather is favourable, and that is not of rare occurrence, the top of the parapet has the appearance of a mirror, or rather of a sheet of ice, and, if in this state, another person stands or walks upon it, at a little distance, an inverted image is seen under him. If, while standing on the foot-way, another person stands on it also, but at some distance, with his face turned towards the sea, his image will appear opposite to him, giving the appearance of two persons talking, or saluting each other. If again, when standing on the foot-way, and looking in a direction from the tower, another person crosses the eastern extremity of the bulwark, passing through the water-gate, either to or from the sea, there is produced the appearance of two persons moving in opposite directions—constituting what has been termed a lateral mirage—first one is seen moving past, and then the other in an opposite direction, with some interval between them. In looking over the parapet, distant objects are seen variously modified, the mountains converted into immense bridges, &c.

On going to the eastern extremity of the bulwark, and directing the eye towards the tower, the latter appears curiously modified, part of it being as it were cut off, and brought down, so as to form another small and elegant tower, in the form of certain sepulchral monuments. See Plate I. Fig. 13.

Fig. 1

Fig. 3.

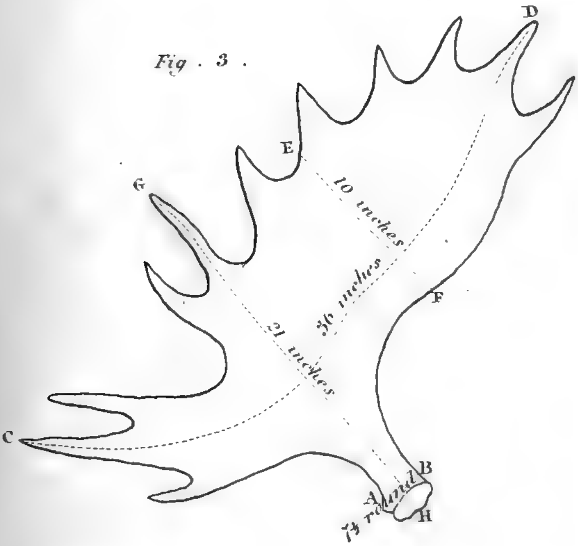
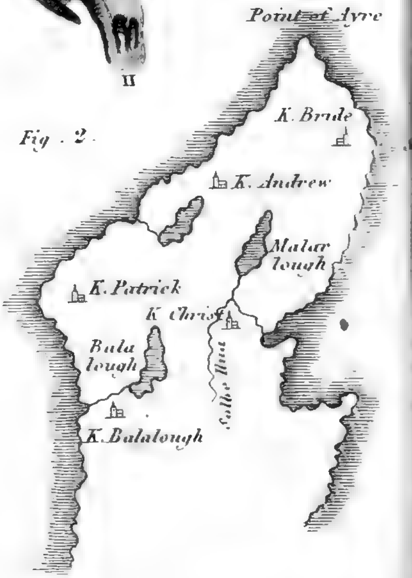
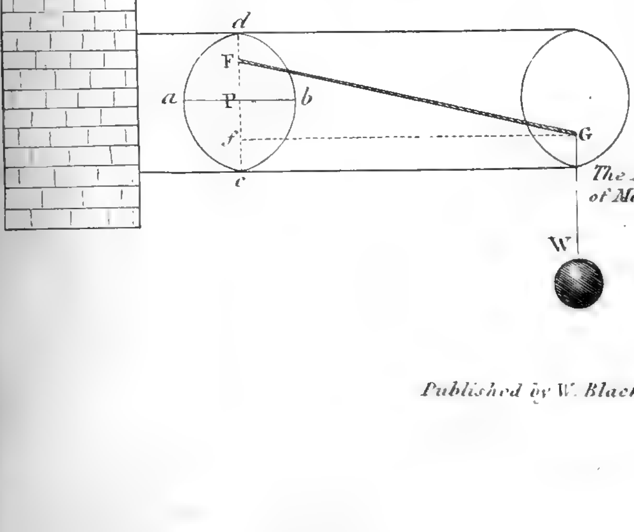


Fig. 2.



The Ancient Lakes now obliterated of the Isle of Man as they subsisted in the year 1656.

Fig. 4.



Published by W. Blackwood 1825.

At other times, it bears an exact resemblance to an ancient altar, the fire of which seems to burn with great intensity. At some distance beyond the tower, there is seen the chimney-top of a house for boiling pitch, or other purposes connected with the docks. When smoke issues from that chimney, the appearance represented in Fig. 14 was produced. The black waved lines under the smoke had a rapid vibratory motion, while the motion of that which represents the fire of the altar, was exactly similar (excepting in colour) to the flame of a strong fire. *

The accompanying outlines will render the above description sufficiently intelligible. Some hygrometrical and thermometrical observations, connected with this subject, may be brought forward on a future occasion.

ART. III.—*Account of the Circumstances connected with the Discovery of the Fossil Elk in the Isle of Man, which prove that this Animal is not Antediluvian, as many Naturalists and Antiquaries have supposed.* By SAMUEL HIBBERT, M. D. F. R. S. E. and M. G. S. Secretary to the Society of Scottish Antiquaries.

THERE are few subjects in Natural History more interesting than the circumstances connected with the discovery of those Fossil Animals, the several races of which are either foreign to the country and climate in which they are at present found, or have become wholly extinct. In reference to this curious investigation, the Irish Elk attracts no small share of attention. The zoologist inquires, whether animals of the same kind are still to be found on the surface of the globe, or have completely disappeared:—if the latter supposition be entertained, the antiquary proposes a question, at what era races of them might have existed? while the geologist contents himself with a solution of the great difficulty, whether their ex-

* A full detail of the principles, on which the phenomena of Vertical and Lateral Mirage depend, will be found in the *Edinburgh Encyclopædia*, ARTICLE *Optics*, vol. xv. p. 617.

tinction is not referable to a period so long prior to all historical records, as to claim for them an antediluvian origin. The last question is the one that I shall at present consider.

The first British naturalist who attracted the attention of philosophers to the Fossil Elk, was Sir Thomas Molyneux, who, in the year 1726, described it with far more accuracy than had been done before. He pronounced it to be of the genus Cervinum, or deer kind, and of the sort that carries broad or palmed horns, bearing a greater affinity to the buck or fallow-deer, than to the stag or rein-deer, which has round horns, branched without a palm. * He also observed, that the Irish elks were gregarious like the elks of Sweden, or the rein-deer of the Northern countries of Europe;—drawing this conclusion from the statement of a Mr Osborne, who, while he was trenching an orchard, found three heads and sets of horns in the compass of one acre of land. The same philosopher again remarked, that these animals were discovered from five to ten feet under ground, in a sort of marl.

These are the leading circumstances, with which we have been long acquainted, relative to the discovery of the Fossil Elk, and they are almost sufficient for any geologist to draw from them the conclusion, that the race of this animal, so far from being antediluvian, has either been but recently extinct, or even yet exists. † And, in fact, this was the very conclusion to which Sir Thomas Molyneux arrived, though he failed in his task of endeavouring to identify the Irish elk with the American moose-deer.

Still, there has not for a century been wanting geologists,

* An accurate representation, by Mr Burman of Douglas, of a fine head of the Elk, in his possession, was sent to Alexander Seton, Esq. an able Antiquary, who has obligingly permitted it to be engraved. (See Plate II, Fig. 1.) The dimensions to which the letters in the figure refer, are stated as follows: "From A to B, 6 feet 11 inches; from B to C, 5 feet two inches; from D to E, 2 feet 6 inches; from F to G, 1 foot 2 inches; from H to I, 1 foot 7½ inches; from N to O, 5 feet. Circumference at L K, 7¾ inches; circumference at the root C, 11 inches."

† Dr Knox was led to entertain this opinion, from different sources of observation, namely, from the anatomical structure of the animal, and its state of preservation.

who, in opposition to this plain statement of facts, have supposed that these Fossil remains were indicative of animals which had been destroyed by the universal deluge. Hence the transportation or drifting of their bones by an overwhelming torrent, into such insular tracts as Ireland and the Isle of Man. And, since the discovery of the bones in the Hyena Cave of Kirkdale, a similar conjecture has been hazarded by Professor Buckland,* though, from some subsequent conversation with Mr Weaver, he now seems inclined to reconsider the subject.

After these remarks, I shall proceed to describe the geological circumstances connected with the earthy deposits in which the elk is found.

A southerly, and far most considerable, portion of the Isle of Man is diversified by irregular mountainous ranges of clay slate, and micaceous schist. In this extensive district it has been affirmed that no remains of the elk are to be found; but that they only occur in the extensive flat on the north of the island, named the Curragh, which is characterized by a thick deposit of clay, marl, sand, and gravel. This is, however, a mistake. About a mile to to the north-west of the Tynwald Hill, at a short distance from the Peel River, there is a low marshy piece of ground from which large quantities of shell marl have been procured for the purposes of manure; and in this marl numerous bones of the elk have been observed in an imbedded state. But in the course of describing this site more particularly, I shall advert, in a very general manner, to the origin of the calcareous deposit in which these interesting relics have been found.

There are several evident indications in the vicinity of the Tynwald Hill of some very ancient lakes having been formed in the low sites of this westerly part of the island, the overflow from which was discharged into the sea by the channel that now forms the bed of the Peel River. The tributary torrents by which these lakes were supplied, had carried with them the disintegrated materials of the rocks among which they

* *Reliquiæ Diluvianæ,* page 180.

flowed, and, in the course of ages, had succeeded by this accumulation of earthy matter in excluding the water from these hollows, as well as in changing the course, or narrowing the bed of the river by which these lakes communicated with each other, and with the sea on the west. But another cause besides this will be found in most instances to have assisted in levelling the land, and as no one has more clearly explained this cause than Dr MacCulloch,* it would be an injustice to him not to give it in his own words. "Many fresh water shells," he observes, "breed in lakes, and even in the shallowest and smallest pools; and as their death and reproduction is very rapid in many cases, a considerable addition of solid matter is made to that which is brought in from the rocks and soil which the feeding waters act on in their courses. Such shells, therefore, produce calcareous beds, which are never, or rarely at least, much consolidated, but are known by the name of marl. This marl also varies in character, as the shells may have disappeared entirely, or it may be further intermixed with the clay or the sand introduced by the rivers."

The shell marl, which is accumulated in the low sites of ground near the Peel River, is of a milk-white colour, also, when dried, very light and porous. All the shelly parts are in such a comminuted state, and so mixed up with clay or sand, that I could not find a specimen in which the organic structure of the animals to which the marl owes its origin was preserved. The bones of the elk are said to be found about six to ten feet deep in this marl, and mixed along with them, particularly in the more superficial strata, are the remains of numerous aquatic plants, as of willows, ferns, reeds, &c. indicative of the ancient marshes which succeeded to the levelling of the land, and to which the elks appear to have resorted. In the upper beds the calcareous matter gradually lessens, showing that the gradual extinction of the race of fresh water shells kept pace with the filling up of the lake. A stratum of sand, the pure and nearly unmixed debris of the neighbouring hills,

* Article Organic Remains in Dr Brewster's *Encyclopædia*, vol. xv. p. 726

is superjacent to the shell marl, while a comparatively modern bed of peat covers the whole.

But a question is now naturally suggested—To what cause do the elks owe their inhumation in the marl?

Dr MacCulloch on this subject observes, that "these animals appear to be collected, as it were, into a herd; and generally the skeletons are entire, or, at least, if bones are wanting, there is no dispersion of them. Farther, it has been remarked, that they are generally in an erect position, and the common people of the country who have dug them out, and who have no hypothesis to serve, assert that their noses, when thus erect, are elevated as high as possible. The natural conclusion from these facts is, that this has been a herd suddenly surrounded by the materials in which the specimens now lie, so as to have been inclosed and preserved in their living attitudes. An inundation of water and gravel, or sand and mud, would explain this, when favoured by peculiar circumstances in the form of the land; while the preservation of the erect posture, no less than the very singular position of the nose, proves that the operation must have been gradual; the animal's last efforts having been those of keeping its head as long as possible above the flood." *

Now, this opinion would not, I think, have been advanced, if it were not for the misrepresentations of the labourers who had been employed in the marl pits of the Isle of Man, and who were consulted on the occasion. Nor does Dr MacCulloch offer his hypothesis with any great confidence, being himself doubtful how far the statements which he received were to be depended upon. For, how could the labourers affirm that the elk is generally found in an erect position, when an entire skeleton of this animal has never yet been discovered? I shall take another occasion to explain, that the specimen in the University of Edinburgh, generally conceived to be entire, is principally composed of dispersed bones. Again, in the vicinity of the Peel River, near the Tynwald Hill, the elk is found in a situation which is perfectly fatal to the notion that a herd

* See Article ORGANIC REMAINS in Dr Brewster's *Encyclopædia*, vol. xv. p. 727.

of animals of this kind was destroyed by immersion, or caught in a sudden and unexpected flood. For it is difficult to conceive of any ordinary torrent, however rapid it might be, which could have succeeded in preventing the elks on any such emergency from securing their escape by repairing to the numerous eminences, which are immediately contiguous to the marl pit in which their bones are at present found.

The hypothesis, then, that I would myself propose, is suggested by the circumstance remarked in Ireland, as well as in the Isle of Man, that the remains of the elk are commonly detected in marl,—or that they are comparatively rare in any other description of alluvial matter. For, may not a reasonable supposition be entertained, that this very general occurrence has a reference to some particular habits of the elk when alive? Now, I have often had occasion to remark, that the pools in which marl is apt to accumulate are often the very spots that are selected by graminivorous animals, particularly of the deer kind, as watering-places; but, whether the predilection which may be given to such pools, arises from calcareous matter being diffused through the water, or from some other quality, I will not hazard a conjecture. Nor would I build any hypothesis upon this result of my own experience, the truth of which remains to be determined by more experienced agriculturists than myself. I can only add, that much countenance is given to my opinion by several facts which have come to my knowledge. Thus, in the vicinity of Altringham, in Cheshire, remains of the common deer have been found imbedded in ancient marl: and from the marl of Wallisey Mere, the pool of which is in part filled up by a deposit of this kind, bones of similar animals were lately extracted.

When, therefore, we reflect, that the remains of elks are chiefly found in those ancient pools which have been gradually filled up by marl, the direct question is,—are we entitled to infer, from this general circumstance, that these animals have met with a *natural* rather than with a *violent* death? On this subject some light may be obtained by analogical examples. In my inquiries respecting the situations in which the red deer of Dunkeld are generally found, when they meet with a natural death, I have been assured that they are most frequently discovered stuck in the soft ground of swamps or shallow pools. An animal of this kind, languid from disease, sinks deep in the marsh to which it may have been accustomed to repair, and not possessing strength sufficient to extricate itself, is usually left in this state to perish. Hence a very plausible hypothesis may account for the circumstances under which the elk is usually found. The animal, during sickness, either in company with the herd to which it is attached, or apart from its companions, may have frequented a familiar watering-spot, in order to quench its thirst, and sinking in the soft marly substance which has accumulated round the margin of the lake, may have in vain exerted its limbs, enfeebled by disease, to disengage itself, and in this situation have actually died. Some of its bones may have been dissipated by the action of the atmosphere, and other natural causes; some may have been borne away by carnivorous animals; while the remaining number may have owed their preservation to rains, which had washed them deeper in the lake, where they would be gradually enveloped by shell-marl in its process of filling up the basin. Such a view of the case is, in fact, attended with much fewer difficulties than if we resort to a cause so adventitious as that of an overwhelming flood, or any other expedient of this kind, as that the animal had been drowned, while attempting to elude the pursuit of its enemies; for Professor Buckland has announced, that this last opinion is entertained by Mr Weaver.

The next question suggested is purely speculative:—From what cause has this animal become extinct in the British islands?

Sir Thomas Molyneux conceived, that a sort of distemper, or pestilential murrain, might have cut off the Irish elks; and, connecting this view with the remains of many of them being found in one place, he supposed, that, as these animals had lived together in herds, they had died together in numbers. He adduces, in support of this view, a passage from Scheffer relative to the distemper which, at times, carries off whole herds of the rein deer. All this may be fair reasoning enough. It is, however, questionable, if the human race has not occasionally proved as formidable as a pestilence in exterminating, from various districts, whole races of wild animals; though we are certainly short of historical evidence, when we would prove that this has been the case with regard to the elks in the Isle of Man and Ireland.

These are the various observations which occurred to me after I had examined the situation in which the elks of the Isle of Man are discovered near the Peel River; but, as I was also informed, that they were still more abundantly found in a northerly part of the country, to which geologists, from its peculiar character, would now give the name of *diluvial*, I was anxious to examine this district. But, before describing the result of my investigation, it may be expedient to advert very briefly to the general distinction that Professor Buckland draws between *diluvium* and *alluvium*.

In a paper which I published in the last number of this Journal, it was stated, that "Professor Buckland had proposed to separate two classes of phenomena which were previously referred to one common cause. Of these, the first is, the general dispersion of gravel and loam over hills and elevated plains, as well as valleys, which he conceives to be the effect of an universal and transient deluge. To the gravel and loam thus said to be dispersed, the name of *diluvium*, in reference to their alleged cause, has been given. The *second* class of phenomena includes the partial collection of gravel at the foot of torrents, and of mud at the mouths and along the course of rivers, this partial collection of gravel, mud, or sand, being distinguished from the first class by the name of *alluvium*. Thus, we are said to have deposits of *diluvium* or of *alluvium*, the first of these being referable to the action of an universal deluge, the latter (or the alluvium) to that of existing causes." Into the reasonableness of this view I shall not at present inquire, my object being rather to show, that, as Professor Buckland claims all animals which are discovered in diluvial deposits, as antediluvian animals, the fossil elk is found under circumstances that completely prevent it from boasting so remote a date of origin.

The strata of clay slate and mica slate, which occupy an area of the Isle of Man amounting to almost three-fourths of it, have a line of direction that most frequently extends from south-west to north-east. They assume the form of irregular mountain ridges, which at Snaefell, the highest hill of the place, attain an elevation of 2004 feet. Keeping, then, these circumstances of the primary strata in view, if we trace a line on the map nearly regular, commencing at the east of the island at Ramsey, and continued across it in a course very nearly west, we shall find on survey that, when the lofty mountain ridges which I have described come in contact with this imaginary line, they abruptly terminate; the remaining fourth part of the island to the north appearing as one vast and nearly dead flat. This expanse is popularly named the Curragh, and it is on this site, as I have before remarked, that most of the remains of the elk are to be found. But before I advert to the circumstances connected with their inhumation, it will be necessary to describe, with some degree of precision, the deep deposit of clay, marl, sand, and gravel, which distinguishes this district.

The lofty ridges of primary strata which constitute the chief part of the Isle of Man, must be considered as forming, along their northerly line of termination, a part of the deep boundary of an immense depression or basin that shelves abruptly to an unknown depth. The question then is, With what materials has this depression of the Curragh been filled?

An attentive examination of the nature of this deposit will prove, that the basin contains transported fragments, the geological character of which is unlike that of any mountain masses that occur in the Isle of Man. Far distant hills, perhaps of Scotland, which have been chiefly composed of transition limestone, trap-rock, grauwacke, quartz, granite, and porphyry, having yielded to the disintegrating effects of atmospheric agents, an immense quantity of debris has, in the course of ages, accumulated; and if we adopt the most ready theory which is suggested on the occasion, an immense wave from the north (which, according to the hypothesis of Professor Buckland, has passed with an incredible velocity over the surface of the earth, and has thus given rise to the Mosaic deluge,) appears, in the course of its progress, to have forced these disintegrated materials from their native site, and while dispersing them in the direction of its current, to have at length obtained a secure lodgement for them in the deep basin of the Curragh.

According, then, to the view of Professor Buckland, the greatest portion of the clay, marl, sand, and gravel of the Curragh would be *diluvial.* But I use this geological term in a far more limited sense. I involve, in its meaning, nothing more than the agency of an immense wave which swept the deposit, now under consideration, from far distant shores; —but it is a distinct proposition to maintain, that this very wave, the origin of which is involved in the greatest mystery, can be the same which produced all the effects that are ascribed to the Mosaic Deluge.

After these remarks, I shall proceed to give a general description of the diluvium of the Curragh, in reference to the circumstances under which the fossil elk is discovered. The disintegrated materials, which contribute most to the diluvium, are limestone, rocks of the trap series of formation, and next in order, quartz, grauwacke, granite, and porphyry. Boulders and pebbles of all these rocks may be detected in the deposit. Fragments of limestone are so abundant, that it is usual, for the purposes of agriculture, to carefully collect them from the sea-shore, after they have been loosened by the inroads which the ocean is constantly making upon the cliffs. Calcareous matter is, in fact, found as a more or less abundant ingredient in all the beds of clay, marl, sand, or gravel, which, variously alternating with each other, characterize this deposit. Mr Oswald of Douglas has detected in the marl the fragment of a shell which appears to be a species of Turritella.

Such is the diluvium of the Curragh, in which no remains of the elk have ever yet been discovered; the antediluvian origin, therefore, formerly ascribed to this animal by Professor Buckland was, upon his own views, destitute of proof.

I may next remark, that the debris, of which the diluvial matter has been composed, is accumulated in the greatest quantity on the coast. It is considerably worn away by the action of the sea, and occasionally presents to the ocean an abrupt face, where it attains an elevation varying from 70 to 100 feet. In other places, however, the height is far less.

But as we recede from the sea, and approach towards the range of hills which forms the southerly limits of the Curragh, we find that the surface of the bank more or less gradually slopes off, so as to form a depression or hollow of inconsiderable depth, in which has formerly subsisted one or more inland lakes or marshes. Accordingly, the channels of several small rivers, deriving their origin from lofty rocks of clay-slate, may be detected, to which the ancient lakes of the Curragh have been indebted for their supply. These mountain-streams have, in the course of ages, carried with them immense quantities of the disintegrated materials of the hills from which they have had their origin, and have deposited them in the form of gravel, clay, or sand, by which means the depression of the Curragh has been in some measure reduced. Again, the lakes in their overflow have formed for themselves various narrow channels or outlets, by which they have communicated with the ocean. These rivers have exerted a deep corrosive action on the loose materials of the diluvium; and while the lakes of the Curragh have become more shallow from the filling up of their basins, a considerable drainage has also conspired to prevent this low tract from being overflowed. But to more particularly describe these effects would be foreign to my present object. Suffice it to say, that the surface of the diluvium has, from these causes, undergone very considerable modifications. On the north-west of the Curragh a terrace of debris may be observed, such as is thrown up by a river, when it forces its way through earthy or stony materials loosely accumulated. This terrace consists of alternating layers of gravel, marl, and sand, and (if I do not mistake the site, which has been pointed out by Mr Oswald) one or two ribs of animals, said to be of the elk, which had probably drifted thither from the neighbourhood, were, many years ago, discovered imbedded in this mass.

I shall now advert to the most frequent circumstance connected with the discovery of the fossil elk in the Curragh, namely, its inhumation in *alluvial* marl. But there are, in this case, two varieties of this substance to be distinguished. The first is that which had once subsisted as *diluvial* clay-marl, but either from being exposed to the action of mountain torrents has become more or less mixed with sand and gravel, or from forming the bed of ancient pools, or lakes of water, has become mixed with the remains of shells, as well as of vegetable substances. "In the flats," says Mr Oswald, "the common marl is loaded with sand, and possesses a laminar structure. In Andreas it is of a reddish colour. The Jurby marl is of an earthy grey, and of a compact texture. A specimen obtained twelve feet deep, contains roots of the fern, and many thin fragments of shells." To this description, I would add, that in marl of this kind no remains of the elk have yet been discovered; they scarcely appear to occur anywhere, (at least in any quantity,) except in the shell marl—a circumstance which, as I have stated, must be considered as connected with some habits of the living animal which I have endeavoured to explain.

The situation in the Curragh, where numerous remains of the elk have been found, was pointed out to me by the Bishop of Man, to whom I have been much obliged for some valuable assistance which I received in the course of my researches. The deposit from which they are obtained is in the parish of Ballaugh; but as the excavation which had been made was then nearly filled with water, I must refer to Mr Oswald's account, inserted in the present number of this Journal, for a more particular geological description. It would appear that, in a basin shaped cavity, a bed of shell marl reposes, which has been worked from eleven to fourteen feet deep. Below this is the diluvial deposit.* A layer of white sand three feet thick reposes upon the marl, and above the whole a bed of peat four to six feet thick. From this deposit the skeleton of the elk in the University of Edinburgh was obtained. This specimen, generally conceived to be entire, was the ingenious compilation of a blacksmith of Ballaugh; it was principally got up from bones that had been dispersed, and, as the osseous system of the proposed antediluvian animal was still incomplete, a few odd joints were necessarily borrowed from other animals.

* Mr Oswald has remarked, that "throughout this district, where a sufficient depth is attained, boulders of grey limestone of various sizes" (the transported materials of the diluvium) "are found."

But the apparent *margin* of another bed of shell-marl in Ballaugh from which the elk has been taken, was not so much concealed as the middle of it. This deposit appeared comparatively recent. The lowest stratum which was exposed had a depth of three feet; it was considerably mixed with sand and small pebbles of clay-slate and quartz, the debris of the neighbouring hills; and in this mass several bones of the elk have at various times been found imbedded. Above this marl was a deposit, one foot thick, of the same substance, though mixed with more sand, and containing some little vegetable matter. In a still higher bed, a layer of sand succeeded, one foot thick, mixed with white quartz pebbles: then a layer of drift peat, and another of black mould, each six inches thick, and over the whole, a thinner coat of drift peat.

This comparatively recent origin of the deposit in which the elk is found, may be connected with another remarkable circumstance, yet remaining to be noticed. The limited district named *Ballaugh*, from which the Isle of Man elks are most abundantly obtained, is nothing more than a corruption of the name *Bala Lough*. In fact, a *lough* or *lake* subsisted, of so recent a date, as to be actually described in a map of the Isle of Man, published in the year 1656, by James Chaloner. (See Plate II. Fig. 2, where part of it is copied.) And as the elk is found imbedded at such a small depth below the surface of this lake, which has been lately filled up, two important questions connected with the natural history of this animal, naturally suggest themselves: first, Have we any evidence from historical records that this animal was well known at a period comparatively recent? and, secondly, Does any similar animal exist in Europe, or elsewhere, at the present day? These questions I shall consider on another opportunity.

The foregoing investigation is one that I consider of no small importance. If the elk can be thus shown to be decidedly *postdiluvian*, may not a just suspicion be attached to the recently assigned *antediluvian* origin of various other animals, especially when, like those of the Curragh, they are found in districts which may, at least in part, be proved to be *diluvial?* Geologists would do well to pause before they admit, as an established fact, what yet remains to be confirmed; and I do not hesitate to add, that the circumstances under which the hyena and other animals have been found at Kirkdale and elsewhere, are still open for a further and very rigid examination.*

*** *Having alluded to the researches of Mr Oswald on the subject of the fossil elk, the communication in which they are contained is superadded to this paper. It will be found to give a very interesting and minute detail of the shell-marl deposit of the Curragh; and the geologist is under considerable obligations to the writer for the pains which he has taken on the subject.*

ART. IV.—*Observations relative to the Fossil Elk of the Isle of Mann;* being the Abstract of a Letter from H. R. OSWALD, Esq. F.S.S.A., &c. addressed to the LORD BISHOP OF SODOR AND MANN, in Reply to certain Queries instituted by Professor BUCKLAND relative to the circumstances under which the Fossil Elk is discovered.

MY LORD BISHOP,

IN compliance with your Lordship's note from Castle Mona, I have drawn up the following answer to Professor Buckland's queries respecting the relics of a species of large elk found in some of the marl beds in this island.

In the extensive diluvial flat which constitutes the north end of the island, the marl is of two kinds, first, white marl of a fibrous and somewhat laminar structure; secondly, common clay marl of a brownish grey colour, and compact consistence.

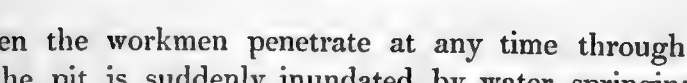
The *white* marl, in which the elk is found, occurs only in small formations in the vicinity of Ballaugh Brewery, and about a mile from the base of the mountains. Though flat at this point, the ground is undulated, and somewhat uneven.

The formations of white marl occur in detached basins, which vary from 50 to 150 yards in diameter. The sites of these are frequently, but not always, indicated by shallow hollows and morasses on the surface. These deposits admit of two varieties. The first of these contains white shell marl, or rather delineations of shells in the marl; the other does not exhibit the remains of shells, and is some shades darker in colour, though in other respects similar to the shell variety.

* See Dr Knox's Communication on the Hyena Bones in this Number, p. 80.

The skeleton of the large species of elk which is now in the Museum of the University of Edinburgh, was found at the farm of Balla Terson, in a basin of the shell variety of marl, about 100 yards by 50 in extent, and situated in a wet hollow or morass, which is filled with aquatic plants, and surrounded on all sides by fields of dry and fertile soil.

The superficial stratum is peat of excellent quality, light and fibrous, and containing a few trees of bog-timber. It is six feet thick in the middle parts of the morass, but passes out thin, into a black peaty turf towards the margin. Between it and the marl a layer of fine bluish white earthy sand is interposed, from two to three feet in thickness. The marl lies at a depth of from seven to ten feet at the middle parts of the pit, but, like the peat, becomes thin at the margin, and passes out when within a foot and a half of the black till which forms the surface crust. Nearly one-half of this deposit has been worked during dry seasons, but I have never seen the pit completely drained of its water. According to the calculation of the workmen, the bed of marl in the middle parts of it is from eleven to fourteen feet thick, independent of the layers of turf and sand which I have noticed. A tranverse section of the deposit may therefore be delineated thus:



When the workmen penetrate at any time through the marl, the pit is suddenly inundated by water springing up from below, from the sand and gravel which form the subsoil.

This marl is highly fibrous, and somewhat laminar in its structure, and when dry, is as light, and nearly as white as chalk. The shells are delineated white upon a darker ground, and are seen by separating the fibrous layers, but are seldom, if ever, found in their original state. I question much whether shells exist in all parts of the basin, certainly not at its margin. In this basin vast quantities of bones of the large species of elk are found. The workmen have constantly met with them since the first opening of the pit, and therefore conclude that an incalculable number still remains. These bones occur at all depths of the marl. At and towards the surface of it the bones, like the shells, are merely delineations of what they once were, with little or no difference in consistence from the mass in which they are contained, and therefore will not bear handling; in the bed of sand above the marl all vestiges of them disappear. The deeper these elks are in the marl, the more fresh and perfect they seem; and near the bottom of the bed complete heads are found. They sometimes, though very seldom, are observed imbedded partially in the gravel below. Those in the marl are generally charged with calcareous matter, yet I have frequently seen the thick part of the stem of the horns so unchanged, as to admit of being worked. The bog timber is in this instance solely confined to the peat on the surface.

The skeleton now in the Museum of the University of Edinburgh, was found at the bottom of the marl, where the bed was very thick. The different bones, though partly in contact, lay irregularly, and possessed little or no relative position to each other. The head lay with its nose upwards, and the other bones around it were in a state of confusion which the workmen cannot describe. This specimen is the only relic approximating to a complete skeleton which has been met with. But it was not perfect when it was set up; some bones were wanting, and I have reason to conclude that Mr Kewish (the blacksmith who put the skeleton together) availed himself of the relics of other animals. It is no uncommon thing to meet with two heads and a number of other relics lying in confusion together. One man assured me, that on a late occasion he saw appearances of a perfect skeleton lying on its side in the middle of the basin, all the bones *in situ*, but whether it would have borne handling was not as-ascertained. To my knowledge two other very fine heads have been raised, one of which, with brow antlers, measured eight feet and a half from the tip at one horn to that of the other, each horn being five feet eight inches in length; it had three molar and three cutting teeth perfect on each side of the jaw. Single horns, ribs, and fragments of these and of other bones are often met with not only in this basin, but in the other pits of white marl without shells.

I shall, in the second place, notice the basins of white marl in which no shells now appear. These lie lower down the plain, nearer to the deposits of common clay-marl.

In one of these basins, distant upwards of a quarter of a mile from that described, the marl lies at a depth of from four to six feet only, being covered by a hard, sandy, blackish earth. The field in which it is situated is crusted over with a wet soil. Before the surface of this basin was broken up, it had a thin layer of turf upon the middle or deepest part of it, but there is none now to be seen. Between the alluvial covering and the marl there is a bed of dark turfy fibrous earth, from two to four inches thick, each horizontal layer showing different degrees of shade. The marl itself is darkest near the top, continuing thus to the depth of eighteen inches. In this upper part of the marl slight veins or rents occur.

This marl is also fibrous, and somewhat slaty, and exhibits between its layers white delineations like grass. It likewise contains bones, but they are few in number, and much decayed; of these are pieces of ribs, condyles of bones, and stems of large horns, &c.

This deposit of marl, though near the surface, and in a field almost level, is basin shaped, like that last described, varying in depth from seven to ten feet in the middle, and passing out to the thinness of a few inches at the margin. The extent of it has not been determined. Excepting a rib and some small fragments, I have not myself seen any of these bones *in situ.* * * * *

I have never heard of or seen any specimens of the head of the beaver in this island, but have learned that large specimens of the head and horns of the common deer have been occasionally met with, and that fragments of ribs of a smaller size than those of the elk usually are, have been sometimes found. * * * * *

I have the honour to remain,
My Lord Bishop,
Your Lordship's very obedient humble servant,

Douglas, *May* 29, 1824.

To the Hon. and Right Rev. H. R. Oswald.
The Lord Bishop of Sodor and Mann.

ART. V.—*An Account of the Frontier between Ava and the Part of Bengal adjacent to the Karnaphuli River.* By FRANCIS HAMILTON, M.D. F.R.S. and F.A.S. Lond. and Edin. Communicated by the Author.

THE river called Naaf by Europeans, which enters the sea in about 20° 50′ north, for a short way forms the boundary between Ava and Bengal; and across it is the only communication known between the kingdom of Arakan subject to Ava, and Chatigang subject to Britain. North from the forks of this river, so far as I could learn in 1798, there was no distinct boundary; but there extends north, along the whole of the Chatigang district, a mountainous frontier occupied by several rude tribes. Through this region flow many rivers; some into the sea, either through Chatigang or Arakan, and some into the Erawadi; and the high land at the sources of such of these rivers as run through the district of Chatigang was commonly supposed to be the actual boundary. The rude tribes, indeed, which occupy the hilly countries on both sides of the central height, claim independence, and support it, so far as their slender means will admit. On this account, we cannot depend on there being no passages through this country, because the inhabitants will naturally conceal them, as an intercourse by these passages would inevitably lead to their more full subjection to either one or other of their more powerful neighbours.

In a map of the Empire of Ava by Mr Walker, the rivers flowing through Chatigang are laid down as anastomosing with those which run through Arakan; and this may be the case, although I heard not the most distant hint from the natives of such a circumstance. Indeed none of those, with whom I conversed, pretended to know any thing of the sources of the larger rivers, on the banks of which they dwelt, alleging that a fear of the independent tribes hindered them from ever penetrating so far. Such an anastomosis, in a very hilly country, is singular, and renders uncertain the above mentioned idea of the boundary. This would increase the probability of there being passages direct from the sources of the Karnaphuli to Ava, through the country of the Jo; but I am not acquainted with the authority on which Mr Walker has proceeded; this, however, from the manner in which it is laid down, would seem to be from an actual survey, and is therefore probably correct, so that the height of the land can only be the boundary towards the northern extremity of the district of Chatigang, concerning which, I am now about to treat.

The total width of the mountainous region, between the Naaf on the side of Bengal, and Zhænbrugiun on the side of Ava, is about 124 miles east and west; one-half of which probably is watered by rivers flowing into the Bay of Bengal, and the other by streams running towards the Erawadi. The whole of this space is occupied by rude tribes alone. As we advance farther north, the width of these wilds increases by low hills adjacent on the west to the Mugg mountains of Rennell, and which, on the Karnaphuli, extend about twenty miles west from these mountains, which, by the Bengalese, are there called Barkal.

The Bengalese, and the rude inhabitants of these hills, have an utter abhorrence at each other, and their manners, in almost every thing, are opposite, the rude tribes having more resemblance to the people of Ava, and even of Europe, than the Hindus have. Even their manner of cultivation is totally different. The natives of Gangetic India, especially, altogether neglect land that is not level; while the rude tribes consider such as nearly useless, and cultivate the hills alone. Notwithstanding their mutual abhorrence, this in some measure prevents encroachment; and the low hills, running north from Islamabad (the abode of Faith) to the Phani, are allowed to remain in possession of the rude tribes called Tripura, Jumea, and Chakma. These people seem to have no dependence on the chiefs of their respective nations. In their jooms they rear cotton, rice, and ginger, and a great part of the first and last they exchange with the Bengalese for salt, iron, earthenware, and fish. They have no black-cattle; but rear hogs, goats, and poultry, and seem to be in easy circumstances. They are subject to predatory attacks from the Kungkis, nominally dependent on Radun Manik.

To the east of these hills is a fine valley watered by the

Havildar river, which falls into the Karnaphuli. This valley is level, and cultivated for rice by the Bengalese. East from this is a chain of low hills called Korilliya pahar, which extends far south beyond the Karnaphuli, on the southern bank of which are two steep cliffs, that return the most distinct echo which I have ever heard. These hills are of inconsiderable height; but, like those north from Islamabad, are neglected by the Bengalese, and allowed to remain with the Muggs, who cultivate after the joom fashion.

The Karnaphuli (Ear-ring) river, which Rennell calls Curumfullee, forms at its mouth a good harbour for ships of considerable burthen, and would be of great importance, were it not so deeply embayed, that in the S. W. monsoon, ships cannot proceed to sea without danger. At Patarghat, the ferry from Islamabad towards the south, it is about a mile wide; and at Korilliya pahar, it diminishes to about 200 yards, but the tide runs up strong.

East from Korilliya pahar, is a fine valley called Runganiyà, which extends north and south from the Karnaphuli, on the banks of the Ishamati towards the former, and on those of the Silun towards the latter. Although it contains some small hills, it is well cultivated by Bengalese peasants; and some parts still belongs, as the whole did formerly, to the hereditary chief of the tribe called Muggs at Calcutta, where they are much employed by Christians as cooks, their habits fitting them for preparing our impure diet, which neither Hindu nor Muhammedan can approach without disgust. Beyond the low hills, which bound the valley of Runganiya on the north, east, and south, no Bengalese cultivators have settled, but the hills are as fully occupied by rude tribes as the nature of the joom cultivation will admit; and, in 1798, when I visited the country, Taubbokha, the hereditary chief of the Mugg people, retained among these hills a kind of independence, although in the parts of his estate, cultivated by Bengalese, he was reduced to the same footing, as the other proprietors of land (Zemindars) in Bengal. In the following account, I shall confine myself to a description of the territory within the hills, which forms a part of the frontier, and, at its southern end, is not above fifteen miles wide from east to west; but it increases much in width farther north, towards the sources of the Chimay and Karnaphuli rivers, where it is probably from thirty to forty miles from east to west. Its length probably is about seventy miles; but of this a considerable portion towards the north, has been occupied by the Kungkis called Lusai, who are quite independent of the Mugg chief.

Some miles within the western boundary of the low hills, a chain of greater height runs northerly (about N. 40′ W.) from the Sungkar, and crosses the Karnaphuli, the course of which, from the Mugg mountains of Rennell, to beyond this chain, is about N. E. by N. and S. W. by S. with most numerous and great windings. This ridge of hills seems to be about 500 feet in perpendicular height; and, being of a good soil, is well cultivated after the joom fashion. The portion of it south from the Karnaphuli, is called Sita pahar or Sita mura, and that north from thence, is called Ram pahar, and the continuation of the same ridge is probably that called by the Tripuras, Debta mura, or the Deities Head, the southern portion being dedicated to the God Rama and his wife Sita. At its northern end, Sita pahar descends to the Karnaphuli with a shelving rock, called Sitaka ghat (the landing place of Sita), which is highly venerated, and the Hindus, therefore, offer grain, flowers, and eggs, to Sita and Rama, while the Muggs worship Taung-mang, (Mountain-prince). Even the Muhammedans of this province have adopted the superstition, having contrived some fable for almost every place held sacred by the Pagans, thinking probably, that it would be disgraceful for their religion, were they not provided with as many ceremonies and holy places as their neighbours.

Above Sitaka ghat, the Karnaphuli is about 100 yards wide, and of considerable depth. Although the tides flow pretty strong, the water is quite fresh; but even in the dry season, is rather muddy. The concave side of its reaches have low banks, while, on the convex low hills come down to the water-edge, as indeed is common in hilly countries and small rivers. The soil seems in general to be good, and rests on a rock consisting of thin horizontal strata of clay and sand slightly indurated. The hills are cultivated for jooms, as much as the nature of the process will admit; and on the levels, there are Mugg-villages (para) surrounded by many plantain-trees, and gardens or small plots, in which are reared ginger, betle-leaf, sugar-cane, indigo, tobacco, and capsicum. These are their permanent places of abode; but, at their jooms, they have temporary villages called Kamar, which are changed almost every year, and are only occupied by the labourers in the season of cultivation.

Each para is under the authority of an officer, termed Dewan, who communicates his name to the place; so that the names of the paras undergo frequent changes. In the paras, the huts are better than in the kamars, although each has only one apartment; but the stage, on which it is raised about twelve feet from the ground, is about forty feet by twenty, affording a platform before the door for air and domestic work. The ascent to the house is by a notched stick, which serves for a ladder, and is drawn up when the family wishes to avoid intrusion. Except the houses of the chief and of his brother, all the huts of the country seemed very much alike; and the wealthy, as usual in India, rather occupy a greater number of huts, than build houses on a large scale. On the whole, however, the huts in the Mugg paras seem more comfortable than those of the Bengalese cultivators. The people have abundance of poultry and hogs; and, as there are many plains of some extent, which are not fitted for the joom cultivation, the Muggs keep some oxen and buffaloes, which pasture there, and are probably fattened for eating, although, to avoid offence, this is concealed from the Hindus; but they are not used in the plough. The country, however, is in a poor unproductive state; and, if cultivated like the West Indies, which its hills equal in soil, it might become of great value.

Every Mugg cultivates as much land as he pleases, and the revenue of the chief arises from a poll-tax, and not from a land-rent. Each man pays in proportion to the strength of his family. It is said, that a married pair, living without any assistance from children or servants, pays annually five rupees; and that other families, in proportion to their strength, pay ten, or even fifteen rupees. If the cultivator disposes of the produce of his farm, he pays the tax in money; but, if he chooses, he may pay it in cotton at a fixed price, so that in case of a bad market, the prince may not have it in his power to exact too great a share of the produce. What part of the revenue goes to the Dewan, for his trouble of management, I did not learn; but it is probably small, as I saw no appearance of affluence about the habitations of these officers. The chief also receives money from the Bengalese, who cut grass for thatch on the plains, which abound with this material of an excellent quality; and he levies some duties on boats ascending the Karnaphuli.

The people called Muggs, at Calcutta, are scarcely known by that name in their native country. By the Bengalese, they are commonly called Chakma or Sagma, or, in ridicule, Dubadse, (two-languaged), because they have in general forgotten their original language, which is the same with that of Arakan or Roang, as they call it, and have attained a very imperfect knowledge of the Bengalese, although several of them read and write this dialect. They all, however, retain some words of the Roang language, especially their names; and their priests use both the character and language of Arakan, little different from that of Ava. They all follow the doctrines of the Boudhas, but have engrafted on these many Hindu superstitions, and especially bloody sacrifices offered to the Debtas, or deities of the woods, rivers, and mountains. In spite of the admonitions of their priests, this superstition is very prevalent among the Muggs. The Debtas are supposed to dance and sing in the air; and, by their manner of doing so, to render their will known to certain women, called Diyari. On all occasions, when the Muggs are strongly influenced by hope or fear, such as in sickness and dearth, they apply to a Diyari, who consults the Debta, and is informed by him what sacrifice will be acceptable. This sacrifice is vowed; and, if the person obtains the object of his wishes, the animal is immolated at the place where the Diyari says that the Debta resides. These Diyaris, by their influence with the Debtas, and by their skill in drugs, are supposed to be also able to render a joom inaccessible to tigers and wild elephants;

which, as the natives repose the utmost confidence in this science, is perhaps a sign that these animals are not very destructive. The magical power, attributed to their Diyaris by the Muggs, by the silly Bengalese, has been extended to the whole tribe, and towards the Megna, a Mugg is beheld with a mixture of abhorrence and fear, from his eating without the observance of cast, and from his supposed power in the black art; so that he is considered nearly as bad as a Christian.

The national religion of the Muggs, is the same with that of Arakan, (Rakhain), that is to say, they follow the sect of Maha Muni among the Bouddhists. The chief priest assumes the same title, Paun-do-gri, with the spiritual guide of the king of Ava. He informed me that they have two orders of priesthood, the Samana, and Moshang; the latter of whom are superior in point of dignity, and by the Bengalese are called Raulims. The priests, like those of Ava, use a yellow dress, and seem very numerous in proportion to their followers; but do not appear to be so much respected by the laity, as the priests of Ava are. Some of the laity assume the yellow dress for a time, and give themselves up to study; but the books which I saw such using, were in the Bengalese character, and except a few words, they understood no other language.

The name Chakma or Sagma, given to this people by the Bengalese, is evidently a corruption from Saksah, the name they give to themselves; while, in the dialect of Ava, or Aree, as they call it, they are termed Sæk. They seem to be the remains of the first colony from Arakan, that occupied Tripura on the conquest of that country from the Muhammedans. Many of them still remain in Arakan or Roang, having probably retired there, when the Moslem power was restored in Tripura, and these are distinguished from the conquered portion by the name Sak-mi, and speak the language of Rakhain alone. The Bengalese they call Koar. The men have adopted the Bengalese dress; but the women retain that of Arakan and Ava; and both entirely resemble in person and features the natives of these cities. Like the other rude tribes in the vicinity, they eat every thing, and have no objection to eat along with individuals of other nations; but they do not intermarry with strangers. Although both their rivers and marshes abound in fish, they have not the art of catching these animals, and employ Bengalese fishermen for the purpose. Their principal men have slaves, but these are chiefly Tripuras; nor is it allowable to hold a Saksah in bondage. Several villages, however, both of Tripuras and Kungkis, in a state of personal freedom, live in the territory of the Saksah chief, and subject to his authority.

From Sitakaghat to the hills, called the Mugg mountains by Rennell, the course of the Karnaphuli, in a direct line, is between thirty and forty miles; but I took almost four days to ascend this length in a good boat, for which there was a sufficient depth of water, and I reckoned the distance eighty miles by the course of the river. For about two-thirds of the way, I had at times a slight tide with me. Above this, the river contracts to about fifty yards in width, and becomes more rapid and clearer. Where it reaches the Mugg mountains, at a place called Barkal, a ledge of rock running entirely across the river, stops boats from passing; and about a mile farther up, there is a higher ledge, over which the river falls in various beautiful cascades, about six feet high, which, in the rainy season, unite in one great torrent, as appears from evident marks on the banks. The river in May is beautifully clear, and full of fish. The western face of the hills near Barkal is cultivated in jooms; nor is the term Mugg mountains known in the vicinity. The rock is *sandstone.*

I shall now give some account of the streams which fall into the Karnaphuli between Sitakaghat and Barkal, and which water the intermediate country, that is the proper seat of the Saksah.

About ten miles above Sitakaghat, following the course of the river, the Kapty enters, coming from hills at a considerable distance to the southward. Canoes can ascend this rivulet to a village named Kamsey. About the year 1795, a large band of the Bonzhu tribe of Kungkis descended by this rivulet, and committed great devastation on the Bengalese of Runganiya.

About eight miles above the Kapty, the Karnaphuli receives the Rain-ghiaun, coming far from the south-east. About two hours and a half rowing from its mouth, lived a Saksah chief of some note, who had several villages (para) under his authority. Six days journey farther up this river brings the traveller to the country of the Kungkis, called Bonzhu or Bonjugies. If Mr Walker's idea of these rivers be right, the Rain-ghiaun must be the anastomosing branch, which connects the Karnaphuli with the Sunkar and Peercally, which last falls into the Arakan river. The Bonzhu, in this case, will occupy the vicinity of the great peaks called the Blue Mount and Pyramid Hill, along the Peercally and Koladyng rivers. At any rate, they have the Saksah and the Longshue or Lusai tribe of their own nation on the west, and the Jo on the east, and extend, near the 93° of east longitude from Greenwich, from about the 22d to the 24th degree of north latitude.

In the course of the next four miles, the Karnaphuli receives from the south-east three small streams, the Duliya cherra, the Tara cherra, and the Kuburiya cherra, which run through a country in general level, and covered with long grass and a few trees. On this account it is less populous than the more hilly parts, being mostly unfit for the joom cultivation.

About twelve miles farther up enters from the north-west a river of little importance, called Manik cherra. A little higher up, on the opposite side, is the mouth of Mug-ban, which comes from a marsh of the same name. This and another marsh, (jil) on the Duliya, are said to contain immense quantities of fish, and to be common resorts of large herds of wild elephants.

Above Manik cherra about ten miles, a little above the mouth of the Ranggamati, is the principal residence of the chief, who, by his people, is called Mang, their pronunciation for what, according to the Alphabetum Barmanum, should be written Mæn, one of the titles usually assumed by the sons of the king of Ava, and therefore analogous to our word Prince. This residence (Rajarbari) contained not only the house of the Raja, but that of his brother, with all their families, except some Bengalese servants, who had huts on the outside of a fence made of bamboo mats, constituting what is called a fort or castle. The whole habitations within were thatched huts, so far as I could see by looking in at the gate; for I did not enter, as the chiefs were absent, and as their women and pigs were alarmed. The former, I was told, might, without offence, be seen by strangers; but their timidity, at the approach of an European visitant, occasioned a general scream, on which I retired. The same cause in general prevented the women of a lower rank of Saksah from approaching me. They seem to be drudges, being darker coloured than the men, who, compared with the Bengalese, are very fair.

From the chief's residence there is a fine view of both the ridges of mountains by which the territory of the Saksah are in a great measure bounded. They appeared to me farther distant than I could allow by computing the distances travelled. Since I was there, to judge from Mr Walker's map, the residence of the chief has been moved farther up the river.

About two miles above the chief's residence, a considerable river enters from the north. By the Bengalese it is called Chingay, Singay, or Chimay, and is no doubt that called Chingree by Rennell. My boatmen said, that canoes can ascend it for six days, which will give a direct course of between thirty and forty miles. One of them, in proceeding to a residence of the chief's, had gone up five days, during which time the canoe was twice unloaded, and carried past water-falls.

The Saksah say, that this river springs from hills near Kundal, so that its total course, in a direct line, may be about fifty miles, allowing Rennell to have placed its mouth correctly, which, so far as I can judge, is the case. They gave me the following account of the rivulets that they pass, in proceeding up its channel, so far as canoes can go. 1*st*, Kanda cherra on the left; 2*d*, Kausgurra on the right; 3*d*, Guy cherra on the left; 4*th*, Tamarang on the left; 5*th*, Karik khung, the first on the right; 6*th*, Khundy cherra on the left; 7*th*, Dungata on the right; 8*th*, Kabutkia on the right; 9*th*, Maha karung on the left; 10*th*, Nana karung on the left; 11*th*, Poli on the left; 12*th*, Incha cherra on the right; 13*th*, Toisakma on the left; 14*th*, Karik khung, the second, on the right; 15*th*, Bæscherra on the left. The Raja had formerly a house at Dungata; but he has been driven from thence by fear for the Kungkis, called Lusai; and no Saksah now reside beyond Kanda cherra, half a day's journey from the Karnaphuli. The country, however, between the Chingay and Rampahar, is occupied by Kungkis, subject more or less to the Saksah chief.

Rather more than three miles above the mouth of the Chingay, the Basunta enters from the south-east, and is navigable a short way for canoes. Here, again, the country becomes more hilly and more populous. About three miles above Basunta, on each side of the river, there are hills higher than usual in this range; that on the south-east side, from a large black rock, is called Hattiya, (the elephant,) and that opposite is called Chela. The scenery here is very romantic. The strata are horizontal, and of a schistose structure. A little above the elephant rock, and beyond the hills on which it stands, there enters from the same side a rivulet, called Sualung, up which canoes can proceed some way, and its banks are occupied by those who cultivate jooms.

About six miles above the elephant rock, the river Kazalung enters from the north-west, and is said to spring from the same vicinity with the Chingay. It is said to be a considerable stream, and that boats, drawing twenty-seven inches, can ascend it for a whole day, while canoes can go much farther. The banks of this river, at a little distance from the Karnaphuli, and those of its tributary streams, are occupied by the tribe of Kungkis, called Lusai, Lushi, Langga, or Lingta, who extend from thence behind the Tripura territory, and are a terror to both Saksahs and Bengalese. The tide extends up to the mouth of the Kazalung.

About seven miles above the Kazalung, we experienced difficulty in passing shoals; and about five miles farther on, two small rivulets enter from the south-east, with a narrow point between them. From thence to the ledge of rocks, which closes boat-navigation, is about two miles and a half; and the waterfalls of Barkal are about a mile farther, nearly, I conjecture, in the 23° of north latitude. These waterfalls are probably occasioned by the river passing through the ridge that extends north-north-west from the Blue Mountain, the name of which, if I understood the natives right, is Meindaun among the Saksah, and Munipahar among the Bengalese. This name, however, I suspect is rather applicable, in a general manner, to all the lofty hills in the vicinity, the Blue Mountain rising to between five and six thousand feet perpendicular; but at the Karnaphuli the ridge is not above seven hundred feet.

I shall now trace the course of the Karnaphuli to another great mountain, from the report of a Muhammedan guide, who had been in the country beyond Barkal three times—twice to cut bamboos, and once to kill wild elephants for their teeth. During the four cold months, the former is a common occupation among the Bengalese. They carry small canoes past the waterfalls, and in these embark their provisions. In the distance which the guide went there are three waterfalls. The first, named Utanchetri, is two days journey from Barkal;—the second, named Harinaka duar, (Deer-gate,) is one day's journey farther;—the third is at Hattiyaka Mu, (Elephant's Mouth,) and is a day and a half's journey above the second. Beyond this the guide went half a day's journey, and from some of the reaches could see the great Muin Mura, which is probably a continuation of the mountains that separate Arakan from Ava. At its bottom the Karnaphuli falls from a high rock, beyond which the Bengalese canoes never attempt to go. This part of the great Muin Mura the guide estimates to be twice the distance from Barkal that the latter is from Sitakaghat. The course of the river winds much; nor does the guide pretend to know its general direction.

In this part of its course the Karnaphuli receives no great branch; but the largest is at Hattiaka Mu. Between the falls the current is very gentle, and at Hattiaka Mu the body of water is as considerable as at Barkal. The country is in general level, with some hills, however, near Hattiaka Mu; but during the rainy season a great proportion is inundated, forming jils or temporary lakes. Around these lakes there are immense herds of wild elephants, and the level country is not inhabited, although well fitted for the cultivation of rice; but the west face of the great Muin Mara is occupied by the tribe of Kungkis, named Bonzhu or Bonjugy. Their prince, by the Bengalese, was named Taibiak; but whether this was a title, or a proper name, I did not learn. The Saksahs called this chief Taikoup, and said, that he lived on the bank of a small river called Taishang; but into what great river this falls I was not informed. A branch of the Kazalung has indeed this name; but all that vicinity is occupied by the tribe Lusai. The Saksahs indeed pretend, that the Lusai also are subject to this prince; but this was denied by the Tripuras, and all the incursions of the Bonjugies of which I heard came from the south-east side of the Karnaphuli, while the Kazalung is towards the north-west; and, so far as I can judge, the former seems to be the boundary between the two tribes.

Art. VI.—*Account of an Improvement on the "Odometer," which, without increasing its size, multiplies its power upwards of One Hundred Fold.* By James Hunter, Esq. of Thurston, F.R.S.E. Communicated by the Author.

To those who are unacquainted with this small but useful instrument, it may be necessary to explain, that it is calculated, by its lightness, to supersede the use of the Perambulator, being easily driven by one hand, while the Perambulator is with difficulty managed with both.

The Odometer consists of a perpetual screw, which turns two concentric wheels of 100 and 101 teeth respectively. It must be evident, that, when the wheel of 100 teeth C has completed one revolution, the other wheel of 101 teeth B will have one tooth remaining unturned. Consequently, an index placed at 0 or zero of C, will point to 1 of B; which 1, therefore, indicates a complete revolution of C, or 100 turns of the perpetual screw, which, being fixed to the measuring-wheel, is equivalent to 100 times the circumference of the measuring-wheel. After a second revolution, it will point to 2 of B, showing two revolutions of C, or 200 turns of the measuring-wheel, and so on until it points to 0 or 101 of B, having completed 101 revolutions of C, or 10,100 turns of the measuring-wheel.

The object of my proposed improvement is to register this step by the introduction of a third wheel A of 102 teeth, to be turned by the same perpetual screw, and upon the same principle that the index fixed to C points upon the scale of B to the number of revolutions performed by C; another index fixed to B will show, upon the scale of A, the revolutions of B; but the revolutions of B are simultaneous with those of C, and, therefore, no account is to be taken of those of B as long as they are the same as those of C, or, in fact, until after C has performed 100 revolutions, having the index of B pointing upon A also to 100. At the end of the next revolution, however, the index of C will point to 0 of B, and that of B to 101 of A; and at this point the improvement begins to take effect.

The 0 of B is equivalent to 101; and I find that whenever B is less than A, 101 must be added to B; we therefore have the instrument pointing to 101 of A, 0 or 101 of B, and 0 of C. A and B, therefore, are still the same, and the calculation is 101 revolutions of C, or 10,100 turns of the measuring-wheel; and at this point the two-wheeled instrument has completed the performance of its duty, and is ready to recommence.

At the end of the next revolution the instrument will point to 0 of A, 1 of B, and 0 of C. Here we find a difference of 1 between B and A, which difference of 1 stands for 10,100; and to it we add the 1 of B, which stands for 100, and we have 10,200 which we know to be the number of turns of the measuring-wheel; accordingly, for the future, the following formula must be resorted to: $B—A \times 10{,}100 + 100\,B + C =$ turns of measuring-wheel; and whenever B is less than A, 101 must be added to B, because, in fact, B may be supposed to continue its scale after 100, instead of commencing anew at 0.

This last wheel I have recommended to be made to measure $6\frac{6}{10}$ feet, because that is $\frac{1}{10}$ of an English chain for square measure, and the same, or $\frac{1}{100}$ of a furlong, for long measure; but there is no practical objection to its being made of any size that may suit the convenience of the person using it.

By means of these three wheels, the Odometer measures $100 \times 101 \times 102 = 1.030.200$ turns of the measuring-wheel, which, at $6\frac{6}{10}$ feet, amounts to the enormous sum of 67.993.200 feet, or $1287\frac{3}{4}$ miles; and if the time of this distance being performed is known within a tenth part, the measuring may go on to ten times the above amount, or $12.877\frac{1}{2}$ miles, being 10.302.000 turns of the measuring-wheel; and there is no doubt that this instrument might be very valuable in a manufactory, where it is of consequence to ascertain the number of revolutions of any particular wheel.

Since the "Odometer" was presented to the Highland Society, I have succeeded in adapting it to the wheel of a carriage, by having a string tied to the bottom of the instrument, and joined to some fixed part of the carriage, while the end of the perpetual screw is inserted into the centre of the wheel; and thus, by ascertaining the circumference of my carriage-wheel, I measure the distance travelled, making a small allowance for the carrriage not going in a perfectly straight line.

Art. VII.—*On a Singular Detached Block of Stone occupying the summit of a Hill at Dunkeld.* By John MacCulloch, M.D. F.R.S. F.L.S. and M.G.S. Chemist to the Board of Ordnance, and Professor of Chemistry in Addiscombe College. Communicated by the Author.

Your readers, who are acquainted with the natural history of Cornwall, cannot fail to recollect the theory of Dr Borlase, respecting the detached blocks of granite so conspicuous in that country, two of which, the Cheesewring near Liskeard, and the Hogging-rock, near the Lands end, I described in the second volume of the Geological Transactions. Dr Borlase's notions, however, were not exclusively his own; as other antiquaries, over whose judgments the obscurities of the Druidical worship seem to have shed their influence, have imagined these, and similar appearances, to be monuments of that superstition or religious government, all our real knowledge of which is comprised in a very few casual hints contained in the Roman historians. The recent increase of attention to natural history, and, more particularly, to geological investigation, has, however, put to flight all these visions, and left us at no loss to distinguish betwixt the appearances produced by the efforts of art and design, and those which have resulted from the ordinary operations of nature. Whatever interest, in a historical view, these phenomena may therefore have lost, they have gained a countervailing one as natural objects; in many cases illustrating, either in a curious or useful manner, the changes which time is daily but slowly making on the surface of the earth.

In Scotland, as in Cornwall, antiquaries have not been wanting who were ready to attribute some of these remarkable natural appearances to a Druidical origin; and, among these, may be enumerated the rocking stone in Strathairdle, which has furnished a page to some of the writers of the day. The rock, of which I transmit you a sketch, (See Plate I. Fig. 3,) has also been called a Cromlech, which it resembles in the peculiarity of its position; but I imagine that your readers will have no scruple in admitting it as an example, (and a peculiar one at the same time,) of those transported stones so often found occupying situations so unexpected, as to render an explanation of the course which they have taken a matter of no small difficulty.

This rock occupies the summit of a hill near Dunkeld, known by the name of Craig-y-barns, (the serrated rock.) Its shape is so irregular that it cannot be described, but the sketch will supersede the necessity of saying any thing on this part of the subject. The same irregularity renders it difficult to form an accurate notion of its weight, but it probably exceeds fifty tons; a judgment founded on comparing it with other stones of known weights resembling it in shape. The greatest length is twelve feet, and the greatest thickness five; from which circumstances, with the aid of the accompanying sketch, a sufficiently accurate notion of its form and dimensions may be conveyed.

From the drawing, it will be seen that the lower flat surface is supported on three loose stones; and, in this circumstance, consists that resemblance to a Cromlech which has led to the unfounded notion of its Druidical and artificial origin. These loose stones also lie at liberty on a flat and solid surface of rock; a circumstance which adds much to the appearance of artifice.

It is now necessary to remark, that this rock, as well as the supporters, consists of the same material as the hill, which is micaceous schist. It is indeed from this circumstance alone, that is derived the proof of its not lying in its native place; but of its having, on the contrary, been moved to its present position, together with the stones by which it is supported. On examining the direction of the laminæ, in all these pieces, it is easy to see that they all lie in different ways, and all different from that of the laminar structure of the solid rock on which they repose. Hence, it is evident, that the large block has been placed on the three loose stones which lie on the solid rock; exhibiting an appearance, it is true, of artifice, as perfect as if it had been the result of the hand of man, and not an accidental operation of nature.

In accounting for it, however, by natural causes, there seems no reason to doubt, that the whole is the result of the accidental fall, or transportation of the larger mass, combined with some posterior circumstances of waste. Originally it has probably been deposited on a bed of loose materials, the smaller of which have disappeared, leaving those three only which were essential to its support and have been retained by its pressure.

The circumstance, in a geological view, most remarkable is, that it now lies on a point, which, if it is not absolutely the highest eminence of the surrounding hill, is yet so nearly at the same elevation with the other summits that it could not have travelled from any of them to its present place; supposing the surrounding parts to have always been in the state in which they now are. The nearest summit is too little elevated to have permitted a stone of so irregular a form to have moved over the intermediate surface; and that which is higher, is now separated by a hollow or depression which would equally have prevented its transportation from that point, unless the intermediate ground were restored to an uniform declivity. The integrity of the mass is indeed sufficient to prove that it has not been carried far; and it affords, in fact, a singular example, rather of the results which follow from the degradation of hills, than from the transportation of blocks. The appearance may probably be explained by imagining that the summit on which it now stands was once higher; and that, in the progress of waste, this mass has fallen from its original position, on the solid rock on which it now lies; overwhelming in its fall a heap of smaller materials or rubbish, of which the three supporting stones are the last remains.

Art. VIII.—*Notice of some of the Rarer Atmospherical Phenomena observed in* 1824. Communicated by the Author.

The following descriptions and remarks, have been extracted chiefly from a Meteorological Journal kept at Leith, and are arranged in the order of time in which the phenomena were seen. To these, for the sake of illustration, a short notice of the general meteorological features of each month is added.

January was remarkable for high temperatures, high pressure, and little rain. The mean temperature of the month was 40°.05. Rain fell on seven days, and that to the depth of 0.90 of an inch. The mildness of the weather had the effect of prematurely hurrying on vegetation; so that, at the end of January, it appeared as if summer was about to commence.

On the 21st, about 9 P. M., there appeared in the north, a faint white light, but about 40° above the horizon, extending over a considerable space, and passing through the zenith. It was not an Aurora; but was arranged in distinct diverging bars, which pointed towards the south, and gradually became fainter and fainter, till they disappeared. The light was steady, very pale, and continued for a considerable time without any visible change. The barometer was rising; thermometer 38°; wind uncertain, quite calm. Next day there was a storm from S. W., accompanied with heavy showers of snow. Might not this appearance have been owing to a *cirrostratus* or groupe of *cirri*, illuminated by electricity in motion through them?

Towards the end of the month, several storms of wind occurred, with variable, but not low, pressures, and great humidity; and, during this period, the *cymoid cirrostratus* was very prevalent.

In *February*, we had very variable and stormy weather. Temperature lower than in January; quantity of rain, 1.81 inch. Vegetation was much retarded, and diseases of all kinds prevailed.

On the 1st, The following observations were made on the *Formation* of *Clouds*. About an hour after sunrise, the sky was partially overcast by lengthened *cumuli*, leaving rather wide spaces between them quite free from clouds. The colour of the sky was then equal to the 18th degree of Saussure's Cyanometer. These large *cumuli*, urged by a very gentle wind, were in motion towards the N.E.; and it was seen, that one of them, which moved over a wide free space of the heavens, at the elevation of 50°, was furnished with pendant cirrose streamers. The portion of the sky over which it moved, had been for a considerable time quite free from clouds; but whenever this *cumulus* approached it, several minute strips of cloud suddenly appeared in various parts. These quickly increased on all sides, and inosculating, formed together a large *cumulus*, which immediately began to move upwards, and, in fine, was blended intimately with the larger one, which continued moving to the N.E.: all this passed in four or five minutes. Immediately after the inosculation of one subordinate *cumulus*, another and another formed in the same manner, and were likewise attached to the larger one. When it had nearly passed, a few other flocculent masses began to form, but on attaining a moderately large size, they were suddenly redissolved. The sky now assumed a much lighter tint in that quarter, the colour not being equal to 13° of Saussure, and some other masses still continued to form; but they were enlarged with extreme slowness, and retained, for a long time, a thin spongy form, and so were carried onwards by the aërial currents. (Therm. 40°, Bar. 29.80.)

The 11th of Feb. produced a most singular phenomenon. About noon, when the sky was rather free of clouds, the pressure considerable, (Bar. 30.40.,) and the wind, W., gentle, there appeared in the north-east, an extensive *cirrostratus*, completely and distinctly divided in a perpendicular direction, by a line about 3° broad, through which the azure of the sky could be seen throughout its whole extent. In a very few minutes after this was first observed, the *cirrostratus* partly dissolved, and partly inosculated with others; but the line of division still existed, and it now began to incline towards the east; in its course always observing perfect rectilinearity, and dividing every cloud in two through which it passed, and sometimes several at once. It made no progress towards the zenith, but inclining more and more to the east, it became at length almost horizontal, and gradually disappeared.

It has been said, that the pressure was considerable during the time of its occurrence; but, in the course of two hours, it began to diminish very rapidly, and in less than twenty hours, the barometric column had fallen *one inch*. A gale of wind, and much rain followed. The rain continued for three days.

Nothing very particular occurred in *April*, except a fine Solar Halo, which was seen on the 6th at sunset. The sun's southern limb was within a few degrees of the horizon. The sky was veiled by a general, but delicate *cirrostratus*, and the sun was partially obscured by denser clouds of the same kind. The halo was a simple one, and of a uniform white colour throughout its whole extent. The perpendicular radius was considerably greater than the horizontal one, perhaps in the proportion of 42° to 35°. At the same time, there appeared a perpendicular column of light rising from the position of the sun to the circumference of the halo. (Therm. 47°, Bar. 30.40., wind N. E.) The day had been remarkably fine. Immediately after sunset, and the disappearance of the halo, a dense *cirrostratus* formed, which continued all night and all next day. April was, on the whole, a very pleasant month, the temperature rather above the mean, and the pressure by no means variable.

The weather during *May* was very agreeable; rain fell on five days. The mean temperature was about 50°, and the sun's force sometimes very great. The maximum of temperature and the maximum of pressure both occurred on the 27th day, at the time of new moon. The thermometer rose to about 80° in the shade that day.

About half-past 6 P. M. of the 1st, while the sky was partially obscured by floating *cumuli*, there was observed in the east, exactly opposite to the position occupied by the sun, numerous luminous rays, diverging from a point apparently a little below the horizon, and extending all round, so as to occupy the full half of the sky. These rays were very delicate, yet perfectly distinct. Very shortly after they were first observed, they vanished, when the *cumulus*, which had veiled the sun during their appearance, had somewhat altered its position. But when this cloud had come near our zenith, another phenomenon of the same nature occurred. This was a broad conical ray darting horizontally from between the eminences of the cloud, and extending to a considerable distance. The ray was very vivid and distinct, and continued visible for some time. The sky was apparently clear, but rather light-coloured. The moon's unenlightened disk was very distinctly seen all night. The phenomenon now described, is the same as that which Dr Brewster saw in October, near Edinburgh, and which he has noticed in the 3d number of this Journal, under the name of "The Convergence of the Solar Beams." Dr Brewster there states, that the appearance is to be considered as a very rare one, since he is not aware of its having been observed by any one, except Dr Smith, in England, and, as he was informed by Mr Haidinger, Professor Mohs at Freiberg. But, doubtless, many others have seen it, although no account of their observations may have been published, since the writer of this paper has observed it four times in the course of three years:—in August 1822, June 1823, May 1824 (as now described), and on the 18th January 1825: and notice has been received of its having been seen at Aberdeen in great beauty, in August last.

June was remarkable on account of the long period of dry weather which then occurred. Including a part of the preceding month, very little rain fell for about five weeks; during which, for the most part, high temperatures prevailed, high pressure, light breezes from the east, and great dryness of the air. The force of the sun's radiation was sometimes very great. On the 2d, accurately observed, about noon, it was found to be about 50°.

Much has frequently been said about the correspondence in the variations of pressure at very distant places, even over a fourth part of the surface of the globe. A very interesting exception to this, occurred on the 18th July. We are informed, that, in the department of the Aude, in France, on that day, the barometer stood at 28 inches, while there was a violent wind, and a storm of thunder;—further, that, in the evening, there was a shock of an earthquake. The barometric column experienced no variation during the shock. The temperature was suffocating. Now, it is singular, that we had here, on the 18th, a very high pressure, approaching very nearly to the maximum for the month, and that just at the time when the earthquake and low pressure took place in France. On the following day at 5 A. M., an earthquake was also felt at Lisbon; it was preceded by excessive heats; the accounts of which being very curious, may, with propriety, be transcribed here, as translated from the Portuguese papers. "The high temperatures experienced in Lisbon on the 18th, 19th, and 20th July, and which did such damage to the fields, deserve some observation. On the 17th and 18th, Fahrenheit's thermometer, in the open air and shade, was from 92° to 96° at 2 P. M., and 79° to 83° at midnight. On the 19th, (the day of the earthquake,) exposed to a hot wind from the N. E., it rose to 105°. "This burning wind did immense damage; it is impossible to calculate it. We can state, however, that the vines in elevated situations, exposed to the N. E., entirely lost the abundant fruit with which they were loaded. A great many persons, working in the fields, were mortally struck with the malignant influence of this excessive heat. Many animals shared the same fate; the leaves of the vegetable world were completetely dried up and reduced to dust."

The month of August was a very fine one. The temperature was moderate; mean 56°. Pressure steady; winds N. E. and W., gentle.

On the 3d, between 5 and 6 P. M., the following curious nepheological phenomenon occurred:—

The day had been very wet; but the rain had ceased about 3 P. M., and the clouds had begun to break up; but still, at 5, they were floating about in every direction, under the form of large *cumulostrati.* At this time, one of these, bearing about S. E., was observed to begin to break into fragments and dissolve on its lower surface, and soon after, when it had thus been considerably lessened in size, it began gradually to ascend into the higher regions of the air, in the most beautiful manner, dissolving as it rose. After attaining an elevation equal to that of some other cumulated masses, it broke down into distinct *cirrocumuli*, which by degrees vanished about the twilight. The ascent of the cloud occupied about five minutes; and, as it was large, it presented an unusually interesting spectacle. In the course of the evening, another cloud, more distant, was seen to present similar phenomena in the same order. The wind was from the north, scarcely perceptible. After this, for several days, much rain fell, with variable winds and moderate pressure.

The 2d of September was particularly distinguished by the occurrence of an unusually high temperature for the season, both here, and all over the south of Scotland and north of England. The morning of the first was very fine, temperature moderate; by noon, however, it had increased much, and the force of the sun's radiation was very great. In the afternoon, *cumulostrati* came from the S. W., (the wind having veered to that quarter, since morning, from the N. E.,) which clouds preventing radiation from the earth at night, caused the heat to be particularly oppressive, as it remained nearly the whole evening at 70° Fahr.; about 11 or 12 P. M. much sheet-lightning was seen in the S. W. Next day was still warmer; in the afternoon the clouds increased, and much rain fell, but here there was no electrical discharge. Although the high temperature was the greatest evil here, it was not so in other places; for reports from Kelso, Berwick, Belford, Newcastle, and many places in Yorkshire and Northumberland, give accounts of a most alarming storm of thunder and lightning having occurred, accompanied with a vast quantity of rain, and spreading destruction over a great extent of country.—Many men and domestic animals were killed by the lightning.

It was during this storm that the subterraneous bog burst at Keighley in Yorkshire, which may be traced to the vast torrents of rain that seem to have accompanied the contemporaneous storm.

On the morning of the 9th, a pretty brilliant display of the Aurora Borealis was seen for some time.

The months of October, November, and December, may be said to have had very nearly the same meteorological character, being very stormy, with very variable temperature and pressure, and an excess of humidity. The pressure during the whole three months scarcely ever exceeded the usual mean. In such a state of the atmosphere, rare and interesting phenomena were certainly to be expected; and, accordingly, they did occur in no small number. The first which may claim our attention is a very curious one, and has frequently attracted the notice of philosophers, ever since the phenomena of the rainbow were thought worthy of investigation; namely, the appearance of what are called *Supernumerary Rainbows.*

These were seen on the second of October, about 5 P. M., during a light shower of rain, within the southern limb of a primary one of great brilliancy. There were three additional sets of colours seen close to one another, all having the red outermost. The red, yellow, green, and blue tints could be distinctly observed; and they varied in brilliancy and breadth as the cloud moved on.

Dr Langwith was the first who described these supernumerary bows, (*Phil. Trans.* 1723;) but he saw only "dark-green, light-green, and purple," repeated thrice within the primary bow. M. Bouguer in Peru, saw one entire repetition of the prismatic tints within the primary, frequently; rarely two repetitions. M. Gentil, in 1756, in France, saw two repetitions within the primary of the blue tint;—and M. Dicquemarre observed supernumeraries outside of the *secondary.* Similar phenomena were observed by Monge, and Daval. "On the 29th July 1813, Dr Brewster observed these supernumeraries under favourable circumstances, when four repetitions of the red and green bows were seen without the primary violet." (Optics, *Edin. Encyclop.*) September 7th 1819, Mr Macome at Paisley, saw "the lower half of the primary, commencing with the green tint, distinctly repeated in the regular and usual succession of the colours, without any colourless interval." (*Ann. Phil.* Vol. XIV. p. 472.)

On the evening preceding that on which the supernumerary rainbows were seen, a lunar rainbow was observed at Middleton, near Edinburgh, about 10 P. M. It is stated to have been fully formed, and the segment of the circle, which it described on a thick cloudy sky, everywhere distinctly, and even strongly marked. It began to fade in a minute or two after being first seen, and had totally disappeared in the space of three minutes. It was of a dull white colour. (*Edinburgh Evening Courant.*)

During the first week of October we had very variable winds, and a high temperature for the season; the thermometer ranging between 50° and 61°.5. The pressure varied much. The 8th was the day of full moon; and then we had a commencement of the most stormy weather that has occured here since February 1823. It was during the 11th that the storm bore the most marked features. The direction of the wind varied a little, but it was mostly from the N. E. It blew very steadily, and not in gusts; and was so violent as to tear the trees up by the roots, and drive the largest ships from anchorages in general secure. The pressure here, during that day, varied from 29.10 inches to 29.20, and remained tolerably steady for several days. It appears, however, from the *Tableau Meteorologique* of the observatory of Paris, that there the pressure was much lower; and that although no storm of any consequence happened in France, yet they expected one.* M. Nell de Bréauté has published, in the *Bibli. Univer.* for November, a note of the rapid descent of the mercury at Dieppe, which fell to 718.73. mm. (=28.301. English inches.)

As lunar rainbows have long been considered the peculiar harbingers of most stormy weather, it is interesting to find, that no less than *three* of these rare phenomena were seen in the course of five weeks, of what may be reckoned as boisterous a period as has occurred here for many years past. One of these has already been described; the second was seen on

* See our Last Number, p. 367, for an account of the dreadful storms and inundations in the north of Europe.—Ed.

the 2d of November at sea, in lat. 56° 56′ N., long. 15° E., and was perhaps as fine an appearance of the kind as has yet been observed. For some time before its appearance, the weather was extremely boisterous and rainy. It was first seen at 11 P. M., and continued visible about half an hour, bearing from W.S.W. to E.N.E., reaching from horizon to horizon. Its colours were those of the spectrum. Besides the primary bow, there was a secondary one, in which the colours were nearly as complete and brilliant as in the principal one. During the appearance of the phenomenon, the wind was exceedingly variable, flying round the compass; and after it had disappeared, it blew a tremendous hurricane, with heavy rains, which lasted twenty hours without intermission. Its appearance, on the whole, was described by the observer, Mr Kerr, as having been extremely beautiful, and in no respect inferior to the most perfect solar iris. The moon was twelve days old. Very few lunar rainbows, perhaps, have been seen so fine as the one now noticed. The only one, of which a description is published, that can be put in comparison with it, is one noticed by Mr Howard, in his *Climate of London*, as having been seen by a friend at Stoke Newington, on the 1st December 1808, a little after 5 A. M. "The moon was nearly full, and setting to the north of west. The rainbow was of unequal brightness. In the most northerly part of it, near the earth, the prismatic colours were very distinct, in the other parts they were scarcely distinguishable; and it had, on the whole, the appearance of a white arch. At the usual distance the *secondary bow* was visible. Opposite the brightest parts at the north end, it was very strong and coloured, as the inner bow in that place was."

The third rainbow, which has been alluded to as having been seen during this period, was observed at Leith on the evening of the 9th November. The moon at the time was nineteen days old: the night was somewhat windy, with dark *nimbi* in the western part of the sky, and *scud-clouds* in the east, where the moon was. The cloud, by which the rainbow was formed, was dark and heavy, obscuring the whole of the western quarter of the sky. The rainbow was of a dull white colour, and quite perfect. In about two minutes from the time when it was first observed, it began rapidly to disappear. Its extremities first faded, and, in a few seconds afterwards, there was no indication of it left.

In the winter of 1782, three lunar rainbows were also seen, which are described in the Philosophical Transactions, and that was allowed to have been one of the most stormy years that ever occurred in Britain.

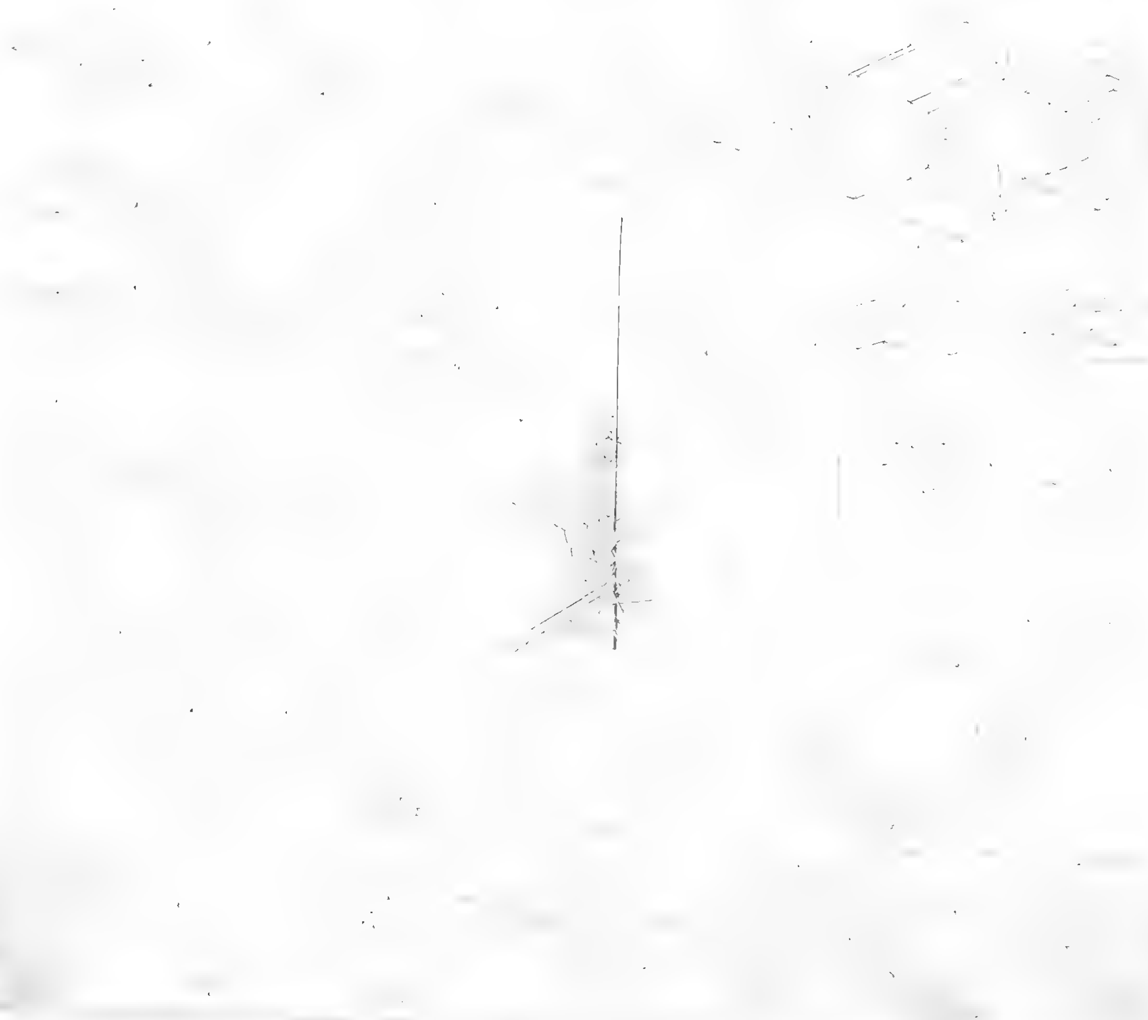
On the 23d November, we had a very low pressure, with very strong N. E. gales, which seem to have been felt all over the kingdom: the barometric column stood at 28.45 inches, near the level of the sea. It is worthy of remark, however, that, although the wind blew most boisterously here on the 23d, from N. E., yet it blew from the S. W. along the shores of the English channel:—and there, it is stated to have been "a most tremendous gale," "a most furious storm," "the most tremendous hurricane ever experienced," and that its effects were "most disastrous."

On the 5th December, a beautiful illustration of the remark, that the appearance of *cirrocumuli* prognosticates a rise of temperature, occurred here. The morning of that day had been very cold, (Therm. at $7^{h}\frac{1}{2}$ 22°,) but the temperature had gradually risen through the day to 35°, and at four P. M. had begun to descend again, when a fine display of *cirrocumuli* suddenly appeared. The temperature immediately increased from 34° to 38° and, contrary to the usual law, continued to rise during the night, and next morning it was 44°. The pressure at the same time diminished, and we had a heavy fall of rain.

Almost every night at this period, fine Lunar Halos were seen, generally with a diameter of 96°; they were always simple.

On the night of the 7th, about 11 P. M., the following very singular phenomenon was seen. There were two very large *cirrostrati* visible, both of a whitish colour, and very dense, one of which occupied the zenith, and most part of the S. W. and N. quarters of the sky, the other the east and south-east horizon; both were arranged in parallel bars, pointing nearly north and south. While examining attentively these clouds, there appeared in the south, near the upper

PLATE III.



margin of the lower one, and about the centre towards which the polarized bars of the *cirrostrati* seemed to converge, a dark space of considerable magnitude, from which rays began suddenly to shoot out, of the same dark appearance, towards the upper cloud; these rays, however, did not continue their dark aspect, on reaching the upper cloud, but seemed rapidly to *dissolve that cloud in stripes*, so that very quickly the upper *cirrostratus* was completely torn into shreds by these rays, and when they had passed, the stars could be seen through the cloud. By and bye, the cloud began to form precisely in the same manner as it had dissolved, and no more rays came from the lower one: the two clouds finally inosculated, and covered the sky with a general haze. Can this phenomenon be considered analogous to the one already described as having occurred on the 11th of February?

Nothing else of any consequence, except a fine Solar Corona on the 13th December, was seen before the close of the year.

LEITH, *February* 1825.

ART. IX.—*On the Regular Composition of Crystallized Bodies.* By WILLIAM HAIDINGER, Esq. F. R. S. E. Communicated by the Author.—(*Continued from Vol. III. p.* 93.)

III. *Pyramidal System.*

THE situation of the plane, in which two individuals, whose form belongs to the pyramidal system, may be joined in a regular composition, and the situation of the axes of the individuals themselves, as in the rhombohedral system, produce a general distribution of these compound bodies into two classes. Either the axes of the two individuals are parallel, or they include an angle. In the latter case, the face of composition is always parallel to a face, or perpendicular to an edge of an isosceles four-sided pyramid, and this kind of composition may take place in any class of forms of a pyramidal species. But, if the axes of the individuals are parallel, and the situation of the one be changed by a revolution of 180°, no change in the appearance will be produced, unless the combinations possess a particular hemi-pyramidal character, in which there is not an absolute symmetry round the pyramidal axis, owing to the enlargement of the alternating faces of isosceles, or half the number of faces of scalene eight-sided pyramids.

Pyramidal forms, in general, are the rarest among those which the products of inorganic nature affect, and few species among those which present them, have been observed in regular compositions; but, wherever these occur, they are very frequent, and in some instances exceedingly varied; so much so, that their existence has not a little contributed for a long time to conceal the true form from the inquiries of mineralogists.

The only law of regular composition hitherto observed in pyramidal Tin-ore is, that two individuals joined will meet in a face of the pyramid P, the angles on the terminal edges of which are = 133° 26′, on the lateral edges = 67° 59′. It occurs, however, in a great many varieties of forms, and variously repeated on the similarly situated parts of the individuals. This law was first ascertained by Lermina, and described in the second edition of the Crystallography of Romé de l'Isle. Haüy has given a good drawing of the most simple case of it as found in nature; but the most exact and ample description of the various appearances which it produces in different crystals of the substance, has been given in Mr W. Phillips's excellent paper on the Oxyd of Tin.* Nothing new can here be mentioned on the subject; but it will be interesting to compare these compositions with what is found in other species, particularly by means of preserving for the figures of all of them a parallel position.

The fundamental pyramid itself, when composed parallel to one of its faces, would produce a form like Fig. 1, Plate III. analogous to the twins of the regular octahedron described among the regular compositions of the tessular system.†

* *Trans. Geol. Soc.* vol. ii. p. 336.

† *Edin. Journ. of Science*, vol. i. p. 56. Pl. III. Fig. 5.

The same law applied to the pyramid P + 1 (*s*), on the terminal edges of which the faces of P appear with parallel edges of combination, will produce a compound form similar to Fig. 2., the edge x being parallel to the edge x′. The crystallographic signs of these two compositions are P, $\{\frac{P}{4}\}$ and P + 1, $\{\frac{P}{4}\}$. The simple pyramid P + 1, composed in this manner, is sometimes met with in the tin-mines of Schlaggenwald in Bohemia, but it is rare, and much more frequently additional faces, particularly those of the two regular four-sided prisms P + ∞ and [P + ∞] produce forms like Fig. 3. and Fig. 4., in the former of which, the additional faces are yet small, which, in the latter, take the greater share in limiting the figure. The variety of pyramidal Tin-ore, from Goshen in Massachusetts, occurs in the form, Fig. 3.; the specimen upon which it has been observed, in the cavities of albite, and accompanied by red and pale green tourmaline, is in the cabinet of Mr Allan. The appearance of Fig. 4. is less common in the varieties of the present species, than that of the preceding composition; it is found in Cornwall.

It is rare to meet with regularly composed varieties of pyramidal Tin-ore, in which the groups consist of only two individuals. Much more generally, the composition is repeated either parallel to one plane only, or in the direction of several homologous planes of the pyramid P. In the first case, the particles beyond two faces of composition, resume an exactly parallel position, as in Fig. 5., and if farther repeated, the whole may consist of alternating laminæ of two individuals. Another kind of geniculated crystals is produced if the composition takes place parallel to two faces from the upper and the lower apex, which, if duly enlarged, would meet in a horizontal edge. The variety, Fig. 7., depends upon exactly the same kind of composition relative to the same number of individuals, with this difference only, that they are here continued beyond the faces of composition, so that, if Fig. 6. is represented in the crystallographic method of Professor Mohs, by P + 1. P + ∞. [P + ∞], $\{\frac{P}{2}\}$, the sign of Fig. 7. will be P + ∞. [P + ∞]. $(P + \infty)^5$, $2\{\frac{P}{2}\}$. Very often every trace of the faces of four-sided or eight-sided pyramids, inclined to the axis, disappears, and then the compound group assumes the appearance of a combination of prisms and pyramids belonging to the prismatic system.

The most interesting, however, among the more complex cases of regular composition, relative to the present species, is, when it takes place at the same time, and to the same extent of the additional individuals, parallel to all the faces of the fundamental pyramid. The result of this composition is represented in Fig. 8., a remarkably elegant form, the symmetry of which would be alone sufficient to prove, that it belongs to the pyramidal system, even though we should remain ignorant of the absolute measures of its angles. It has been found in the Cornish and the Bohemian tin-mines. Its crystallographic designation, according to the method of Mohs, is $P+1. [P+\infty], \{P\}$.

Another species, well known for the frequency of its occurrence in regular compositions, is the peritomous Titanium-ore. The composition takes place parallel to a face of the pyramid P—1, the angles of which are =128° 41′ and 76° 31′, according to Haüy; the inclination, therefore, of the axes of the two individuals, (Fig. 9.) is =104° 29′. Although this kind of composition be exactly the same as the one in pyramidal Tin-ore, yet the apices of the combinations are less frequently observed, and the geniculated appearance remains to ascertain the existence of regular composition. Upon the situation of the plane in which the individuals meet, and the observation that this plane is frequently parallel to a face of crystallization, Haüy has grounded his first determination of the angles relative to the fundamental pyramid of this species, forms which he had never seen before; and though afterwards corrected by the more accurate measurements of Mr Phillips in regard to the angles themselves, yet the method which he followed deserves a praise proportionate to the degree of importance attached to it by Haüy himself. Particularly among the varieties from Buytrago and from St Yrieix, we meet with a continuation of the law, according to which two individuals are joined to a third, forming thick crystals like the groups represented in Fig. 10. It has been observed by Haüy, and this is by no means rare among regularly composed minerals, that in these compositions the transverse section of the prisms does not exhibit the appearance of a figure belonging to the pyramidal system, although he has correctly ascertained this to be the class of forms to which the crystals of peritomous Titanium-ore belong. The composition is often repeated parallel to all the faces of the isosceles four-sided pyramid; a central individual, generally a four-sided prism, thicker than the rest, is then surrounded by numerous crystals respectively in parallel positions with each other, branching off in four directions, each branch assuming very often again the function of a central individual, which supports new branches, fixed to it according to the same law. The 11th Figure will convey a faint idea of an extremely elegant group of this kind, of the same size as the sketch, inclosed in rock crystal from Brazil, in the cabinet of Mr Allan. It is impossible to give it the freshness and lustre which it derives from the contrast of its almost metallic appearance, and dark colour, with its transparent colourless matrix. A composition of acicular crystals of the species, disposed on a plane surface, produces the well-known reticulated appearance, in allusion to which Saussure adopted the name of sagenite, from σαγήνη, a net, for this species, which formerly had been considered as a variety of Schorl.*

The mineral most nearly allied to the two preceding species in regard to its forms in general, but more particularly for its regular compositions, is the pyramidal Manganese-ore of Professor Mohs, a species but of late more accurately described by mineralogists, though it seems to have been known at an early period of mineralogical inquiry. According to Mohs,† the fundamental form P (Fig. 12.) of it is an acute isosceles four-sided pyramid of 105° 25′, 117° 54′, (by approximate measurement.) This pyramid is cleavable with considerable facility in the direction of P—∞, the plane perpendicular to the axis, and likewise, though less distinctly parallel to P and parallel to P—1, another isosceles four-sided pyramid, which replaces the terminal edges of P, and the angles of which are 114° 51′ and 99° 11′. Messrs Brooke and Phillips found the angles of

* *Voyage dans les Alpes*, tome vii. sect. 1894.

† *Treatise on Mineralogy*, transl. vol. ii. p. 416.

the fundamental pyramid =105° 45′ and 117° 30′.* Also in the Wernerian system,† the pyramidal form of the crystals was described in the Black Manganese, but too little attention had been paid to this description, and it had not been received till very lately by the Abbé Haüy. Manganese crystallized in octahedrons from Piedmont was analysed by Berzelius, and a similar variety described by Sage.‡ The octahedrons engaged in heavy spar, like those of Sage, quoted by Count Bournon, if regular, evidently cannot belong to the pyramidal species; which cannot be maintained with the same degree of probability of the varieties mentioned by Sage and Berzelius. The regular composition, very frequent in this species, takes place parallel to one of the faces of P—1; the result being similar to Fig. 13, if the form of the individuals is the fundamental pyramid. It is designated by P, $\{\frac{P-1}{4}\}$. The composition repeated on all the homologous terminal edges of the pyramid yields a form similar to Fig. 14. where a central individual is surrounded by four others as in Tin-ore and Titanium-ore, with this difference, that here the apices of the pyramids can be more generally observed than in either of the two preceding species. Generally the surrounding individuals are of a much smaller size than the central one, and appear only sticking on the terminal edges, much in the manner represented in Fig. 15; the occurrence of the same law on all the terminal edges of the pyramid being of itself sufficient to prove that the forms belong to the pyramidal system, as in the compositions of the two preceding species.

The mineral species possessing hemi-pyramidal forms, which have been observed in regularly composed varieties, are the pyramidal Scheelium-baryte and the pyramidal Copper-pyrites of the system of Mohs. Also the Cyanide of Mercury belongs to this class of forms, and in the last species, in particular, the whole disposition of faces and the regular compositions are highly interesting.

* *Phill.* 3d ed. p. 387.

† *Hoffm. Handb. by Breithaupt,* iv. 1. sect. 149. *Jameson's System.* Ed. I. vol. ii. p. 460. It is said here to occur in octahedral crystals having a single cleavage.

‡ M. Sage (*Elém. de Min.* ii. 136.) cite encore une *manganaise noirâtre octaèdre*, dans un spath séléniteux blanc. *Romé de l'Isle,* vol. iii. p. 101.

The only kind of composition hitherto observed in pyramidal Scheelium-baryte is the one represented in Fig. 16. The face of composition is parallel, the axis of revolution perpendicular to a face of the rectangular four-sided prism, which is in parallel position with the pyramid of 107° 27′ and 113° 35′, that is of $P+\infty$. The individuals are continued beyond the face of composition, so that the result assumes the appearance of a crystal belonging to the prismatic system. We are prevented, however, from being led into error, by the observation of the striæ upon the faces of P, which are parallel to the edges of combination between this form and $\frac{(P+1)^3}{2}(b)$. They terminate abruptly at a certain line upon faces which else might be taken for such as belong to the same individual. This kind of composition is not unfrequently met with among the large yellowish-white crystals from Schlaggenwald in Bohemia, and has been first mentioned by Mr Mohs.* A fine specimen of this variety is in the cabinet of Mr Allan. The form of each of the individuals taken separately is that of Fig. 17, which, in regard to the general distribution of its faces, much resembles the rhombohedral species of apatite.

The simple crystals of the Cyanide of Mercury which join in regular composition may be traced in general to the form of Fig. 18. It may be conceived to arise from Fig. 19, the same combination with the full number of its faces, by the enlargement, first of the alternating faces contiguous to both the apices, and secondly, of two of the remaining faces to the exclusion of the rest. Two of these crystals now are joined in one of the faces of $[P+\infty]$, in an inverse position, and compressed between the two faces, so that the transverse section of the compound crystal is again a square, or nearly so. The result is Fig. 20, of which Fig. 21 is a projection upon a plane perpendicular to the axis. The face of $P-\infty$, which is likewise often found in the varieties of this species, is striated as in the projection Fig. 22, parallel to its edges of intersection with the plane in which the two individuals meet. The faces *s* belong to the isosceles four-sided pyramid $P+1$, a form which

* *Treatise on Mineralogy*, transl. vol. ii. p. 115.

produces horizontal edges of combination with [P+∞], and is frequently found in the crystals of Cyanide of Mercury. The following are the dimensions of its forms: P=134° 36′, 66° 8′; P+1=122′ 46′, 85° 17′. The axis of P is $=\sqrt{0.424}$. Cleavage takes place pretty distinctly parallel to [P+∞]. I have been indebted to Dr Turner for a great number of crystals in which I observed this regular composition; they had been obtained by the slow cooling of a solution concentrated at a pretty high temperature, but their inside was opaque, only the external coats, formed during the last stage of cooling, and the subsequent process of spontaneous evaporation, were perfectly transparent.

Pyramidal Copper-pyrites presents a kind of regular composition, somewhat analogous to that of the preceding species. The individuals, however, are here continued beyond the face of composition, and the hemi-pyramidal character is expressed only in the alternating enlargement of the faces of P, the fundamental pyramid. Fig. 23 represents the result of this law, if the form of the individuals contains nothing but the faces of P, alternately larger and smaller. This is the rarest among the regular compositions of the species. I have observed it in some varieties from the mine of Kurprinz near Freiberg, generally associated with composition in other directions.

By far the most frequent among them is the composition parallel to one of the faces of P, the isosceles pyramid of 109° 53′ and 108° 40′, which, if it takes place in crystals having the form of this pyramid, produces an appearance very much resembling the twins of the regular octahedron in Spinelle, in octahedral Iron-ore, and other minerals, similar to Fig. 24. The hemi-pyramidal character of the combinations of this species causes them, however, generally to assume a shape somewhat different from this figure, which, nevertheless, also frequently occurs, and, besides, supposes the individuals to terminate at the face of composition. The 25th figure, which represents a crystal in the cabinet of Mr Allan, is intended to convey an idea of this composition. The combination $\frac{P}{2}.-\frac{P}{2}$. [P+∞] (Fig. 26.) is the form of the individuals, one of which appears as if engaged in the centre of the other in a reversed position, easily discovered at least in the present instance, if we attend to the faces of the four-sided prism [P + ∞], which are striated in a horizontal direction. Except the difference in the system of crystallization, we have here a case extremely resembling the twins of Grey copper, represented Vol. I. Plate III, Fig. 18, of this *Journal*, and also some of Blende, a species whose crystallizations agree in general very nearly with that of the Grey copper. This composition is often repeated, either in parallel plates, as in Fig. 27, which is very frequent among almost all varieties of the species, and may often be observed even in massive specimens, by the want of continuity in the cleavage, or it takes place at the same time parallel to two faces of the fundamental pyramid. A group, resulting in the manner last mentioned, is represented in Fig. 28. On account of the hemi-pyramidal character, the individuals in the composition possess a different appearance from each other, so that it requires some attention to find out their shape to be that of Fig. 33.,* a combination of P, P + 1, and P + ∞; particularly as the relative irregular enlargement of the faces adds to the difficulty. Here, as in many other com-

* The specimen in Mr Allan's cabinet, in which this variety was observed, is peculiarly interesting on account of the distribution of the tarnished colours on the surface of its crystals. The tint of $\frac{P}{2}$ (*P*) is generally the violet or purple, frequently inclining to the yellow colours of the scale, while the tint of P + 1 (*c*) is a distinct, and often very deep blue, that of P + ∞ (*l*) being a fine green. The lustre of *l* is not so bright as that of the other faces;—$\frac{P}{2}$ (*P'*) generally agrees in colour with *c*. In some crystals where the tint of *P* is a brownish-yellow, that of *c* has not gone beyond the purple. This difference is probably owing to a slight difference in hardness upon the faces of crystallization belonging to different forms; it is in close connection with the physical quality of these faces themselves; and corresponds in some respect to the phenomenon of cleavage, which often takes place parallel to two forms at once, but with different degrees of facility. Lead-glance and the rhomboidal Iron-ore from Elba have been described as presenting a difference in the tarnish of their faces of crystallization. The hexahedron in the former, and the face perpendicular to the axis (R—∞) in the latter, retain their natural colour and brightness, while the rest of the faces assume the tints of tempered steel.

pound varieties of Copper-pyrites, the striæ upon the faces of crystallization yield the means of ascertaining the situation of the individuals. Generally the number of individuals, aggregated according to this law, is not confined to three; but we find, that to every one of those added to the central one, some other individuals are attached.

Regular composition often also takes place in this species parallel to a plane of P—1, or perpendicular to the terminal edges of P; there are particularly two varieties of this case, which, in the present place, deserve our attention. The individuals are either joined in pairs, or one central individual is surrounded by four others, added in the direction of all the edges of P. The product of the first, in the fundamental pyramid, would be Fig. 30. This has not yet been observed; but it will serve for explaining Fig. 31, a variety of the form, $P-\infty \cdot P-2 \cdot P \cdot \frac{3}{2\sqrt{2}}P \cdot \frac{3}{2\sqrt{2}}P+1$, from the mines in the district of Siegen in Prussia. This and several other interesting varieties of forms from the same locality, I have described, on another occasion,* from specimens in the possession of Mr Sack of Bonn.

If repeated in all the terminal edges of P in a form consisting of $P-\infty$. P—1. P and P+1, the result is like Fig. 32, in which the re-entering angles produced by the faces of P+1, and the striæ upon P, parallel with the edges of combination with P+1, diverging in three directions from the centres of the faces of P demonstrate, that we really observe a compound crystal, while mineralogists have been long deceived by the equal brightness of the faces of $P-\infty$, in directions apparently corresponding to the hexahedron. When the hemi-pyramidal character of the combinations is more distinctly pronounced, a figure is produced resembling a tetrahedron, combined with various other forms, but consisting of six individuals, the apices of which are contiguous to the edges of the tetrahedron, or of five at least, if we conceive the central individual to be continued through the centre of the group. Generally the individuals are much striated parallel to the

* *Mem. Wern. Soc.* vol. iv. part i. p. 1.

edges of combination between P and P+1, which, in a form merely consisting of $\frac{P}{2}$ and P+1, will produce Fig. 29, a variety which has been found in Cornwall. I have lately observed a composition of this kind, similar to Fig. 34, likewise from Cornwall, in Mr Allan's collection, the form of the individuals contained in the group consisting of $P-\infty . -\frac{P}{2}. P+1. P+\infty$, and several other simple forms which it was impossible to determine with any degree of accuracy, on account of the numerous and deep furrows upon the faces, parallel to their intersections with $\frac{P}{2}$ and P+1, and the want of lustre of the surface, which prevented the application of the reflective goniometer. A simple crystal of the form represented Fig. 35, occurs upon the specimen which contains the compound varieties.

(To be continued.)

Art. X.—*Facts relating to the Formation of Dew.* By George Harvey, Esq. F. R. S. Lond. & Edin. Communicated by the Author.

The tower of St Andrew's Church, Plymouth, is situated about 500 yards to the east of the meadow, in which I have usually performed my experiments on the interesting subject of dew, and the elevation of its summit above the level of the field, about 110 feet. For the purpose of tracing the law which regulates the deposition of dew at different altitudes above the surface of the earth, I frequently found it necessary, in conjunction with Mr Pridham, to perform analogous experiments, at the same time, on the top of the tower, and on the surface of the meadow; and I select, from many interesting results, that obtained on the night of the 21st of May, on account of the remarkable states of equality which were observed, both in the temperature of the air, and in the quantities of moisture deposited on bodies of the *same* kind, when placed on substances having *different* radiating powers.

The night was serene and tranquil, but the sky not remarkable for its clearness. The first observation was made at 10 P. M., when the air, at the summit of the tower, and at three feet above the ground, were found to be each 51°; and it is remarkable, that no alteration of temperature took place during the night, since a register thermometer left on the tower, and another placed at the above mentioned elevation in the meadow, indicated that the quicksilver had not in either case been below 51°. At the time the first observations of the temperature were made, that of the grass indicated 49½°, at which time there was laid on it equal plates of glass and tin, and on them equal masses of wool, (12 grains each,) exposing equal radiating surfaces to the heavens. On the summit of the tower, at the same time, similar parcels of wool were placed, similarly circumstanced. At half-past six the next morning the masses of wool in the meadow had gained *equal* increments of moisture amounting to 14 grains, and those on the tower *equal* increments of 7½ grains. Hence it appears, that during the whole night the temperature of the air, at the respective elevations of three and one hundred and ten feet, remained *stationary*, and that the increments of moisture obtained in the meadow, by equal masses of the *same* substance, in contact with bodies possessing *different* radiating powers, were the *same*; as likewise, *equal* but smaller increments, by equal masses similarly placed on the summit of the tower. In the whole course of my experiments on this very interesting subject, I never before met with so many remarkable states of equality as appeared during this night.

Gersten remarks,* that an horizontal surface is more abundantly dewed, than one perpendicular to the ground, a phenomenon arising from the latter radiating less copiously than the former. To confirm experimentally the remark of Gersten, an evening was selected, distinguished by its beautiful serenity, and for the clear and perfect transparency of the sky. A six inch hollow cube of block-tin was placed in my meadow, two inches above the herbage, with its vertical faces equally exposed to the cloudless horizon. To these faces, and to the upper surface of the cube, equal parcels of wool were attached, with equal radiating surfaces. The air was so perfectly tranquil, that the flame of a candle remained entirely undisturbed. At five the next morning the wool on the upper surface of the cube had gained 15 grains of moisture; and the

* Wells *on Dew*, p. 127, 2d edition.

parcels attached to its vertical surfaces, *equal increments of dew*, amounting to five grains. Hence, if the quantities of moisture deposited be regarded as measures of the radiating powers of the respective surfaces, the former exceeds the latter, in the ratio of three to one;—a difference arising entirely from position.* All the exposed parts of the cube were covered with particles of dew, those on the top being the greatest; and it was most interesting to remark the gradual diminution of magnitude in the particles, from the upper part of the vertical faces to the lower.

Another evening was selected for repeating the same experiment, when a gentle breeze was blowing from the east, one surface of the cube being placed directly exposed to its influence. During the night the parcel of wool on the top gained an increment of moisture, amounting to 10 grains, notwithstanding the breeze swept freely over its surface. The wool, on the eastern side, being exposed to the full influence of the wind, gained only a grain and a half of dew; but that on the western side, from its being comparatively sheltered, obtained an addition of five grains and a half.† The masses of wool on the northern and southern surfaces of the cube being equally exposed to the lateral action of the wind, gained equal increments of dew, amounting to two grains; an effect due to the equally diminished radiation of the wool, by the equal action of the wind on the two surfaces.

This experiment shows clearly the influence of wind in checking the formation of dew. In the former experiment, when the air was perfectly tranquil, all the parcels of wool at-

* Dr Wells very properly remarks, p. 59, 2d edition of his Essay, that "the same degree of cold in the precipitating body, may be attended with much, with little, or with no dew, according to the existing state of the air in regard to moisture; and from which it appears, that the relation between the temperature of the body on which the dew is deposited, and the quantity deposited at *different* periods, must be variable. But the quantities deposited at the *same* time, on surfaces of the *same* kind, differently circumstanced with respect to the aspect of the sky, may, without impropriety, be regarded as comparative measures of the radiating powers of those surfaces.

† This result is in conformity with a remark of Dr Wells; "A body placed at the leeward end of the raised boards generally acquired more dew than a similar body at the windward extremity."

tached to the vertical surfaces of the cube, were equally influenced, their radiating powers being the same, and their accessions of moisture equal; but in this last experiment, the quantities deposited on the sheltered, and unsheltered surfaces, were in the ratio of eleven to three; and it is remarkable also, how very nearly the effect produced by the *direct* action of the wind, on the eastern surface, approximates to its *lateral* action on the northern and southern.

It is worthy of observation also, that although the western surface of the cube was, from its position, much more sheltered from the wind's influence, than the upper surface, yet the increment gained by the latter, exceeded, in a two-fold ratio, that of the former. The upper surface, moreover, must have been exposed just as much to the lateral influence of the wind as the northern and southern surfaces, and the superior energy of its radiating power, arising from *position*, is strikingly shown by its increment of moisture, amounting to 10 grains, when the additions to the last mentioned surfaces were only two grains each.

PLYMOUTH, *May* 10, 1825.

Art. XI.—*Astronomical Observations made at the Observatory of Paramatta in* 1824. Communicated by his Excellency Sir THOMAS BRISBANE, K. C. B. F. R. S. Lond. and Edin.

THE following important observations have been just received by the Editor from Sir Thomas Brisbane:

1. *Eclipse of the Moon of January* 1st 1824, *observed at Paramatta.*

1824. H. M. S. —

Jan. 1. ⊙ Eclipsed, beginning at 1, 23, 59, 50, by sydereal clock.

Diameter of the sun near noon by micrometer = 30, 222 rev. div.

H. M. S.		rev. div.
At 1, 32, 17,	dist. by micrometer =	22, 695
„ 35, 1, 5	- -	21, 373
„ 37, 7, 5	- -	20, 343
„ 38, 19, 0	- -	20, 008
„ 40. 12, 5	- -	19, 120
„ 41, 36, 5	- -	18, 314
„ 43 set among the trees.		

H. M. S. —

Beginning of eclipse at 6, 44, 26, 82, mean time.

2. *Occultations of Stars by the Moon, observed at Paramatta.*

		H. M. S. —	
July 5.	Immersion of 4 Sagittarius (Bode)	15, 11, 21, 66,	sydereal time.
6.	Immersion 595 Mayer ———	17, 29, 25, 15,	sydereal time.

Aug. 27. Immersion of a star of the 8 mag. R 13, 35, (H. M.) decl. 15, 3 or 4 (H. M. M.) south at 18, 15, 58, 10, (H. M. S. —) sydereal time.

		H. M. S. —	
27.	Immersion 85 Virgo (Bode) at	18, 57, 27, 40,	sydereal time.
Sept. 30.	Immersion *o* Sagittarius at	9, 30, 40, 42,	mean time.
	Emersion	10, 12, 11, 12,	mean time.
30.	Immersion *π* Sagittarius	12, 15, 29, 84,	mean time.

3.—*Observations on the Planet* Herschel *near the Opposition, with the Mural Circle, made at Paramatta, July* 1824.

1824.	Baro.	Thermo. Out.	Thermo. In.		Magd.	Transit over the Meridian Wire.	Mean of the 4 Microscopes.	
July 4.	29,956	37,0		o Sagittarius	6	18, 54, 51	146, 38, 18, 75	rather
				xviii 294 Piazzi Cat.	7	57, 6, 5	145, 52, 13, 42	faint.
				♅ Planet		19, 1, 5,	145, 28, 27, 97	
				xix 12 Piazzi	8 & 9	3, 47, 3	145, 46, 29, 12	
5,	29,932	48	55	o Sagittarius	6	18, 54, 52, 6	146, 38, 21, 82	
				xviii 294 Piazzi	6 & 7	57, 8,	145, 52, 15, 05	
				♅ Planet		19, 0, 56, 8	145, 28, 16, 27	
				xix 12 Piazzi	8 & 9	3, 48, 7	145, 46, 28, 35	
6,	30,000	41,2	55	o Sagittarius	6	18, 54, 53, 2	146, 38, 19, 25	
				xviii 294 Piazzi	6 & 7	57, 9,	145, 52, 15, 87	
				♅ Planet		19, 0, 47, 3	145, 28, 1, 9	
				xix 12 Piazzi		. . . .	145, 46, 25, 98	: : cloudy.

Cloudy and rain prevented the observations being continued.

4. *Stars observed with the Moon near her parallel.*

1824.		Difference in Sydereal Time.	No. of Wires.
June 3.	Moon's first limb		4
	Regulus	+ 5h 5′ 04″	5
June 4.	Regulus	— 49 41 12	5
	Moon's first limb		5
Aug. 30.	Moon's first limb		5
	δ Scorpio	+ 29 41 90	5
	Antares	+ 58 23 50	5
Oct. 3.	*μ* Aquarius	— 33 56 38	4
	Moon's first limb		5
Oct. 25.	Antares	— 7 11 78	3
	Moon's first limb		5
Nov. 2.	*γ* Poisson	— 6 57 13	4
	Moon's first limb		5

ART. XII.—*Account of a Stickleback that was found with a Leech alive in its Intestines, July* 1818.* By Mr JOHN RAMAGE, Aberdeen. Communicated by the Author.

WHEN taking a walk in the evening, with some of my children, they observed, in a small rivulet, south side of King's College, Old Aberdeen, a shoal of sticklebacks in the water, which attracted their attention. I immediately put down my hand and caught one of them which was skimming near the surface, apparently as active and lively as the others, with this difference only, that it was much distended, and appeared full of roe. One of the children, to whom I had given the stickleback, after keeping it in his hand for a few minutes, told me that its gut was coming out; and, upon looking at it, I found about an inch of a white substance protruding from the anus. At first I suspected the child had squeezed it, and that it was part of the roe that appeared; but, upon examining it more minutely, I found the substance to be alive and in motion; and, to my astonishment, in the course of half a minute, a leech fully as large as the stickleback had disengaged itself, and was crawling about on my hand. The stickleback died almost immediately after giving birth to this strange offspring, and the leech survived it only about twelve hours. Its appearance and motion corresponded in every respect with those of the common leech, excepting that the colour was entirely white. (The present brown colour is owing the solution of nitrate of silver in which they are preserved.)

Upon examining the stickleback minutely, it seemed to me that the leech was lodged in the small gut, and most probably had been swallowed by the stickleback for food when of a small size, and had grown to its present dimensions in the stickleback's belly after having been swallowed.

* Mr Ramage, already well known to the public from the two magnificent reflecting telescopes which he has constructed, has transmitted the stickleback and the leech to the museum of the Royal Society of Edinburgh.—ED.

ART. XIII.—*Observations on the Temperature of Springs, Wells, and Mines in Cornwall.* By JOHN DAVY, M.D. F.R.S. Communicated by the Author.

THE following very interesting observations, on the temperature of springs and mines in Cornwall, were made by Dr Davy after his return from Ceylon. They formed an appendix to the valuable Hydrographical Journal of his voyage, which we have published in our preceding numbers. The labour which is necessary in ascertaining temperatures under such circumstances has deterred many persons from prosecuting so important an inquiry; and the difficulty of making them correctly throws a doubt upon all those observations which have not been made by observers of known accuracy and experience.

We therefore attach a high degree of value to the following temperatures, because they were measured by the nicest instruments, and by a philosopher distinguished for his accuracy.

We may safely conclude, for the reasons here given, that the temperature of the earth in Cornwall is not far from 54½° of Fahrenheit, which is than that of the atmosphere.*

PENZANCE.

August, 10, 1820.—Temperature of the well at Alverton 55°, 5, that of the air being 70°, at 11 A. M.

THE BOY MINE.

August 30,—It is many years since this mine was wrought. The engine-shaft is now full of water. Its temperature to-day, at 6 P. M., was 55° at the surface.

HUEL MINE, just by Huel Virgin.

It is many years since this mine was worked. The temperature of the water, in what appeared to be the adit-shaft, was, at 7 P. M., 55°. The water was about 30 fathoms from the surface, and it may be assumed to be running from the mine.

* See Dr Forbes's *Observations on the Climate of Penzance, and the District of the Land's End in Cornwall.* Penzance, 1824.

Marazion.

The temperature of a pump-well about six fathoms deep, a little after 7 P. M. was 54°.

Huel Fortune.

September 16.—This mine has been stopped about three years. There are now only three shafts open. The water in each is about 16 fathoms from the surface. At 11 o'clock this morning I found the temperature of each

Temperature of water from old engine shaft,	55° 5′
From the Boy pipe shaft, - -	55 5
From Brandon shaft, - - -	56

The last shaft was more open than either of the others, and its temperature consequently $\frac{1}{2}$° higher. The depth of this never exceeded, I believe, 100 fathoms.

Vanfell.

Within the last two months, a pump has been sunk at Vanfell. It is five and a half fathoms deep, and contains pretty much water. I tried its temperature at 1 P. M. to-day, and found it 53° 5′. It is covered over.

Alverton Well.

Temperature of its water, which is now very scanty, 56°.

November 17.—At noon to-day I found the temperature of this well 54°. The flow of water is very little increased.

November 18.—Found the temperature of the water in the engine shaft of the Bay to-day 53° 5′. The height of the water the same as before. Captain Banden says the shaft was 46 fathoms deep.

Immediately after, I found the temperature of the old engine shaft of the boiler, and of the Boy pipe shaft at Huel Fortune, 54° 5′ each, the water being in both at 16 fathoms from the surface. The depth of the first is 133, of the second 98, and of the third 78. The temperature of the air was 50°.

ART. XIV.—*Observations on the Flints of Warwickshire.** By EDWARD GRIMES, Esq., R. N. Communicated by THOMAS ALLAN, Esq.

I OBSERVED these flints first at Churchover in Warwickshire; but have since traced them from about ten miles north of Leicester to the village of Brandon, about ten miles south of Rugby, comprising a distance of about forty miles north and south; also to about fourteen miles eastward of Churchover, towards Northampton. In the direction of Coventry they do not appear to extend beyond Brandon, where the style of the gravel alters. They are the common chalk-flint, and are found in the gravel, and in the ploughed fields. They appear to have been broken by some convulsion, probably while in the matrix, and the fracture has been *flat*, and *not conchoidal*. It is also remarkable that many of them have lost an intermediate portion of their substance, as if they had undergone considerable attrition; and the two parts have been so exactly adapted, and so firmly re-cemented to each other, that the line of junction, on a transverse fracture, is sometimes hardly perceptible, and is occasionally indicated by a white mark.

Most of these flints have lost the angles which they had acquired by fracture, either from rolling or decomposition, though some few still remain perfect. They do not appear to have been separated in a soft state, for they bear no mark of compression.

The principal line of dislocation is generally longitudinal, though they have often had many crooks besides, in all directions, as is shown by a very perceptible ridge or line upon the surface. (See specimen, letter A.)† Such a fact would be exhibited in a piece of wax, if cut through with a hot knife, and immediately reclosed.

They have no appearance of having been acted upon by fire.

* Read before the Royal Society, December 2, 1823.

† The specimens described in this paper are deposited in the Museum of the Society. The references to them are left for the sake of those who may wish to examine them.

We have three kinds of chalk-flints in this country, which, like those of all others, I believe, have some central part more opaque than the rest, as though there had been a nucleus of matter, (perhaps organic,) but without any distinct outline. Parts of shells are often enveloped in them, which occasionally retain their calcareous character, sometimes with a fibrous, sometimes with a spathose structure. They are all porous or vesicular, but in different degrees.

The most compact is the black flint, which is also the most brittle, and the easiest of fracture. Those which appear to be the most porous (if porous they be,) are the translucent grey flints; and the most cohesive are of a muddy-yellowish, reddish-grey, slightly, if at all translucent, and these, perhaps, are the most vesicular, owing to their containing more remains of shells, &c.

They all contain either water, or some other fluid, possibly more volatile. On breaking the stone, it may be seen exuding from the vesicles, by applying the eye quickly in a strong reflected light.

I have found that sometimes a slight film is deposited by this fluid, resembling the effect of gum-water. It is not affected by acids, but easily removed by the finger, and even by the action of water poured upon it.

More frequently, however, are to be found upon the flaws of the stone little stellular concretions, (see specimen letter B,) evidently produced in the same way. These, when the exudation has been sufficient, take a more decided character, becoming minute fibrous crystals, either cuneiform or diverging and rose-like. (Specimen, letter C.)

This same substance is still more frequently to be found in much larger quantities, circularly arranged round a centre, which has the appearance of being a small orifice. It is often, at the outer edge, of the size and thickness of a wafer, (see specimen, letter D:) these three latter adhere firmly to the stone. The flakes generally split when the stone is separated by a blow, one half adhering to each side; and one may often perceive the same ragged stringy appearance, so often exhibited, and more particularly visible in the common fracture of a black flint.

There is no stage between this and the absolute cementation of the two parts by means of this exudation; and I suppose that the whiteness of the substance may be occasioned by its greater liability to decompose, when not completely hardened; and where the white line is of any considerable thickness, as it often is, to a quarter of an inch or more, it seems probable, that the interstice has been partially filled up by the abraded particles produced by friction, or by the chalk falling in between.

But how is this substance condensed without the aid of atmospherical air? Very compact flints of considerable size, and agate-balls, are found to contain crystals of quartz and chalcedony in the interior; and sometimes flints, which appear to have rent in the heart by the effect of contraction when drying, have been filled up with siliceous matter, (see specimen, letter F,) none of the rents reaching to the surface. Similar effects of drying are to be observed in balls of lime and ironstone, which sometimes remain vacant, and in others are filled up with calcareous matter, &c. probably by infiltration.

The moisture above mentioned, as being found in flints, in a great measure disappears when they are exposed to the atmosphere, though not entirely; for I have found it in some that have been exposed for a great length of time, and after baking them too for some hours. Possibly the stones may partially crack, by exposure, in a manner imperceptible to the eye. They appear to contract, and to be elastic to a certain degree.

I never could induce them to re-imbibe any moisture by soaking them in water.

There is a common effect of the atmosphere upon chalk-flints which is curious and interesting. It commences in little white spots or rings, which appear upon the surface. After a time, pieces break out in the form of a crescent, with three angles, the lower angle being perpendicular to the plane of the surface, so that a crescent-shaped hollow is left, the inner side of which forms a half cone; these of course multiply; and the projecting parts falling into dust, if the stone exists long enough in an exposed situation, they are succeeded by others.

When a flint, therefore, decomposes, what does it first part with? It becomes white, opaque, and earthy, and at last it would appear calcareous, yet in bulk it is the same; must it not lose that principle to which it is indebted for its tenacity, its compactness, and its transparency?

ART. XV.—*Observations on the Habits of the Hyæna.* By ROBERT KNOX, M. D. F. R. S. E. Lecturer on Anatomy and Physiology, and Conservator of the Museum of the Royal College of Surgeons. Communicated by the Author.

ABOUT a year ago, the Wernerian Society of Edinburgh did me the honour to publish in their Transactions, a brief notice by me of the habits of the hyæna, at present existing in Southern Africa, in which I endeavoured to show, 1st, That the Rev. Mr Buckland, in his Geological Speculations, intended not so much to advance science, as to fix the era of a universal deluge, had taken up inaccurate, or at least by far too sweeping views of the natural habits of this ferocious animal: and 2d, That it was of little moment to a geological theory, what were the habits of modern or postdiluvian hyænas, since the antediluvian relics belonged to a different species; which latter circumstance Mr Buckland seems to have forgot, (or perhaps was not acquainted with,) until reminded of it by Dr Fleming. I shall now take the liberty of returning to the subject, and of pointing out to Mr Buckland, (since he has honoured my former brief notice with a short comment,) several facts in the history of these animals, which militate against his "Theory," and render his mode of accounting for the accumulation of bones in the Cave of Kirkdale, absolutely untenable.

1. In the immediate vicinity of the abodes of men, the hyæna usually drags his prey to a considerable distance, *in order that he may not be disturbed at his meal*; but his enormous voracity is a hindrance to his dragging the prey to any great distance, much less to store up food in caves, with a foresight exceeding most of the savage human tribes. Where the country is thinly inhabited, they will eat the carcase of an animal a few hundred yards from the houses; and where there

are no houses, they will eat until they are filled to the mouth within thirty yards of a great number of armed men. I saw this happen;—a large striped hyæna was killed, during the night, by a sentinel, within thirty yards of an encampment of nine hundred men; on dissecting the animal, it was very evident that it had been engaged otherwise than dragging the bones to its den, (possibly twenty miles off,) for its stomach was so enormously distended with the offal of the cattle which had been felled all round the camp for the use of the troops, that it seemed, at first sight, to occupy the whole abdominal cavity. Now this dissection was performed by me before hundreds of persons.

2. I feel surprised that Mr Buckland can have forgot the account Bruce gives of a hyæna which ate, during the night, and close to his tent, more than would have sufficed half-a-dozen dogs. It is true, that Mr Bruce's reviewers made it out, that the hyæna had ate more than his own weight; but, setting aside this part of the story, which, of course, is a diverting exaggeration, Mr Bruce might have told his reviewers, that until they had examined the stomach of the hyæna, they could not well imagine its vast capacity, commensurate with the natural voraciousness of the animal. I could easily multiply these instances from my own experience, for there were killed sometimes four or five hyænas within eight days, close to our habitations. Assuredly these animals were not busied in carrying away bones to remote caverns for future geologists to speculate upon.

3. It is not improbable that, in thickly inhabited countries, the habits of the hyæna may be much altered, as we find to be the case in all other wild animals.* When much harassed they become timid, and fly far from the abodes of men. I

* My friend, Dr Versfeld, a native of the Cape, informs me, that he has, on two occasions, observed caves in the Table Mountain, in the immediate vicinity of Cape Town, which contained a few bones, apparently of some ruminating animal; he ascribed the presence of these bones in the caves to the agency of hyænas, with which opinion I entirely agree. When we reflect on the proximity of so populous a town as the Cape to the Table Mountain, it is quite surprising that large collections of bones have not been found in its caves; the number of hyænas inhabiting these mountains must be very great.

should be glad to offer this explanation in support of the supposed habits of the Kirkdale hyænas, but, unfortunately, the antediluvians had not discovered Britain, which, though a fine country, and full of nature's finest productions, did not boast of them as tenants.

4. Hyænas do not *congregate*; they are solitary. Consequently, all that Mr Buckland has said about *a den of hyænas*, is simply the work of the imagination heated by a false theory.

5. The young of the hyæna follow the dam early into the field, so that the quantity of food required to be carried to them must be small.

6. I do not believe that hyænas reside in caverns; they are too timid and distrustful of every thing. The almost inaccessible parts of the country to which they retire during the day-time, must have been visited by very few travellers. I cannot say that I have ever discovered hyænas in dens, though I have often been present when they were roused from their lurking-places.

These are all the observations I intend offering on this subject. It probably did not merit even these, since, as I formerly hinted*, the habits of modern and antediluvian hyænas might be entirely different, as they belong to different species. But however this may be, none who has inspected the Kirkdale bones, deposited in the Hunterian museum, can hesitate for a moment in declaring, that these bones have never been fractured by hyænas; they have been broken by great external violence, and not by the agency of the teeth of living animals; and they do not differ in any respect from the bones found at Oreston and elsewhere, which bear no such marks of violence. It seems indeed strange that the agency of wild animals should be resorted to in explaining the osteological collection of the Kirkdale cave, when so many other collections are allowed to have been formed in an entirely different manner. But the truth is, that we have evidence in the nature of the relics themselves, subversive of Mr Buckland's speculations on these subjects; 1. The bones found in the cave of Kirkdale do not bear the marks of having been broken by hyænas, but of having been dashed to pieces, and exposed to the action of water; 2. They belong to animals of a different species

* Wernerian Transactions, vol. v.


Section of the Railroad
Plan

from any which now exist; like the mammoth, they have entirely disappeared from the face of the earth; the very race has been utterly destroyed. But the deluge which effected this, was not the universal deluge described in Scripture, for of all that then lived, and was liable to be destroyed by the devouring element, *individuals were carefully preserved to extend the race of animals to the present day.* Mr Buckland will, I trust, see the propriety of in future avoiding all speculations which have even a remote tendency to mingle up matters esteemed by most men as sacred, with short-sighted human theories, amongst which, I fear, must be ranked that which he has brought forward, and defended with much ingenuity and labour.

Art. XVI.—*Account of the Explosion of Oil Gas which took place at Edinburgh, on the 23d March* 1825, *with Observations on the Safety of Gas.*

Among the events of the physical world, which record at distant intervals the fury of the elements, there are few which occasion so great alarm as the explosion of those powerful agents which we have, as it were, domesticated for our use. The mind soon reconciles itself to dangers, however appalling, which it can neither foresee nor control. The West Indian breathes with tranquillity the same air which, but a few hours before, has been agitated with a hurricane or a tornado. The South American treads fearlessly on the very soil in which the earthquake has engulfed his friends and his relations; and the Catanian rebuilds his habitation, with that very lava which, in torrents of liquid fire, had swept his former dwelling into the sea. It is far otherwise, however, with those calamities which spring from carelessness or miscalculation. If, in augmenting our comforts, we have unthinkingly added to our dangers; or if, in availing ourselves of the wisdom of the serpent, we have forgotten to protect ourself against its sting, we must then submit to that self-reproach, to which our want of judgment, or our want of caution, has so justly exposed us.

During the last thirty years, science has been making vast contributions to the immediate comforts and wants of our species. While the giant of mechanism has been thrusting his brawny arm into the bowels of the earth, and stretching it over the face of the deep, a more gentle spirit has been scattering around us every species of refinement, and transferring to the humblest dwelling, what were once the ornaments and the luxuries of the palace.

Numerous as these improvements are, there are none that so eloquently bespeak the predominance of science, as the introduction of gas-light into our cities, our manufactories, and our dwellings. To convert the blackest coal, and the most rancid oil, into an ethereal element almost capable of turning night into day, was a step in practical discovery, which the most sanguine speculator could scarcely expect to realize; but even after this step was taken, how much invention, how much skill, how many combinations were requisite, before the inflammable element could be made to flow in currents beneath our streets, and circulate in safety between our partitions? All this, however, has been accomplished, and we may safely affirm, that there is none of the powers of nature, which Providence has made subservient to man, more completely under his control, or less likely to break loose from the bondage to which science has committed them, than that gaseous element of which we are now treating. It has, accordingly, been introduced into all the principal cities of the united kingdom, both for public and for private use; and in our own northern metropolis, two extensive establishments have already been completed for coal, and for oil gas; and a third is in a state of forwardness, for supplying the public with compressed oil gas in portable vessels. All these establishments are placed under the management of able and respectable individuals, who have hitherto shown themselves more solicitous to promote the interests of the public, than to look after their own individual advantage; and we venture to say, that there are no establishments conducted with more liberality, more skill, and more attention to the public safety, than the two gas establishments in our own city.

The oil gas establishment had just began its operations, when that alarming and melancholy accident took place, of which we propose to give some account; but in order that our readers may fully comprehend the true cause of this explosion, and may appreciate the real amount of the danger which is supposed to attend the use of gas, we beg their attention to the following observations.

As gas itself is not an explosive substance, and as it is not compressed in any of the pipes by which a house is supplied, it is *impossible* that any explosion can take place within the pipes, even if the gas were by any accident set on fire. Even if a room were filled with pure gas, the gas would not explode, though a lighted candle, or a piece of red-hot iron were placed in the middle of it. Gas becomes explosive, and consequently dangerous, only when it is mixed with a certain proportion of atmospheric air. It is then called an explosive mixture, and may be exploded by carrying a lighted candle into the middle of it. The proportion of atmospheric air necessary to render gas explosive, depends on the nature and qualities of the gas, and it may be said in round numbers to vary from *three-fourths* to *fourteen-fifteenths*, that is, there must be from 1-4*th* to 1-15*th* of gas in the mixture to render it explosive.

In order that an explosive mixture of gas and air may be formed, it is necessary that the stop-cocks which let off the gas should be left open for a great length of time; that there should be no change of air in the apartment; and that a lighted candle should be brought into it after the mixture had become explosive, and before it ceases to be so. All these circumstances must be combined before an explosion takes place. With regard to the first, we can conceive nothing more unlikely to happen. We never hear of a servant leaving open a water-cock and inundating the house, though there is no personal danger to himself in committing the fault. In the case of the gas, the servant knows that by his carelessness he is exposing himself to the chance of an accident;—but admitting that his carelessness is such as to overlook this consideration, and that he *has left open the stop-cock*,* the gas flows slowly out, and must flow for very many

* The difficulty of leaving open a gas-cock, by mere carelessness, is very considerable. As the lights are put out by shutting the gas-cock, it must necessarily be shut before the flame disappear, and it is not to be supposed that any servant will turn it back. Those who are so shamefully ignorant

hours, before it has discharged itself to a dangerous amount. Is it at all probable, or even possible, that the careless servant, or the other domestics, shall wander about the house for a day or more without being annoyed by the noxious smell of the emitted gas?* Let this contingency, however, also take place, and let the gas stream out unperceived for a whole day. Even then it by no means follows that an explosive mixture is to be generated. The constant current which takes place in every room, with a door, a window, and a chimney, is perpetually changing the air in the apartment, and *even that which lodges in its remotest corners.*† The gas will consequently be carried off by the ventilation, and, in proof of this assertion, we may state, that there *is no case on record where an explosion of gas has taken place in an apartment with the ordinary ventilation.* But let this, too, be rendered probable, and let us suppose that the ventilation is somehow or other suspended. In this case the gas must be issuing from every crevice, and it is impossible, if a servant does approach the room with a lighted candle, that he should ever reach the door without being repelled by the odious smell of the gas. Should the servant be suddenly deprived of the use of one of his senses, he may carry the candle into the explosive mixture, (if it happen at that time to be explosive,) and thus fall a sacrifice to a miraculous combination of circumstances; but if he advances with the use of his olfactory nerves, he must be considered in the same aspect as a madman, who should light himself into a powder magazine with a pan of burning coals. In this argument we have supposed, that the gas has been

of the nature of gas as to blow out the flame, or put it out with an extinguisher, without turning the cock, should be sent to school before they are admitted into rational society.

* We do not allude to small apartments or cellars without windows or chimnies, (though even here it will be seen from facts that the argument is applicable,) for we are of opinion that the engineer who fixes a gas light in such places ought to be indicted for a felonious ignorance of his profession.

† This arises from what is called the lateral communication of motion in fluids, and has been established by the numerous experiments of Venturi and others. See the Article *Hydrodynamics* in the *Edinburgh Encyclopædia,* vol. xi. p. 493—497. where these experiments are fully detailed.

escaping during the precise interval when it has not been in use in any other part of the house, for it is well known, and will be proved in the subsequent part of this paper, that the lights which are burning will indicate to the family that the gas is discharging itself in some part of the house, and will, therefore, induce them either to apply for help to the Gas Company, or to send a servant without a light to discover the place of discharge, shut the cock, and ventilate the apartment. If the escape happens during the day, when no lights are burning in the house to give these indications, then there is no danger whatever of an explosion, as there is no occasion to carry a light about to discover the place of escape, or for any other purposes.

Having thus pointed out the nature of the danger which may be apprehended from excessive and palpable negligence on the part of the engineer and the consumer, we shall proceed to give an account of the explosion which took place in the house of Colin Mackenzie, Esq. on the 23d March 1825.

In the area, and immediately under the stair leading to the front door of Mr Mackenzie's house, there was a small outhouse B, Plate I. Fig. 1., about six feet high, and four feet square, which was completely covered in, partly by the steps of the stone stair above, and partly by a stone covering at the back. It was plastered on the top inside, and had no outlet whatever except a very small door D, with two small slits in it, which opened into the area. The place was very close and completely unventilated. It was used for cleaning shoes and knives, and in it was placed the meter G, through which the supply of gas for the whole house passed. A gas light *b*, was most unfortunately fixed in this very small out-house, and supplied by a quarter inch branch pipe, which terminated in a bent brass tube, called a knee, the aperture of which was three-eights of an inch in diameter. Into this knee was inserted a jet burner, which is put into the brass knee like the stopper into a wine decanter, and can be removed like it at pleasure, being neither screwed nor soldered.

On Saturday, the 19th of March, the inspector examined the meter and the gas-fittings in the shoe-house, and through the house. He ascertained that they were perfectly tight and correct, and found that there was not the smallest appearance of leakage, or any symptom of smell in the place.

Without the knowledge of his master, or any member of the family, the footboy, Robert Whitewright, between fifteen and sixteen years of age, had been in the habit, since the introduction of gas into the house, of trying various experiments with the gas, and of removing the burners or jets from the knees, and burning the gas from these knees at full flame; and he had done so not only at his master's, but in the house of another gentleman. He was also in the habit, it would appear, of taking off paper bags full of gas and exploding them. The boy had been strongly cautioned by different persons against continuing such practices, but without effect. Cleaning the knives and shoes being his particular department, he had thus constant access to the small shoe-house already mentioned, and to the pipe and burner placed in it.

On the night of Wednesday, the 23d March, about half-past five o'clock, while Mr and Mrs Mackenzie were in the country, the smell of gas was perceived by the family in the dining-room, which is above (above M,) the area where the shoe-house is situated, but after searching every where through the house, they were unable to discover whence the gas issued. The lustres in the dining-room were lighted at six o'clock, and during the space of ten minutes the gas burned as brightly as usual, but it afterwards became bluer, and at last went out. Mr Mackenzie, jun. went down stairs to ascertain the cause of this, and asked the boy if he had turned off the gas. Having learned that he had not, he returned into the dining-room, and again tried whether the gas would burn, and on applying a match to it, it burned and lighted as usual. At a quarter past seven the smell became so strong in the dining-room, that the window was put up to ventilate it, and the boy was then sent to the gas-office to give information there of the smell; but the inspector had not time to arrive before the explosion took place.

Besides the boy, there were two women servants in Mr Mackenzie's house, a nursery and a kitchen-maid. The nursery-maid does not know, and the other is unable, from the state in which she is at present, to say at what time the boy returned. It is certain, however, from the declaration of Lady Ramsay's butler, that the boy was in Mr Mackenzie's house at ten minutes past eight o'clock.

In the mean time the smell of gas continued to be perceived in the house, and by passengers on the street, very strongly. It was so strong in the dining-room of Lady Ramsay's house, (above N,) which is immediately adjoining Mr Mackenzie's, and the windows of which are very near that part of Mr Mackenzie's area, in which the shoe-house is situated, that the ladies complained of it. At ten minutes past eight o'clock, Lady Ramsay's butler accordingly went into Mr Mackenzie's area, and knocked at the door C for the purpose of informing the footboy of the smell, and also that the gas was escaping. The boy came to the door with a light in his hand, and told the butler that he had been to the gas-office, and that a person was to come to examine the house. While they were speaking a woman servant came into the passage leading to the door C. Without mentioning his intention, but, as Lady Ramsay's butler supposes, for the purpose of examining the state of the shoe-house, the boy proceeded towards it with the light in his hand, and had no sooner opened the door D than the butler observed the gas issuing from it in a blaze, he heard an explosion, and saw the wall of the shoe-house blown outwards. This was all the work of an instant. He was at this time about two paces behind the boy, and was instantly thrown down, and remained insensible, but he neither saw what became of the boy, nor of the woman that was in the passage at C. In the course of a few minutes the boy was found extended in the area quite lifeless at A, and the woman was found insensible within the passage of the house at C. The butler has received no material injury, except being scorched in the face; and the woman, though very severely injured, is considered not to be in immediate danger. The windows of the house were shattered by the explosion, as well as those of some of the neighbouring houses. The walls and doors of the shoe-house were driven out, and the cellar-doors at 1, 2, and 3, driven in and broken, but, with the exception of the windows, no part of the house, nor any thing within it, was injured.

Shortly after the accident, the shoe-house B was examined by

Dr Brewster, Mr Hunter of Thurston, and others, when the gas meter G, and the pipes leading to and from it, were found quite entire and right. The knee, or pipe before mentioned at *b*, Fig. 2, which supplied gas to the burner in the shoe-house, was found, as it was before the accident, rivetted to the wall, but *without the jet burner belonging to it.* The fastenings of the service pipes, and every part of the gas apparatus were examined, and appeared to be in the best order.

It is, of course, impossible to ascertain, by *direct evidence*, how the shoe-house came to be filled with gas; but Mr Milne's workmen and the company's inspector concur in opinion, that it could not escape from the service pipes or the meter; and that there was no other possible way in which it could have escaped, except from the open pipe belonging to the burner *b* in the shoe-house. Dr Brewster concurs in opinion with the inspector, that this pipe would fill so small a space as this unventilated shoe-house in little more than two hours, and he also concurs with him in the belief, that it was from this pipe that the escape took place. They are further confirmed in this opinion, by the mode in which the gas burned in the dining-room in the earlier part of the evening, for if the end of this pipe were left without the burner during the day time, the atmospheric air would enter the service pipe through it, and displace the gas in the distributing pipes throughout the house to a certain extent, so that, when the gas was first lighted in the dining-room, the pure gas, propelled forward by the atmospheric air, would burn with its usual brightness, until it was expended, and the flame came in contact first with the mixture of gas and air, when it would burn blue, and next with pure atmospheric air, when the light would be extinguished; but when the gas was turned on by the stop-cock on the general service pipe, the pressure on it would naturally force the atmospheric air wholly out of the pipe and the lustres would light again; while, at the same time, the gas would be driven out with great velocity by the pressure from the street through the open pipe *b* in the shoe-house, so as to fill the place in a very short period. Dr Brewster is of opinion, that the jet burner could not be displaced from the mouth of the pipe by the explosion, and he also stated, that had it been allowed to remain in its place, even under any circumstances of carelessness, gas could not have escaped from it, even in a considerable space of time, sufficient to form an explosive mixture.

To those who read with attention the preceding statement, for the minute accuracy of which we can pledge ourselves, it is unnecessary to add, that the particulars which have been detailed, point out, in a striking manner, the *safety*, and not the *danger* of using gas. The gas made its escape, neither from *accident* nor from *carelessness*; but the *jet* which closed up the end of the pipe was *forcibly removed* and *carried* off, and the unfortunate boy, who had done the mischief, fell a victim to the consequences which it produced. This accident must, therefore, be ascribed to the following causes:

1. To the blunder of the engineer in placing a burner in an unventilated cellar.

2. To the misconduct of the boy in having removed the burner, so as to allow the gas to flow out of a large orifice; and,

3. To the ignorance and carelessness of the same person in using a lighted candle, when it was known to himself that gas had been escaping for a considerable time from some of the pipes.

Although these conclusions have been drawn by all persons of intelligence, yet, in a city like this, where the explosion was heard at a great distance, and its effects witnessed by all, it is not to be wondered at, that ignorance and timidity should have been induced by this accident to array themselves against the introduction of gas into their houses. The first of these grounds of hostility has been already removed by the accident itself, which, from being the subject of frequent conversation, has made the nature and advantages of gas very generally understood. The second ground of hostility has also, in a great measure, disappeared; though to a certain extent it will, perhaps, always maintain its influence over timorous minds.

All such apprehensions, however, whether they originate in ignorance, or timidity, must soon be dissipated by the lights of knowledge. Individuals may receive or reject benefits which science has offered only to themselves; but those boons, which she has conferred upon the species, must be accepted alike by all. No vulgar fears, no intrigues of faction, no exercise of power, can stem that tide already set in upon the world, which is bearing on its wave to the remotest lands, the treasures of intellectual wisdom. We do not allude to that vain and speculative knowledge which raises practical men out of their sphere, and which inflames the ambition, while it paralyses the hand of industry, but to that useful and applied wisdom, which ripens its fruit where it displays its foliage, and ameliorates the condition of its possessor in his professional, his domestic, his social, and his political relations.

This general principle is in no case more applicable than to the great discovery of gas illumination. Those who are afraid to avail themselves of its benefits, are placed in circumstances of as great danger as those who enjoy them; and it is a singular fact, that the greater number of accidents have happened from the leakage of gas into houses where it was not used, and where the inhabitants could not have taken any precautions against its approach.

Although we cannot doubt that the dread of gas explosions will disappear as quickly as the dread of explosions on board steam-vessels, yet it is right that those who patronize and recommend the use of this light, should strive to remove even unreasonable apprehensions, by providing securities against the most improbable contingencies. With this view, we shall conclude this article, by enumerating several safety contrivances, some of which will, we think, go far to remove all suspicions of danger even from the most timorous minds.

1. The *safety, or self-closing, burner* of Mr Jennings, described in our last Number, p. 344., offers the most perfect protection against the escape of gas. If the gas flame is blown out, or put out with an extinguisher, or if the cock is left entirely open, this burner closes itself, and prevents the escape of gas. We are not aware to what extent this burner has been used; but whether it answers its purpose or not, which, however, we do not doubt, it is very obvious, that a self-closing burner may be constructed in various ways, and made quite effective for all practical purposes.

2. Another protection against the escape of gas may be ob-

tained by shutting the gas entirely off when it is not used, by means of a *stop-cock* placed near the main door where the pipe enters the house. This, we believe, is already adopted in Edinburgh; and as it is next to impossible that gas could escape unperceived to any dangerous extent while it is burning from various apertures, this main stop-cock must be held to be a great security. Lest the servant or the master of the house should neglect to put out this stop-cock when the lights are put out, various contrivances might be adopted for preventing any such negligence. A light, for example, issuing from a small jet, might be so arranged that it could only be put out by turning the main stop-cock; a reflector might be so placed on the stop-cock as to indicate, during the day, that it had been left open; and various other simple contrivances might be resorted to for reminding the master of the house of his duty.

3. The most important safeguard of all, and the only one which we think really useful both to those who use, and to those who do not use gas, is one of Sir Humphry Davy's *safety lamps*, which should be lighted whenever there is any suspicion that gas has been making its escape either from the pipes of the house, or leaking into the cellars from the main pipes in the streets. With this lamp we may advance with perfect security into rooms filled with the explosive mixture, and thus protect ourselves against every possible risk.

Art. XVII.—*Description of a Machine applied to a Gig, for Measuring Distances.* By William Edgeworth, Esq. C. E. and M. R. I. A. Communicated by the Author.

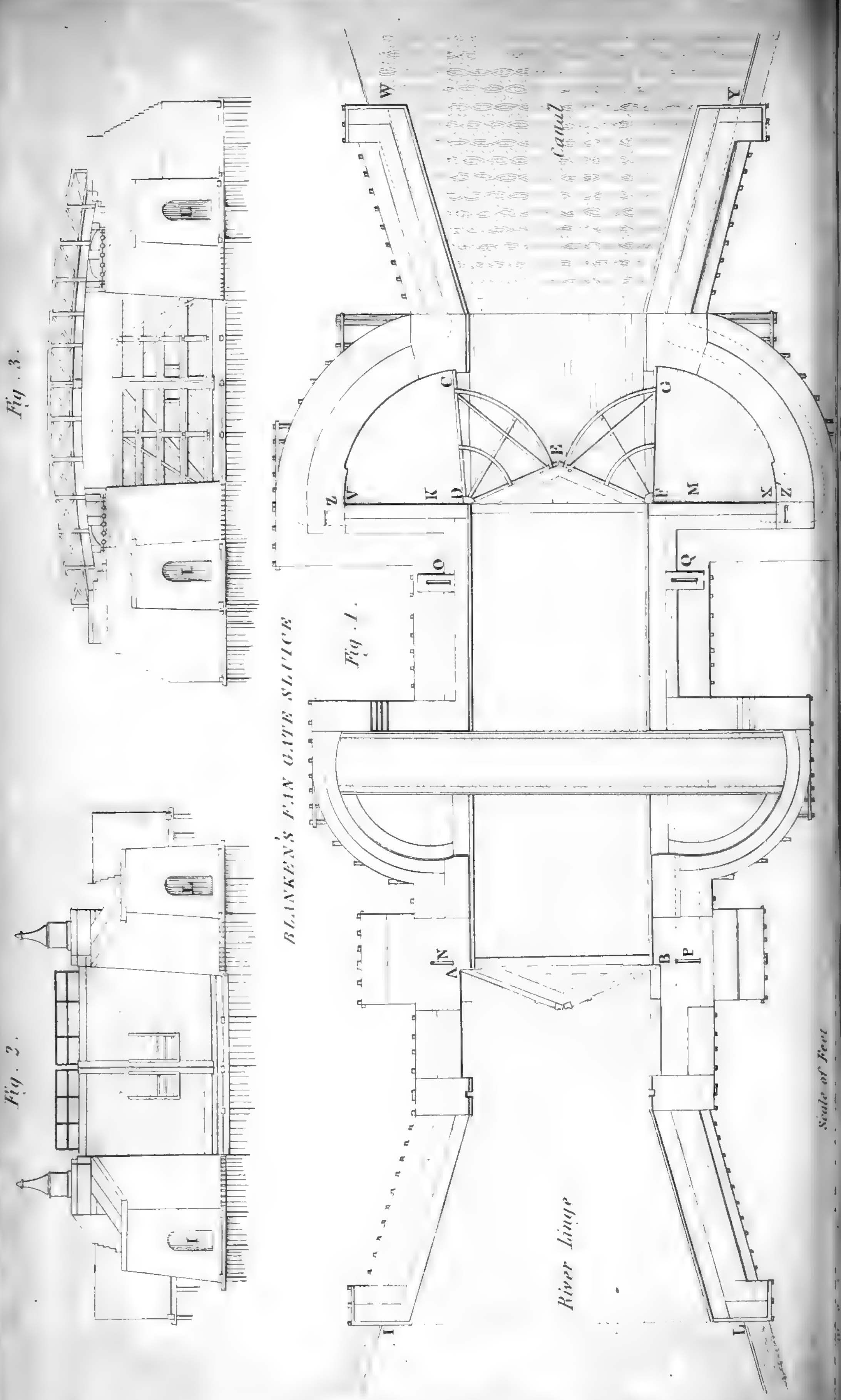
There have been a variety of machines applied to carriages, for counting the revolutions of the wheel, and thus measuring the distance travelled over; but all that I have ever heard of, wear rapidly and get out of order, as the machinery is placed on or near the axletree, on parts of the carriage that are subject to jar.

For this reason, I was determined to suspend on the body of the carriage, which was on springs, all the machinery requisite for registering the revolutions of the wheel. I availed myself of R. Gout's patent pedometer, which is of little accurate use in the pocket, worn as a watch, for counting the number of steps in walking.

I placed this pedometer horizontally in the elbow of the gig: It was there secure, concealed by a little door covered with cloth, so that the dial-plate was not easily discovered, except by a person who knew the opening. The difficulty in the machinery was to communicate motion to the pedometer, which being in the body of the gig, and of course on springs, was subject to constant alteration of distance from the wheel; but as the springs played in nearly a perpendicular direction, I passed through the side of the gig, an upright spindle, which came some inches below the axletree. The lower end was bent in a crank shape, and this crank came in contact with a pin of about half an inch diameter, that was driven in to the nave near its circumference.

Round the spindle there was a helical spring, which slightly urged the cranked part against the axletree, but every time the wheel revolved, the pin in the nave pushed the crank out for a few inches from the axletree, and it returned to its place by the action of the spring as the pin receded. On the top of the spindle was placed a lever of about two inches long, a little above the level of the pedometer; this acted against the short perpendicular arm of a crooked lever, the long horizontal arm of which lifted up the handle of the pedometer, and by this means caused the hand to advance one division on the dial-plate. Now, this horizontal arm was elastic, and allowed the motion, communicated from the nave, to be much more than was necessary for raising the handle; the elastic lever was also bent by the motion, so that no jolting should cause any variation in registering the number of revolutions. In fact, this idea of allowing by elasticity an overplus of motion, and of placing the whole machinery on springs, are the only new principles in this little contrivance.

It will be best to have a mile measured accurately on a straight road, then, by driving backwards and forwards a few times, and taking the mean of the number of revolutions which the wheel performs in the mile, a table can easily be formed for any carriage, whatever may be the size of the wheel,



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W. H. Lizars

showing the value of the revolutions in miles, furlongs, and perches.

When the roads are in good order, there will not be found a difference of one revolution in five hundred, or not one in the distance of a mile.

It is curious, that, in wet weather, it always shows a smaller measure than the true, from this reason—that the tire of the wheel becomes lined with mud, which, in fact, adds to the size of the wheel. When the mud is very stiff and adhesive, there is a difference of one in two hundred. Measuring with the wheel of a carriage is more accurate than with the common wheel odometer, the carriage wheel being larger, and the load that it supports preventing the possibility of its slipping, and also tending to prevent the jumping that takes place when an unloaded wheel meets with any obstacle. The dial-plate of this pedometer admits of travelling more than twenty miles before the long hand makes a complete revolution, and the distances can be seen by mere inspection without stopping the gig.

I tried this machine during five years of constant travelling, while I was employed on the survey of Roscommon: It remained in good order, and I found it saved me time in supplying any little omissions in the maps of my surveyors.

This machine has also been used by a friend in London for some years, and he has found it remain free from sensible wear.

EDGEWORTHSTOWN, *March* 25, 1825.

ART. XVIII.—*A Description of Fan-Gate Sluices,* invented and Constructed by Mr J. BLANKEN, Jun. Counsellor of State, Inspector-General of Public Works in the kingdom of the Netherlands. By Dr G. MOLL, Professor of Natural Philosophy in the University of Utrecht. Communicated by the Author.

IN 1808, Mr Blanken published a paper on this invention, which soon after was put to trial by order of government. As it met with success, about twenty sluices, of large dimensions, have been constructed on the same principle since that period, all of which have been found perfectly to answer. In this country, it has always been held a desideratum to find the means of opening locks against a powerful head of water; this, I think, Mr Blanken accomplished successfully; I, therefore, deemed a description of these sluices worthy of being inserted in your *Journal.*

The properties of Mr Blanken's sluices, or locks, are the following:

1*st*, That the flood-gates, destined to act against the pressure of exterior high water, will, if required, equally act against the interior when it is expedient to sustain it at a higher level than the exterior water.

2d, That, when the tide or current runs with great force, either in or out of the locks, the gates may be easily, safely, and speedily shut, whatever be the direction of the current.

3*d*, That the gates can be opened with ease, even when a head of seven or eight feet of water bears upon them.

The annexed drawing in Plate IV. is of a sluice of this description. It was built in 1818, near the town of Gorinchem, in Holland. It opens a communication between the river Linge and the newly made canal of Steenenhock, and it is alike destined for the purpose of inland navigation, and of evacuating or retaining superabundant water. Whenever the waters of the Linge are swoln by a rise of the Rhine, it becomes dangerous to admit them into the canal; but, at the same time, it is required that the locks can be opened at pleasure, whatever be the difference of levels in the river and the canal.

Figure 1st of Plate IV. shows a section of this sluice, the second the plan, the third a front view, and the fourth the back part of the sluice, the whole on a scale of $\frac{1}{200}$ of the real dimensions.

A B are flood-gates, constructed on the ordinary principle, the angle which the gates form being opposed to the river Linge.

C D and E G are *the fan-gates*, thus called by Mr Blanken, from some analogy in their form to that of a lady's fan.

The gates, C D E, turn on one common axis, D H, Fig. 1. so that, when the gates are shut, D C is in the position shown by the drawing, but when the gate opens, D C moves backwards in its semicircular case of masonry.

The same takes place with the other gate E F G, which equally turns on the same axis. The parts, F G and C D, are of greater length, but of the same depth, than the parts D E and F E. In this sluice, F G and C D are each twenty-two English feet in length, whilst D E and F E are seventeen feet only. This difference in length of the two connected parts of the gate, contains the principle on which its action depends. The figures show, further, how the different parts of the gate are braced together by framing of iron and timber.

The dotted lines, I K and L M, indicate canals or conduits through the masonry of the walls. Their apertures are seen in Fig. 2 and 3, at L and I. They open a communication between the exterior river-water, and the simicircular spaces in which F G and C D turn. This communication may be shut or opened at pleasure, by means of slides at N, O, P, Q, and which are lowered or raised by iron windlasses.

There is another similar conduit in each part of the sluice, communicating from the semicircular spaces behind the fans, with the water of the interior canal; they are shown by the dotted lines at V W and X Y, and this communication can also be shut up by slides, at Z and Z.

It is thus that a communication may be opened or shut, first, between the exterior or river-water, with the semicircular spaces in which the fan-gates turn; and, secondly, between these semicircular spaces and the water of the interior canal.

The following two cases may occur in the use of these locks: the exterior water in the river Linge may be higher than that in the canal, or the water in the canal may be higher than that in the Linge. In the first case, when the exterior water is highest, supposing the flood-gate A B to be open, it is required to resist the superior force of the river-water by the fan-gates alone. Let the slides N, O, P, Q, be raised, and those at Z and Z′ be shut or lowered; the communication between the external or river-water, and the water behind the fan-gates, rises to the same level as in the river; and as the length of the gates, D C and F G, is superior by about 1-5th to the length of the gates, D E and F E, it is clear, that the hydrostatical pressure against the former must be superior to that against D E and F E. The consequence is, that this superior pressure against D C and F G, keeps the gate shut, and precludes the exterior water from running through the sluice in the canal. In locks of the common construction the gates must open, as often as the water is highest, on the concave side of the gates. In Mr Blanken's sluices, the gates may be kept shut at whatever side of them the water stands highest.

Now, things being in this state, let it be required to open the fan-gates, and thus give free access to the water of the river. Nothing more is wanted for this purpose, but to open the slides Z and Z′, and shut those at O and P; thus, the level in the semicircular cases will descend to that of the canal. The hydrostatic pressure will be the strongest against the parts D E and E F; of course, they will yield to that superior pressure, open and admit the water of the river into the canal.

Supposing now the water to run in from the river into the canal, with a difference of level of seven or eight feet, nothing is more easy than to prevent any further supply of water into the canal, and to shut the fan-gates against the current, which seems to run through it with unbounded strength. Let down the slides Z and Z′, and raise those at O and P. The pressure of the water running through the conduits L M and I K, against the greater surface of the gates D C and F G, is more powerful than that against the smaller surface of D E and F E, consequently, the stronger pressure will prevail, and shut the gates leisurely against the current. The column of water, which rushes through the sluice, is gradually contracted by the shutting of the gates, and, finally, on their coming together is reduced to nothing.

If our supposition is reversed, and the water in the canal stands higher than in the river, Mr Blanken's sluice may be equally well managed. Let the gates A and B again be open, and the fan-gates shut against the higher water of the canal. It is well known, that it would be impossible to open the gates of a common sluice, when the difference of levels is somewhat considerable. In this it may be effected without any difficulty, by again rendering the pressure which the water exerts, greater on D C and F G, than on D E and E F. For that purpose, open the slides P, O, N, and keep Z and Z′ shut; the water in the semicircular cases will descend to the level of the river; thus the hydrostatic pressure on the exterior side of D C and F G, will become superior to that exerted by the canal water on the gates D E and E F; of course, the latter will open even against a difference of level of several feet.

It will now, I trust, be easily understood, how, by a similar operation, the gates may be shut again, whilst the canal waters are running down through them. The slides P and O are shut, and Z and Z′ opened. The semicircular cases will be again filled by the higher water from the canal, and the difference of pressure, against both part of the fan-gates, will determine the shutting of the gates.

The velocity with which the gates are opened or shut, may be managed at pleasure by those who guide the slides; and by opening or shutting the slides more or less, according to the difference of levels, a slow and gradual motion is effected. Even when the fan-gates are in the act of shutting or opening, the operation may be reversed in an instant, and the gates either shut or opened as occasion requires.

It will also be understood, that the flood-gates A and B are merely intended for passing vessels from one level to the other. Whenever such passage is not wanted, the gates A B, may be dispensed with. Accordingly, in the several inundation sluices, which have been built lately, only one pair of fan-doors is required.

I hope it will appear from this description, that the fan-gates may be opened and shut with ease and safety, whenever occasion requires, and whatever is the difference of the levels. When sluices, on the ordinary plan, are once opened, it is impossible to shut them again whilst the water is running through them, and, if once shut, as long as the exterior water is somewhat higher than the interior, it is quite out of the question to open the gates. In this country, at least, it is of high importance to have the means of opening and shutting gates with every difference of level, and, in this respect, the inventor of the fan-gate sluices has certainly conferred a great benefit on his country.

A successful practice, of more than twelve years, has confirmed the expectations anticipated from this invention. A great number of fan-gates have been constructed, and many more are now building.

Utrecht, *6th September* 1824.

Art. XIX.—*Table of the Rise of the Tide at Hobart Town, Van Diemen's Land, in April and May* 1822, *and January* 1823. Communicated by his Excellency Sir Thomas Brisbane, K. C. B. F. R. S. L. & E. &c.

1822.		Morning Tides.	Rise.	
Month.	Day.	High Water.	Feet.	Inches.
April	25	At Noon.	5	6
	26	1 0 P. M.	5	0
	27	2 20	4	6
	28	3 4	4	2
	29	4 10	4	0

1822.		Afternoon Tides.	Rise.	
Month.	Day.	High Water.	Feet.	Inches.
May	20	At 6 0 P. M.	4	6
	21	8 0	4	4
	22	10 12	4	5
	23	11 14	4	6
	24	2 0 A. M.	6	0
	25	3 6	5	2
1823.				
Jan.	1	6 0	4	9
	6	11 10	4	3
	8	2 4	4	8
	10	4 16	4	3
	21	6 40	4	2
	26	2 0 P. M.	5	1

Art. XX.—*On the Application of the Expansive Power of Liquids to produce a Reciprocating Rectilinear Motion.* In a Letter to the Editor.

Sir,

It has sometimes occurred to me that the almost entire incompressibility of liquids, employed with so much effect in Bramah's invention, might likewise be used to produce an incontrollable reciprocating motion, and be thus made to communicate uniform motion to machinery of any extent. I was curious enough to make some calculations upon the subject in the *rough way*, and if you think they will answer any of your readers, they are at your service. The raising and lowering of the temperature of a liquid produces an alternate expansion and contraction which may move a piston. Let us take a particular example in order to form definite ideas respecting the expence of such a motion. Suppose that to a cylinder, A B, Plate I. Fig. 7, whose interior diameter is three inches, there is fitted a piston, the rod of which is in diameter two inches. Suppose also that the cylinder is five feet long. Now, if the openings communicate with two vessels containing a liquid, whose alternate and opposite expansions and contractions are to produce the alternate rise and fall of the piston, it is plain that the liquid communicating with the cylinder at *a* must expand a quantity equivalent to the content of the cylindric space betwixt the cylinder and the rod; and that the liquid communicating with the cylinder at *b* must expand a quantity equivalent to the content of the cylinder itself. According to our supposition, this in the former case will be 235.6 cubic inches, and in the latter 425.11. Fix for an instant the alternate increase and diminution of temperature at 60°. Alcohol expands about $\frac{1}{27}$ of its bulk for an increase of temperature to this amount. Hence the requisite expansion will be provided for if the vessel communicating with *b* contains about 6.6 cubic feet of alcohol and the vessel communicating with *a* about 3.6 feet. A stroke of the piston then will be effected by a waste of heat capable of raising about ten cubic feet of alcohol 60°. And this stroke will (neglecting the small allowance for the compressibility of the liquid) be able to overcome any resistance, however great. A slight glance at the relative specific heats of the substance, will show that this waste is equivalent to that obtained from the condensation of about 940 cubic feet of steam at 212°.

If this quantity of steam is employed in the double stroke steam-engine, it will raise 90 tons 5 feet high. In engines of different powers, this effect is produced in different times. In the 40 horse power engine, for instance, it is produced in $\frac{4}{5}$ of a minute, and in the 10 horse power, in $3\frac{1}{5}$ minutes. Hence, if the alcohol could, in one instance, be heated in the space of $\frac{4}{5}$ of a minute, and in another in $3\frac{1}{5}$ minutes, the engine we are describing would give us a dynamical effect of an almost illimitable magnitude, at precisely the same expence of time and fuel, as would produce the foregoing definite effect in the two specified steam-engines. But its superiority to these engines does not depend upon the supposition, that the expansion of the alcohol could be effected during such times as are indicated above. An increase of resistance is evidently of slight consequence with respect to it. And although the primary mover may not perform the effect in the time demanded, it may do so by a secondary move, which is connected with it by the means of acceleration. Hence, *theoretically* speaking, a engine of this sort may be made infinitely superior in every case to the common steam-engine in point of *economy*, and I might add *simplicity*. It is evident, however that it would be extremely desirable to expand the alcohol quickly, and I do not see many difficulties in the way of effecting it. It might be done by sending a quantity of water, at a high temperature, into a spiral pipe in the interior of the vessel containing the alcohol, or into a number of thin rectangular cisterns within it. These pipes or cisterns might be made of thin iron plate, and, by a simple contrivance for always keeping them full during cooling, the incompressibility of liquid, upon which the whole engine depends, would save them from being crushed during the expansion of the alcohol. Upon the extent of the surface of these pipes or cisterns, will depend the rapidity of the expansion, and here it may be modified at pleasure. After the piston had reached one extremity of the cylinder, it might admit a stream of cold water into the vessel whose expansion had just raised it. Contraction would immediately take place; and expansion beginning in the opposite vessel, the piston would move to the other extremity. If the expansion should become more rapid than the opposite contraction, the apparatus would probably give way. In order to prevent this, there must be attached to the vessels *safety-valves.* These may be of a very simple kind. Part of the vessels may consist of cylinders, in which pistons are placed, free to rise only when the great piston has reached the extremity to which it has been sent by the expansion of that particular vessel. Too rapid expansion in one of them, will merely have the effect of raising this piston in the other, and the hot water may not issue into the pipes until the contraction is complete and the piston is again shut. This arrangement, however, might have the effect of keeping the piston stationary at one end of the cylinder for a certain time. A mode of obviating this difficulty will occur at once. There may be two or more similar vessels at each end of the cylinder, one of which will always be in the proper state of contraction, and from it may the machinery cause the expanding alcohol to flow. By a few other simple contrivances, a regular reciprocating motion may be ensured, and the machinist put in possession of *the greatest power which can be derived from the agency of heat.* The foregoing calculations were made on rather approximating principles, but they are sufficient for the general purpose I have in view. I have merely intended to throw out some hints, which I conceived might lead to important practical results. My errors will therefore be pardoned.

I beg to subjoin the result of part of some investigations, in which I am now engaged with respect to a kindred subject. The operations of the high pressure engines in Cornwall have now entirely set to rest the question regarding the eligibility of such engines. The ratio of the increase of the density of steam along with its elastic force, is likewise quite decisive of this question. It is stated, if I recollect aright, by Mr Southern, and several other engineers of authority, that the density increases in the exact ratio of the elastic force. I have been led to a somewhat different conclusion, by circumstances upon which I rely with confidence. I subjoin a table expressive of them, within a certain range of pressure. The density is given only to one decimal, because I would not affect greater accuracy than the present state of my investigations entitle me to do. I indulge the hope of soon laying before you a connected view of the habitude of an aëriform body with respect to heat, in all circumstances. A particularization of the analysis contained in the 12th Book of the *Mecanique Celeste*, leads us immediately to refer the relations betwixt the elastic force, temperature, density, specific attraction for heat, &c. to the experimental determination of one constant quantity, characteristic of the nature of the substance under discussion.

Pressure under which the Steam is generated in Mercurial Inches.	Corresponding Density.	Pressure.	Density.	Pressure.	Density.
5	.2 —	55	1.7 —	105	3.0 +
10	.4 —	60	1.9 —	110	3.2 —
15	.5 +	65	2.0 —	115	3.3
20	.7 —	70	2.1 +	120	3.4 +
25	.8 +	75	2.3 —	125	3.6 —
30	.0	80	2.4	130	3.7
35	1.1 +	85	2.5 +	135	3.8 +
40	1.3 —	90	2.7 —	140	3.9 +
45	1.4 +	95	2.8 +	145	4.0 +
50	1.6 —	100	2.9 +	150	4.2 —

I am, Sir,

Your very obedient servant,

22*d February* 1825. Σ.

Art. XXI.—*Additional Observations on* Leslie's *Photometer, &c.* By William Ritchie, A. M. Rector of the Academy at Tain. In a Letter to Dr Brewster.

Dear Sir,

In the last number of your Journal you remark, in a note to my paper, on Leslie's Photometer, that an opinion of mine is in direct contradiction to the experimental results of Delaroche and Berard. You must have misunderstood my meaning; as all the experiments which I have performed, with transparent screens, are in perfect unison with the results of these eminent philosophers, viz. That invisible caloric, radiating from an elevated source, will, like light, permeate very thin plates of glass, whilst it is completely intercepted by thicker plates. I have lately performed numerous experiments with transparent screens, of such extreme tenuity, as to allow the instantaneous passage of heat, radiating from a source at an inferior temperature, with the same facility and copiousness as light through thicker plates. Now the glass case, which surrounds the instrument, is sufficiently thick to arrest the progress of heat unaccompanied with light, and consequently the effect upon the instrument will be the same, as if the case were perfectly opaque. With regard to the apparent discrepancy between the results of Dr Christison and Dr Turner, and those which I obtained, permit me to offer a few remarks. In the portable photometer, (the one most probably employed by Drs C. and T.) more heat will undoubtedly have an influence on the higher ball, though both balls were perfectly transparent; for the caloric, conducted through the glass-case, will first combine with the film of air adjacent to the interior surface of the cylinder, and cause its immediate expansion. The air, thus rendered specifically lighter, will mount to the top of the cylinder, and accumulate round the higher ball. The temperature of the air in the higher ball will thus receive a greater elevation than that in the lower one, and cause a depression of the fluid in the stem. When both balls are, however, placed on the same level, (as in the stationary photometer,) no such effect can take place, since mere caloric is equally absorbable by white and black surfaces. In the portable form, the instrument will be differently affected by mere heat, according to the distance between the two balls.

The portable photometer is also subject to several inaccuracies besides those already mentioned. As the end of the cylindrical case is closed by the blow-pipe, it is almost impossible to preserve it of the same thickness and transparency with the rest of the tube. Hence the quantity of light, which permeates the case, will vary with the different altitudes of the sun, though the quantity of incident light should remain uniformly the same. It is also obvious, that the light, reflected from the interior surface of the case to the balls of the instrument, will also vary with the altitude of the sun. If the photometer be carried to the torrid zone, the incident light being then in the direction of the two balls, the black ball will act as a screen to the transparent one, and thus cause the liquid in the stem to descend farther than it would do, if the transparent ball were also exposed to the direct rays of the sun. Another inaccuracy results from the variable quantity of light absorbed by the transparent ball, arising from the different altitudes of the sun. When the rays fall upon the instrument, in a direction nearly horizontal, they will find a ready passage through the thin transparent hemispheres; but when the sun is considerably elvated, a large portion of the incident light will be absorbed by the lower hemisphere of the transparent ball, in consequence of its connection with the tube. The transparent ball will therefore, in this position, absorb a great proportional part of the whole incident light, and occasion an error of considerable magnitude. The results of different photometers cannot therefore be compared, as they have no relation to an invariable standard.

The instrument in this form cannot, therefore, be regarded as a photometer, but merely as a photoscope. But though philosophers can place no confidence in its results, it must nevertheless be considered as a very ingenious and elegant instrument. Though it does not mark with numerical accuracy the dilute shadings of light, "the photometer nevertheless exhibits distinctly (as the Professor poetically expresses it) the progress of illumination, from the morning's dawn to the full vigour of noon, and thence its gradual decline, till evening has spread her sober mantle; it marks the growth of light from the winter solstice to the height of summer, and thence its gradual decline through the dusky shades of autumn."

One of the greatest *desiderata* in meteorology at present seems to be, an accurate and expeditious method of comparing the calorific effects of the sun's rays in different latitudes, at different elevations, and at different periods. Mr Daniell, in his interesting work on meteorology, has collected a great number of observations on the heating power of the sun's rays, from the polar to the equatorial regions. Most of these observations were made by comparing two thermometers, one of which was kept in the shade, whilst the other, having its bulb blackened, was exposed to the direct rays of the sun. These experiments and observations are, however, quite vague and unsatisfactory, as no correction seems to have been made for the variable causes which abstract caloric from the blackened ball of the exposed thermometer.

A simple and ingenious method has lately been proposed by J. F. W. Herschel, Esq. Sec. R. S. Lond., which promises complete success. As I am not aware that his method has yet been printed, I shall take the liberty of quoting his own description from one of his letters:—"My object in the instrument alluded to above, was to ascertain, by direct experiment, the relative heating power of the sun's rays. This I did, by exposing in a glass vessel, or large thermometer, at different times and places, *a deep blue liquid*, for a given time, to the direct ray's of the sun—noting the increase of temperature, which was purposely rendered very small, by properly adjusting the capacity of the instrument, then shading the sun's direct rays, and leaving it exposed for an equal time to the free influence of all the other heating and cooling causes, radiation, conduction, wind, &c. and again noting the effect of these. The same difference of these, according to their signs, was the effect of the mere solar radiation. Dividing this by the time of exposure, I had the momentary effect, or differential coefficient, which is the true measure of the intensity of radiation."

Availing myself of the ingenious remarks of Mr Herschel, I have been enabled to obviate the objections to which Mr Leslie's photometer is obviously liable, and can now employ it with considerable accuracy as a measurer of the sun's radiation. This may perhaps form the subject of a future communication. I have the honour to be,

Dear Sir,

Yours truly,

William Ritchie.

Tain Academy, *May* 20, 1825.

ART. XXII.—*Account of a Remarkable Explosion of Gas in a Well near Leith Fort.* By Mr JOHN COLDSTREAM. In a Letter to DR BREWSTER.

DEAR SIR,

I HAVE the honour to acknowledge the receipt of yours of the 19th instant, requesting me to make some inquiry concerning the explosion of inflammable gas which took place in this neighbourhood, a few weeks ago. Having been from home at the time of the occurrence, I was not acquainted with any of the particulars of the case, before I received your note; but I lost no time in proceeding to make the necessary examinations, and now, I trust, I can lay before you a satisfactory account of the very interesting event.

About three months since, a bore for a well was commenced in Cannon Street, near Leith Fort. Nothing particular was observed to occur in the course of the workings, till Thursday the 28th ult., when the depth of 87 feet from the surface had been attained, without finding water. The bore had been sunk to this depth, through seven feet of vegetable soil and sand, and 80 feet of a very stiff dark coloured clay, containing imbedded, numerous rounded pebbles of quartz, chlorite slate, hardened sand-stone, and coal. On the morning of the 28th, at half-past six, the two men, who had hitherto wrought at the bottom of the bore, went down, as usual, without lights, and commenced their labours. In the course of an hour after this, while driving their jumper, (three inches broad,) perpendicularly through the clay, they suddenly found it slip down about six inches, into an open space. Immediately, through the hole, thus made by the jumper, there issued with tremendous violence, and terrific noise, a vast quantity of some air, which, rushing past the workmen in the bore, ascended with such velocity, as to carry along with it masses of the clay of considerable size. The men below, instantly prepared to ascend, and one having got into the bucket was drawn up without delay, and the rope again lowered for the other one. He was seen to get into the bucket, and was drawn up about thirty feet, when it was observed that he appeared as if dead, and leaning over the bucket, so as to be in danger of falling out altogether. The men, therefore, above, fearful of his falling down and being killed, instantly lowered the bucket again, and one of them, ignorant of its being noxious air that had burst from its confinement, slid down on the rope, still without a candle, to see what was the matter with his comrade; on finding, however, his breathing beginning to be affected, he returned to the mouth of the bore. A lighted candle was now procured, and brought to the mouth of the pit; no sooner had its flame reached the level of the ground, over the bore, than the whole air in the pit, inflamed and exploded with a report as loud as that produced by firing a large piece of ordnance; the flames rose to the height of forty feet and more from the pit's mouth, and are described as having been of a blue colour. A strong sulphureous odour was immediately perceptible.

It was not until two hours after this explosion, that the unfortunate man was drawn out; he was quite dead—his clothes were but little injured by the flames. Those, who were standing near, or over the mouth of the bore, at the time of the explosion, got themselves much scorched, and otherwise hurt. The whole neighbourhood was violently shaken, but no windows were broken by the shock.

No work was done in the pit for a week after this occurrence; but on the eighth day after, a candle was again brought to the pit's mouth, when immediately a second explosion, not quite so violent as the first, but of the same character, ensued; nor could the men venture down for several days; and the gas collected in such quantity, that, for about a week after this, it was exploded every morning; and the men found, that the quantity collected seemed to be greater in wet than in dry weather. On continuing the workings at the bottom of the bore, it was seen, that the jumper, used by the deceased and his companion, had penetrated a large cavity, situated immediately under the clay, and having for its floor a stratum of soft bituminous shale, called by miners blaize. In this cavity, therefore,—the size of which could not be exactly ascertained,—the gas seems to have been confined. By the 20th of May, they had got about ten feet below the surface of the shale, and still the gas continued to escape through the shale from the floor of the pit; in quantities, however so small, as not to prevent the miners from working all day; they now complain more of the loathsome sulphureous odour, which they still experience at the bottom of the pit, than of any difficulty in breathing. The pit is now 100 feet deep, and no water has beeen found. Its mouth is situated about fifty yards from, and is elevated about twelve feet above high water mark.

I collected all the information, now communicated, from the workmen, four of whom were eye-witnesses of the events. It will give me much pleasure to make any further inquiry you may think necessary.*

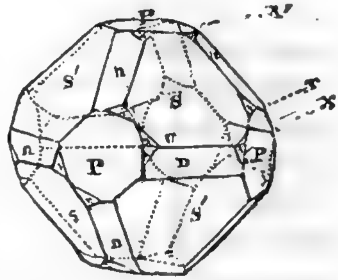
I have the honour to be,
Dear Sir,
Yours most faithfully,

LEITH, *23d May* 1825. JOHN COLDSTREAM.

ART. XXIII.—*Notice of a Remarkable Variety of Boracite.* By WILLIAM HAIDINGER, Esq. F. R. S. E Communicated by the Author.

A VERY interesting variety of Boracite has been lately discovered at Lüneburg, in crystals of the form represented in the annexed figure. Dr Turner has favoured me with a specimen which he had received from Professor Stromeyer of Göttingen. The crystals are engaged in a mixture of gypsum and anhydrite, both of them, but particularly the latter, crystallized in the drusy cavities, distributed throughout the rock. The general appearance of the crystals is that of a combination of the hexahedron, the octahedron, and the dodecahedron, in which the faces of the octahedron take the greater share in limiting the

* Since the above was written, quantities of the gas have several times suddenly rushed from the bottom of the bore, with a noise like thunder, but a sufficient quantity has not again been accumulated to admit of explosion on the approach of fire. It was attempted to collect in bottles some of the gas on those occasions; but in none of these (one of which Dr Turner was so kind as submit to a careful examination) could anything but the common ingredients of the atmosphere be detected. It is probable, however, that the explosive gas was carburetted hydrogen.—J. C.



compound form. The small triangular planes x, x, &c. sufficiently enlarged, produce a trigonal-icositetrahedron, having the general aspect of the tetrahedron. This form, already described, and figured by Romé de l'Isle,* seems to have been first noticed in the varieties of boracite by Breithaupt; † Haüy's *variété plagièdre* ‡ contains faces of it, and it is likewise indicated by Mohs. § It is generally supposed, however, to be the third variety of those forms, as described in the *Treatise on Mineralogy* by Professor Mohs, || in which the inclination of x on x, over the edge between P and s, is $= 162° 14' 50''$, over the edge between n and $s = 144° 2' 58''$. In this case, the edge of combination between x' and s would not be parallel to the edge between s and x'', which yet takes place in nature; and immediate measurement with the reflective goniometer likewise proves, that the two above mentioned incidences are equal to each other, and very near $= 152° 20' 22''$, which is the angle of the second variety described by Mohs. The situation of any single plane of the form is consequently the same as that of a single plane of the tetragonal-icositetrahedron n, first ascertained in hexahedral iron-pyrites by Haüy,** in the variety which he calls *parallélique*, while the situation of the faces x in boracite, as he himself indicates them, would coincide with the situation of the forms noted s and o in the same variety of iron-pyrites. The inclination of x on an adjacent face x, over P, is $= 122° 52° 42'$.

* *Traité de Crist.* Pl. I. Fig. 25.

† *Schriften der Min. Ges. zu Dresden*, vol. i.

‡ *Traité de Min.* 2de ed. tom. ii. p. 59. The 106th figure incorrectly represents forty-eight faces, instead of twenty-four.

§ *Treatise on Mineralogy*, vol. ii. p. 348.

|| Vol. i. p. 58.

** *Tabl. Comp.* p. 69.

Art. XXIV.—*On a Dike of Serpentine, cutting through Sandstone, in the County of Forfar.* By Charles Lyell, Esq. Secretary to the Geological Society of London, F.L.S. Communicated by the Author. *With a Plate.*

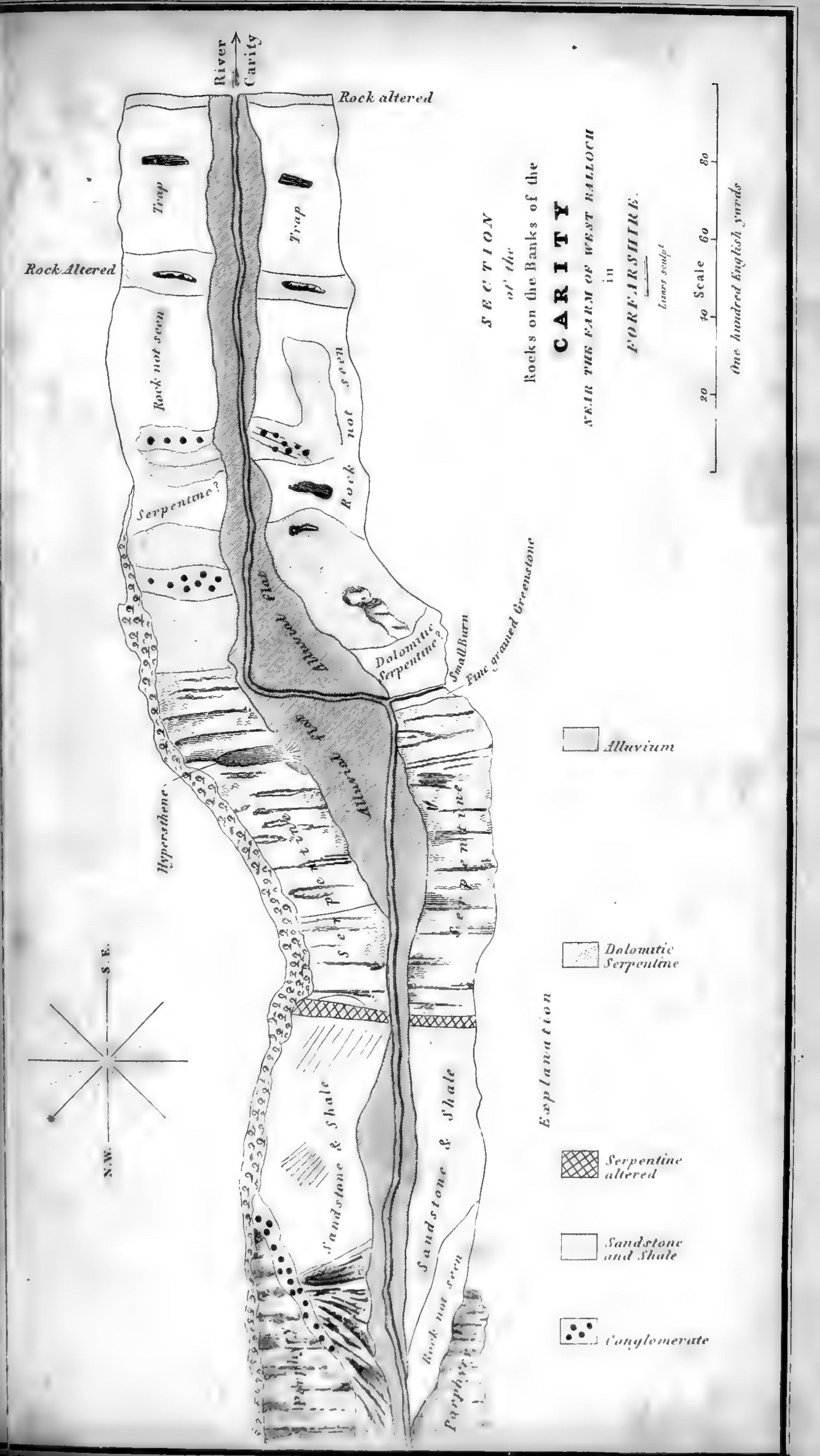
The natural history of serpentine is still involved in considerable obscurity, and although of late years much attention has been directed to its examination, there is, perhaps, no rock of such extensive occurrence, and such decided characters, whose geological relations are equally unascertained.

In the locality which I am now about to describe, the connections of the serpentine with the accompanying strata are clear and unequivocal, and as it occurs there in great abundance, and distinguished by its most striking mineralogical characters, the phenomena which attend it can scarcely fail to throw light on its general history.

I was fortunate in having an opportunity, during the last summer, of examining the spot where it is found, in company with Professor Buckland, from whose active co-operation, I derived great assistance.

The age and relative position of the stratified rocks, with which the serpentine is associated, are preliminary points, on whose determination depends much of the novelty and importance of the geological facts which it will be my object to detail.

The limits, however, of the present communication will not permit me to enlarge on the history of these strata, which I have carefully examined on the coast of Forfarshire, near the Red Head, where the cliffs present us with a section of those beds, which lie beneath the great conglomerate, and which form the chief part of the Seedlay chain. The coast on the north of Stonehaven, the rivers N. and S. Esk, Melgum, Islay, and others, have also afforded me distinct sections, of the same formation, which is there seen extending along the southern boundary of the Grampians. From the study of these sections, I am enabled to state, with regard to the strata in question, that they are younger than the greywacke and clay-slate, and older than



SECTION
of the
Rocks on the Banks of the
CARITY
NEAR THE FARM OF WEST BALLOCH
in
FORFARSHIRE.
Lizars sculpt
Scale
20
40
60
80
One hundred English yards
River Carity
Rock altered
Trap
Trap
Rock Altered
Rock not seen
Rock not seen
Serpentine?
Alluvial Flat
Dolomitic Serpentine?
Small Burn
Fine grained Greenstone
Hypersthene
Alluvial Flat
Serpentine
Serpentine
Sandstone & Shale
Sandstone & Shale
Rock not seen
Porphyry
Porphyry
S.E.
N.W.
Explanation
Alluvium
Dolomitic Serpentine
Serpentine altered
Sandstone and Shale
Conglomerate

the great mass of conglomerate, which, in Scotland stretches along the foot of the Grampians, from sea to sea.

In this conglomerate, which may probably be regarded as the lowest member of the old red sandstone formation, are found imbedded numerous masses of the above mentioned slaty sandstone and shale, and it follows, from the above facts, that the latter occupy, in Forfarshire and Kincardineshire, the same place in the series, as the strata of the red sandstone and shale, so exactly resembling them in character, which, in Gloucestershire, are inter-stratified with the transition limestone.

No organic remains, however, have hitherto been discovered in these lower sandstones in Forfarshire, Perthshire, and Kincardineshire, by which they might be identified with the red sandstone, containing trilobites, and the fossils of the transition limestone in Gloucestershire and Herefordshire.

Although I cannot enter fully at present into a discussion of this question, I must here remark, that, after examining the slaty red sandstone, containing trilobites, in Gloucestershire, which is beneath the old red sandstone, as well as the accompanying porphyries and trap rocks, I have satisfied myself that a strong analogy exists between them and the inferior sandstone and trap rocks of Forfarshire; but it is impossible to convey in words to others the identity which may at once be recognized in their general aspect.

I shall content myself, therefore, by stating, that these strata of shistose, red, and grey sandstone, shale, conglomerate, &c. in Forfarshire, succeed immediately the clay-slate and greywacke, and repose upon them. They will be classed by some geologists with the greywacke; others will regard them as the inferior member of the old red sandstone. But if, at length, organic remains shall be discovered in them, they may perhaps be referred, like the inferior red sandstone of Gloucestershire and Herefordshire, to the transition limestone series of the English geologists. *

* Mr Weaver has lately informed me that, on the coast of Waterford, between Dungarvan and Tranmore, strata of red and grey micaceous sandy slate, associated with similar quartzose, conglomerates and trap rocks, abound, and they occupy a similar position above the clay-slate. Although,

No limestone, with some partial and unimportant exceptions, * occurs to the south of the Grampians, on the east side of Scotland, between the clay-slate and the coal. If, therefore, the inferior micaceous red and grey sandstones, sometimes slightly calcareous, with their associated strata and trap rocks, are grouped with the old red sandstone, the latter formation must be regarded as of immense thickness, and as occupying, to the exclusion of the English transition limestone series, the whole space between the clay-slate and the coal. I have considered these observations necessary, lest the strata, with which the serpentine is associated in Forfarshire, should be considered more recent than those in which it has often been found elsewhere. This, I believe, is not the case, though such an idea would be conveyed to most geologists if the red sandstone in question were described as a member of the old red sandstone formation.

I now hasten to a particular description of the serpentine and accompanying strata, of which the annexed ground plan was sketched on the spot. See Plate V. The Carity, a small river which descends from the micaceous shist district in the northern part of Forfarshire, enters, soon after quitting the Grampians, a deep defile, near the farm of West Balloch, in the parish of

large districts may be examined without the occurrence of a single fossil, yet, in some few places, he has met with some in the red sandstone, corresponding precisely with such as characterize the English transition limestone.

* A thin vein of limestone, corresponding exactly to the cornstone of the English geologists, is found in the old red sandstone of Strathmore, extending in a direction N. E. and S. W. from near Stracathro to Careston, and again in the same line at Reedie, a few miles S. W. of Kirriemuir. The cornstone of Forfarshire, like that in England, contains no organic remains, and is in small quantity, though in consequence of the scarcity of limestone, it has, in many places, been burnt for lime. The trap rocks also, as is well known, contain occasionally much calcareous matter. For an account of the limestone of Clunie, see the First Article, No. I. of this *Journal*, by Dr MacCulloch. There is also a stratum of limestone at the Boddin, to the S. of Montrose, which has been long worked, but is now nearly exhausted. Although I have carefully examined this, it may be premature to pronounce an opinion on its geological relations, until it has been compared with some other strata of limestone, occurring near Montrose, which may perhaps belong to the same formation. I am, however, at present inclined to refer the limestone of the Boddin to an era more recent than the coal.

Kirriemuir, about half a-mile above the bridge of New Mill. The course of the river then is about N. W. and S. E. cutting at right angles the general direction of the strata. The first rock which rises precipitously on both its banks on the northern extremity of the ravine, is an unstratified porphyry, having a base of clay-stone, in which are imbedded crystals of felspar and hexagonal mica, small particles of quartz, and sometimes spots of soft white talc. Angular fragments of green foliated talc, undulatingly curved, are frequent in it. The rock is of a brownish or purplish red colour. A porphyry, exactly resembling it in character, is seen in a similar position near Lintrathen, and on the Isla, near the Falls of the Reekie Linn, also on the North Esk, where Colonel Imrie has described it.* It is sometimes very granitiform, and, in one instance, I found, near Lintrathen, large boulders of it in the field, in which rounded pebbles of granite were imbedded.†

This porphyry continues on both sides of the river for several hundred yards, and is seen followed on the left bank by a conglomerate. The relations of the conglomerate with the porphyry are obscurely seen, as the fragments of the decomposing porphyry, fallen from the cliff above, have covered and concealed the junction, but it is evident, that the edge of the porphyry, as it thins off, overlies a portion of the conglomerate. The conglomerate contains pebbles of quartz and mica-shist in a base of sandstone, sometimes highly ferruginous, sometimes quartzose. Its dip, as far as can be ascertained, is northerly, whereas the sandstone, which immediately follows it, is inclined in a contrary direction, at an angle of 44 to S. S. E. The strata must here have suffered great disturbance. The sandstone, for the first twenty yards, approaches to a shale; it is of a deep ferruginous brown colour, fine-grained, and very thinly laminated, being full of minute plates of mica, disposed parallel to the dividing surfaces. The sandstone above mentioned, after extending twenty yards, becomes grayer, and less argillaceous; it is still thinly laminated, and dips also

* *Transactions Royal Society Edinburgh*, vol. vi. p. 3.

† Specimens of the various rocks, mentioned in this paper, are deposited in the Museum of the Geological Society of London.

to S. S. E. at an angle of about thirty-five, and, after extending thirty-six yards, is suddenly cut off by the dike of serpentine.

The side of the dike is composed, on each bank of the river, of a very hard compact rock, about three yards thick, which stands vertically and parallel to the serpentine, forming a parting wall between it and the sandstone.

This rock consists of equal parts of green serpentine, and an indurated brick-coloured rock, harder than serpentine, and sometimes passing into jasper. It is often very siliceous, and resembles red argillaceous shale, as it is sometimes seen altered by the contact of a trap dike. Small specks of magnetic iron are dispersed through parts of this rock. On the inner side of this rock is seen some layers of contorted sandstone and shale, which must evidently be considered as entangled in the dike. The rock, which is in contact with the shale on the other side, is unseen, owing to an interval of four yards of deep soil, nor is the interruption supplied by the opposite side of the river. Upon causing the ground to be dug up, the rock, which had decomposed, appeared to have been serpentine.

Next follows an olive-green serpentine, traversed by innumerable veins of fibrous asbestus. The serpentine, more towards the centre of the dike, becomes dark green or blue; the surface has generally a glazed appearance, much resembling the ordinary green serpentine of the Lizard district in Cornwall, but without a similar admixture of red serpentine. It extends thirty or forty yards. In some places, irregular roundish crystals of serpentine are imbedded in a softer matrix of serpentine. There is much greenish bronze-coloured diallage in the middle of the dike, in which part it precisely resembles the green serpentine with diallage near Coverock. in the Lizard district in Cornwall. Towards the eastern side of the dike, a projecting mass of hypersthene rock, closely resembling some specimens of that which Dr MacCulloch found at Loch Scarvy in Skye, is seen; it does not interrupt the serpentine, but appears inclosed in it. It is occasionally accompanied by some small fragments of talc. Next to the hypersthene, is a light olive-green serpentine, with specks of magnetic iron in parts, which extends four or five yards to the edge of the dike, where sandstone and shale again appear.

The whole mass of serpentine which I have now described on the left bank, is ninety yards in thickness. It is not stratified, but is shistose on the great scale, dividing, with some degree of regularity, into slabs, if so they may be termed, about two feet in thickness, which are parallel to the sides of the dike, and which are again divided into flattish masses, with wedge-shaped terminations. The direction of the dike is about E. and W., and it is nearly vertical, but with a slight inclination to the W. Where the sandstone and slate, which I have already mentioned, join the eastern extremity of the dike, there is a small interval of decomposed serpentine; but the strata are nevertheless distinctly seen to dip away from the vertical serpentine at an angle of fifty, and, like those on the western side, they are inclined towards the S. S. E. The slaty sandstone is here soft and ferruginous, but it does not present any decided indications of being altered by the contact of the serpentine. Next follows a vertical mass of rock, unconformable to the last mentioned sandstone. It is seven yards or more in thickness, and consists of an indurated siliceous sandstone, much iron-shot, and containing a few quartzose pebbles much charged with iron. The sandstone is traversed by veins of brown spar. Its fracture approaches to conchoidal, and it has every appearance of being an altered rock. In contact with this mass on the other side, serpentine again appears, differing from that which constitutes the great dike from which it is separated by the strata of sandstone and conglomerate already described. This rock is composed of green serpentine and white magnesian carbonate, the latter in smaller proportion. These are blended together so as to form an irregularly striped rock.

This serpentine is only a foot and a half in thickness, but it appears to have belonged to a mass twenty-five yards or more in thickness, and which has decomposed and left an interruption, at the further extremity of which the serpentine again is seen, having all the same characters, and containing small crystals of quartz of the usual form. On the opposite bank, the soil clearly indicates the decomposition of a similar serpentine, but it has extended there much farther towards the great dike, and may even be connected with it. On that side of the river, some angular blocks of greenstone are strewed over part of the space where the dolomitic serpentine has decomposed, from which we may presume that greenstone is there associated with the serpentine, of which connection, unfortunately from the want of a section, no distinct knowledge can be obtained.

To return to the left bank of the river. The dolomitic serpentine is flanked by a vertical mass of sandstone conglomerate, evidently much altered, about five yards thick. Some parts of this rock approach to jasper in fracture and appearance. A remarkable fact was pointed out to me by Professor Buckland with regard to this conglomerate. The quartzose pebbles which it incloses are split, and sometimes firmly reunited at an angle by ferruginous matter which abounds in the stratum. The cracks sometimes divide the pebbles into two or more fragments, since cemented together again ; sometimes they only penetrate a short way in.

This phenomenon is the more worthy of notice, as it also presents itself in the conglomerate which flanks a large dike of greenstone on the Isla in this county.

That the conglomerate, however, on the Carity has, in this instance, been altered by the neighbourhood of the dolomitic serpentine, cannot be with certainty affirmed, since the rock, which has been in contact with it on the eastern side, has decomposed, and if greenstone has existed there, the case would only be a parallel one with that above alluded to on the Isla. I have no reason, however, to conclude that there has been greenstone there, for, as far as can be presumed from the opposite bank, it appears to be sandstone and shale which has wasted away, and left an interval of forty yards or more.

Strata of sandstone, shale, and conglomerate, when hardened by their vicinity to trap, generally resist decomposition more than either greenstone or unaltered sandstone. The last rock which I shall mention as forming part of the above section exposed on the banks of the Carity, is a trap dike from thirty to forty yards wide, which has almost entirely decomposed, and left an interval of argillaceous soil. This dike is parallel to the great dike of serpentine.

When it can be seen, it is composed on the right bank of a well characterized greenstone, sometimes spotted with round specks of white carbonate of lime, but these not sufficiently numerous to constitute an amygdaloid.

On the left bank some masses appear, in which compact felspar with green earth predominates.

This dike is flanked on both sides by a vertical and parallel mass of altered rock, probably sandstone and shale. That on the west side of the trap is very hard, and traversed by veins of brown spar, and containing some green earth. It is seen on both sides of the river, as is also the mass on the eastern side of the dike, in which mica, quartz, and indurated ferruginous shale appear, and also flesh-coloured foliated brown spar in immense quantities.

We have now descended the Carity to the point where the section becomes no longer intelligible, and I have described the rocks on the left bank of the river, alluding to those on the right only, where they might supply an interruption, which, however, they scarcely ever do, since, in each case, decomposition has produced nearly the same deficiencies.

But, in the section on the right bank, there is a want of correspondence in one spot, which deserves our particular notice.

The great dike of serpentine, after being seen for 90 yards on the bank, instead of coming in contact, as in the opposite bank, with shale and conglomerate, is flanked by a bed of fine grained greenstone, about two feet wide, from the disintegration of which, a hollow has been formed, down which a small stream descends.

This rock has decomposed into small spheroidal masses, which, in their interior, are of a bluish black colour. Their fracture is conchoidal, and they give out, when breathed upon, a strong argillaceous smell. Their outer coating is of a light green colour, and very hard, and has a tendency, when fractured, to present an irregularly mammillated surface. The entire decomposition of this rock produces bright green and yellow clays.

An excellent account has appeared in the first number of the *Edinburgh Journal of Science*,* by Dr MacCulloch, of a

* Vol. I. Article 1.

dike of greenstone at Clunie, in Perthshire, at whose contact with a bed of limestone, a thin band of serpentine occurs. The author has observed, "that the greenstone, as it approaches the limestone, acquires a finer texture and a laminar structure. The laminæ are often intersected by cross fissures, dividing the whole into cuboidal masses, which sometimes decompose still further into spheroidal forms. A regular gradation may be traced from the greenstone to the serpentine, in proportion to its approximation to the limestone."

I have visited Clunie, and was much struck with the exact resemblance of the fine-grained rock above mentioned, and that which appears at the edge of the serpentine dike at the West Balloch. I find, however, that all the specimens which I possess of the fine-grained greenstone of Clunie effervesce with acids, which the rock at the Balloch does not. These two cases may be regarded as the converse the one of the other, for the greenstone on the Carity is as insignificant in quantity, when compared to the dike of serpentine, as is the vein of serpentine at Clunie when compared to the accompanying greenstone dike. It is much to be regretted, that on the Carity, the rock in contact with the fine-grained greenstone on the side opposite to the serpentine dike, is not seen. I caused a deep trench to be sunk, but did not succeed in reaching any rock, though the soil strongly indicated a decomposed serpentine. I think it highly probable, that the variety of serpentine, which has here disappeared, is that which I have already described, into whose composition the magnesian carbonate enters so largely; for a mass of this rock is the first which appears *in situ*, on this side of the river, approaching much nearer to the great dike than any of the dolomitic serpentine on the opposite bank, as the section will explain.

I have before stated, that, in another place, on the right bank, in an interval left by the decomposition of the dolomitic variety of serpentine, blocks of greenstone indicate clearly the association of that rock with the serpentine. The spot where this occurs, is distant about fifty yards from the thin bed of fine grained greenstone to which I have alluded, and it is a circumstance which confirms my supposition, that the dolomitic variety of serpentine has also been in contact, on one side, with the greenstone at the edge of the great dike, although it has now wasted away and cannot be seen.

If this conjecture be correct, the association of rock on the Carity becomes still more analogous to that at Clunie; for, in the latter case, are found greenstone, serpentine, and limestone, whereas in the former, we should have greenstone, serpentine, and dolomite.

Although the two opposite banks of the Carity, which present us with the sections which we have now considered in detail, are not much more than fifty yards apart, yet they afford, as we have seen, very different appearances, as far as regards the junction of the serpentine with the stratified rocks.

If we view the left bank alone, we perceive two parallel dikes of serpentine, the first, 90 yards wide, the latter, in which the dolomite abounds, about 25 yards in width. Between these are placed strata of shale and sandstone, highly inclined, as also a vertical mass of conglomerate, much altered and indurated. But if we turn to the right bank, these intervening stratified rocks appear to be entirely wanting; and it seems that the two kinds of serpentine form one dike, a thin bed of fine grained greenstone alone separating them, and another bed of greenstone being also associated with the dolomitic serpentine, towards its south-eastern edge.

The phenomena which attend the serpentine at the West Balloch enable us, in the first place, to add another fact in confirmation of the geological connection, already observed to exist, by other geologists, between greenstone and serpentine. We are also presented with examples, more decisive than any I have yet seen described, of stratified rocks affected by their contiguity to serpentine, in a manner exactly similar to that usually observed at their junction with trap dykes. We have also pointed out in one place, a small portion of contorted shale and sandstone, inclosed, and as it were entangled, in the serpentine, as is often found in trap dikes, where they pass in a similar manner through the regular strata. But what is most striking in the general view of the section at the West Balloch, on the left bank of the river, is the fact, that, while on each side of the vertical mass of serpentine, the inclined strata of sandstone are cut off at an angle, and are evidently disturbed, the dike of serpentine itself, pursues its course uninterruptedly, and in a direct line for many miles, both to the eastward and westward.

If we attempt to follow the course of this dike, we find that the country is deeply buried under gravel, which consists chiefly of pebbles of primitive rocks, washed down from the Grampians, and that the subjacent strata are only visible at those points where, as at the West Balloch, the strata are intersected by deep ravines, or "dens," as they are called, through which rivers descend, and which they appear, in a great measure, to have worn for themselves.

The first of these, towards the east, is at the distance of about two miles, at Proson Haugh, on the Proson, a mile below Pearsie, the seat of Charles Wedderburn, Esq. The blue serpentine there resembles the great dike on the Carity, and contains diallage. Its junction with the regular strata is not seen, as it has decomposed much; but an altered rock, approaching in its characters to jasper, and traversed by numerous veins of brown spar, crosses the river a short distance above it.

Rather more than a mile west from thence, in the same line, the serpentine reappears on the south-east, at the bridge of Cortachie. The red slaty sandstone, there seen on its northern side, has a northerly dip, which is a rare occurrence in the strata at the foot of the Grampians, in this district in Scotland.

I have not yet traced the serpentine farther to the north-west, but have sought for it in vain on the North Esk, about fifteen miles in a direct line from the last mentioned locality, although the section of the rocks on that river, which have been so well described by Colonel Imrie,* is complete. There are, however, on the North Esk dikes of greenstone, which cross the river in the same direction, and nearly in the same place as the serpentine might be expected to occupy.

It will now be interesting to return to the Carity, and to trace the serpentine stretching in an opposite direction towards the W. S. W. After leaving the W. Balloch, it first reappears at the distance of about four miles in the farm of Burn-

* Trans. Royal Society, Edinburgh, vol. vi.—3.

side, in the parish of Kingoldrum. The small burn, in whose channel it is here obscurely exposed, falls afterwards into the Backburn. The rocks, which are there clearly seen associated together, are greenstone, with serpentine, containing much dolomite, and a red indurated rock abounding in brown spar. A little higher up the burn, as on the Carity, the claystone porphyry appears, which must not be considered as having any connection with the serpentine. If we continue our line to the south-westward for about two miles, we arrive at the ravine through which the Melgum flows, when the serpentine is not recognizable, unless it be considered as represented by the great dike of greenstone which crosses that river immediately below the mill of Shanalaw.

But I am aware, that great caution must be used in the attempt to identify these dikes, as we have seen that there is on the Carity a dike of greenstone parallel to the serpentine. Proceeding about a mile and a half farther, a fine section of the rocks is presented on the precipitous cliffs which rise on each bank of the Isla, a short distance below Peel. There a dike of greenstone crosses the river, possessing for the most part the ordinary characters of that rock, but in some places intermixed with carbonate of lime, and assuming then a finer texture, and appearing not very unlike much of the English black compact mountain limestone. Its junction with the strata through which it passes is only seen on its northern side, on the left bank of the Isla, and the phenomena which attend it are exactly analogous to those already described on the Carity. Next to the greenstone is a parallel mass of altered indurated rock, much charged with brown spar, and in parts calcareous, then a mass of conglomerate, in which the quartz pebbles, before alluded to, are split, and reunited by ferruginous matter. Without advancing any theory to account for this curious fact, I may be allowed to say, that the rounded fragments of quartz appear exactly as if they had divided upon being heated, and had only been prevented from flying asunder by the matrix in which they are imbedded. Beyond the conglomerate is sandstone, very ferruginous, hardened, with a fracture sometimes conchoidal, and traversed by veins of brown-spar. It dips towards the dike, and its stratification becomes obscure in proportion to its proximity to the greenstone.

Although no serpentine is seen here, I am informed by Mr Blackadder of Glammis, that, in following the course of the dike through the neighbouring fields, he found blocks of serpentine on the land, from which it appears that that rock is either connected with, or replaces the greenstone.

About three miles farther to the south-west of the last mentioned locality on the Isla, serpentine, like that on the Carity, occurs to the south of Bamff, near Alyth, in Perthshire, the seat of Sir James Ramsay, Bart. The greenstone and serpentine of Clunie, in Perthshire, described by Dr MacCulloch, is only nine miles distant from the last mentioned place, and precisely in the same line.

This is certainly a remarkable fact, although not sufficient to lead us to conclude, that the Clunie dike is a prolongation of that which we have been tracing through the country; for no serpentine can be found on the banks of the Erroch, a river which intervenes between Clunie and Bamff, and which, like all the other rivers descending from the Grampians into Strathmore, affords a deep section of the strata.* There are

* The section of the rocks on the Erroch, ascending from Blairgowrie to the northward of Craig-Hall, differs, in one respect, from any of those, which I have seen between that river and the sea of Stonehaven, or from any that I have examined in the Seedlay Hills, or in the cliffs between Auchmithie and the Red Head. This difference consists in the absence of the inferior fine-grained sandstone, shale, &c. The conglomerate, composed chiefly of rounded masses of trap-porphyries, continues above Craig-Hall, forming precipitous cliffs, till we arrive nearly opposite East Drummie. There trap rocks succeed, and nothing else appears until opposite the Milltown of Drummie, where greywacke and clay-slate are seen.

It may be suggested, that the trap, which succeeds the conglomerate, is an overflowing mass, and conceals strata of inferior or transition sandstone. In answer to this, I should state, that we might rather expect greywacke and clay-slate, were the trap not present. For it is only necessary to consider on the map, the general line of bearing of the inferior or transition sandstone series through Kincardineshire and Forfarshire, at the foot of the Grampians; and it will appear highly improbable that it exists so far to the north as East Drummie. May we not conclude that the inferior sandstone strata, which have, in all instances, suffered under the influence of that violent action which formed the great conglomerate, have here been completely annihilated. We find almost universally in two dikes of greenstone which cross the Erroch, both not very far from the line which the serpentine, if continued from Bamff to Clunie, would take. One of these dikes is rather more than a mile above Blairgowrie. Its thickness is about twenty feet, and the strata of sandstone and shale, in contact with it, are much indurated. The other dike traverses the conglomerate several hundred yards below Craig-Hall.

Whether there exists any connection between the serpentine of Clunie and that on the Carity is uncertain; but it can scarcely be questioned by any who consider the facts above stated, that the same dike of serpentine is found recurring at intervals for the space of at least fourteen miles or more, stretching in a straight line from Cortachie to Bamff, its direction being parallel to the Grampians, and to the outcrop of the several formations which succeed each other in regular order in Forfarshire and Perthshire, from the granite to the old red sandstone. But, notwithstanding this general conformity of direction, the serpentine, wherever it is seen in contact with the stratified rocks, intersects them, and is therefore not of contemporaneous origin, but, like the greenstone with which it is connected, of posterior date.

Before concluding this communication, I shall take the opportunity of briefly mentioning an instance of the connection of serpentine, greenstone, and sienite, which I examined in the Lizard district in Cornwall, during the last summer, in company with Monsieur Constandt Prevost, a gentleman well known to geologists by his memoirs on several countries on the Continent. This occurs at Cadgwith, near Coverack, and is slightly alluded to by Professor Sedgwick.* The serpentine there is

the great conglomerate, as well as the superior red sandstone of Forfarshire fragments of the older shale and micaceous sandstone. But although the evidence of the partial destruction of those beds is thus decisive, yet, with the single exception above stated, I have never found them entirely wanting to the eastward, along the foot of the Grampians, nor in the neighbouring Seedlay Hills, where they are more fully developed, and where, with their accompanying trap rocks, they almost exclusively compose that chain. When the conglomerate consists exclusively, or nearly so, of trap pebbles, as at Craig-Hall, and many other places, we must suppose that, at the epoch of its formation, the inferior sandstone was, in those particular spots, entirely overlaid by trap.

* Trans. Camb. Phil. Society, vol. i. p. 310.

regularly stratified, with a northerly dip, and contains subordinately greenstone slate. At a point on the sea-coast, which is at a small distance to the east of Cadgwith, where some quarries of a red and green serpentine have lately been opened, and much of the rock exposed, a bed of shistose greenstone is seen conformable to, and interstratified with the serpentine, and in the midst of the greenstone is a granitic rock, a few feet in thickness, which I term Sienite, merely because its position and decided geological connections forbid me to apply to it the appellation of gneiss, or mica shist. It consists principally of quartz, with a certain proportion of mica disposed in laminæ, so that specimens may be selected from it exactly resembling much of the mica shist of the Grampians. A reddish felspar is occasionally present, and it might then, in single specimens, be called gneiss. In its general aspect it is not unlike much of the sienite of the Malvern Hills, but it divides, upon being fractured, into slabs parallel to the strata in which it occurs.

Mr Herschel has lately discovered at Predazzo, in the Tyrol, a locality well known to many geologists, a striking fact with regard to the relations of serpentine with other rocks; for he has found layers of well characterized serpentine, forming, as it were, the parting stratum between a granitiform sienite, and a rock of dolomite. As there is so much analogy between this fact and the case of the serpentine of Clunie, before alluded to, and the latter is so intimately connected, as I have shown, with the subject of this memoir, I have requested Mr Herschel to favour me with an extract from his notes, explanatory of the specimens which he has brought from Predazzo.

Art. XXV.—*Notice of a Remarkable Occurrence of Serpentine at the Junction of Sienite with the Dolomite of the Tyrol.* By J. F. W. Herschel, Esq. Sec. R. S. Lond. and F.R.S. Edinburgh. Communicated by the Author.

In the course of a Mineralogical ramble through the Tyrol in the months of August and September of last year, I encountered the phenomenon I am about to describe, in a small rounded hill called Canzocoli, forming a lump or projection at the foot of the mountain ridge which bounds the valley of Lavis on the west. This valley communicates with the valley of Fassa, or rather constitutes its lower portion, or embouchure into the vale of the Adige, and the immediate spot in question is about half a mile from the village of Predazzo, a spot already remarkable among geologists from the asserted superposition of *granite* on *chalk*, an account of which is to be found in a late Number of the *Edinburgh Philosophical Journal*, but whose true nature will perhaps be better understood from what follows.

Predazzo itself stands on the borders of a district of fine red granite, perfectly well characterized, but which gives place to a compound of felspar and mica, unaccompanied (so far as I could discern) by quartz, of which (4) is a characteristic specimen,* and which itself passes into a close grained rock, in which the crystalline structure is much less perceptible (3.) The transition is sudden, and is perfectly well seen in the specimen (4). These are from the mountains (Monte Mulazzo) on the opposite side of the valley.

Immediately above Canzocoli, the rock (which for brevity I shall term Sienite, without pretending to decide whether it is entitled to that appellation or not) is a crystalline compound, containing abundance of felspar and dark-coloured mica, perhaps also hornblende, and possibly experienced eyes may detect in it quartz. 1, 5, 6, 7, 8, are specimens of this rock, (1) and (8) being characteristic of the general mass, the others having peculiarities to be noticed presently. Along the summit of the ridge runs a crest of dolomite reposing on the crystalline rock, the line of junction being nearly horizontal, but about a furlong south of Canzocoli this line suddenly changes its direction, and descends the mountain in a curve which is at first nearly vertical, but soon inclines backwards, (or to the north,) and descends obliquely to the point where it intersects the most northern summit of the little mound to which the name Canzocoli is appropriated. Accordingly, in all the interval from the place of its vertical direction, the dolomite distinctly underlies the sienitic rock. The junction, however,

* The specimens referred to are deposited in the collection of the Geological Society of London.

is so encumbered with blocks of the sienite rolled down from above, that the actual union of the two rocks cannot be seen except on Canzocoli. The specimens, (1) and (2) however, were detached from a point of contact, where the dolomite, at least, is undoubtedly *in situ*, and presents no peculiarity of appearance, but that of being less saccharine, and more scaly in its structure than the usual dolomite of the country.

On Canzocoli, however, the case is different. The actual junction of the rocks is there accessible, and had fortunately been in some degree laid bare by some travellers who had visited it the day before,* and who pointed out to me the locality. The phenomena of this junction are very remarkable. The dolomite distinctly underlies, at an angle from 50° to 60°, dipping towards Predazzo, and appears to have sustained a remarkable alteration in its mineralogical character, presenting, in place of its usual highly crystallized saccharine structure, a flaky and very talcose appearance, arising from the interposition of infinitely thin pearly plates, which give it a tendency to break in irregular wedge-formed masses, and impart to it a smooth feel, in some degree steatitic. (Spec. 12.) The incumbent sienite is no less affected. Its grain is smaller, and it is intersected by innumerable veins parallel to the plane of junction, of a white mealy substance, which partly dissolves with effervescence, and partly gelatinizes with nitric acid. (Spec. 13.) Chabasie in regular small crystals also occurs in the fissures of the sienite, (spec. 6, 7,) and a beautiful small dodecaedral garnet was found among a quantity of the white matter (13) on subsequent examination. (Spec. 14.)

But the most remarkable fact attending this junction, is the occurrence of a thin lamina of serpentine between the sienite and the dolomite. When I first encountered it, on prosecuting further the excavation commenced by the gentlemen above alluded to, I had no suspicion of its nature, its appearance being dark and dull from the moisture which had penetrated it, and from a degree of weathering it had undergone. The same causes had rendered it much more friable than is usual with this rock, so that, being quite in doubt as to its nature, I contented myself with merely packing up the

* Il Marchese Petrucci, di Pezaro, Mons. Bertrand Islin, and Signior Perolini, di Bassano.

specimens (9, 10, 11,) for examination at leisure, a circumstance I now regret, as it deprived me of the opportunity of studying so minutely as I should otherwise have done, its relation to the surrounding rocks. It was, however, not united either to the sienite or dolomite *en masse.* The former, as it approached the dolomite, became gradually more and more intermixed with layers of the mealy substance above described, lying parallel with the general direction of the plane of junction, and in the midst of these layers occurred the lamina of serpentine. Below this again was found the mealy substance in a state of greater purity, but still not free from layers of the sienitic matter, which however gradually disappeared, leaving it nearly pure up to its contact with the dolomite. The whole transition took place within a thickness of about eighteen inches or two feet.

These specimens are now (the moisture being exhaled) not to be mistaken, and have all the characters of the best defined serpentine—the greasy lustre, unctuous feel, and irregular fibrous appearance of their surfaces, the dulness of their cross fracture, translucency at the edges, and variation of colour from dark to light green. I am not aware of the occurrence of any serpentine rock in the neighbourhood.

I shall not attempt to reason on this fact, which presents considerable analogy with that recently described by Dr MacCulloch, as occurring at the junction of a trap vein with limestone in Scotland, (vide vol. i. of this *Journal*, p. 1,) but content myself with submitting the specimens, with this very imperfect account, to the judgment of better geologists than myself.

Art. XXVI.—*Notice of the Remains of an Animal resembling the Scandinavian Elk, recently discovered in the Isle of Man; with Suggestions on the Importance of distinguishing this Animal from the Fossil Irish Elk.* In a Letter to Dr Brewster, from Samuel Hibbert, M. D. F. R. S. E. and M. G. S. Secretary to the Society of Scottish Antiquaries.

My Dear Sir,

I transmit you the following communication, which must be considered as an appendix to my paper inserted in the early part of the present Number, relative to the circumstances under which the fossil elk is discovered in the Isle of Man. I have this day, as you requested, seen Mr Seton, who has been so kind as to put into my hands the letters which he has received from Mr Burman of Douglas. I learn from them, that the relics of another animal, apparently of the present race of elks which inhabit the north of Europe, have been recently found in the marl of Ballaugh, being the same site in which the remains of the extinct Irish elk have been found. This is a very curious fact. It also gives an additional degree of support to the view which I have taken, that the circumstance of animals of the deer kind being very frequently discovered enveloped in shell marl, bears some reference to the habits of the living animal. Thus the older naturalists, who had the best opportunities of learning the habits of the Swedish elk when he was much less rarely found than at the present day, affirm, that he usually frequented wet marshes. "In locis palustribus," says Aldrovandus, "sese plurimum condit, illic et partus edit suos." The Irish elk (as the animal is usually named) had probably similar habits, as it is in the sites of lakes and pools now obliterated, that his remains are usually found.*

I find that Mr Burman has not, in his communication to Mr Seton, delineated the actual horn of the unextinct species of elk which was found at Ballaugh, but that of a recent animal of the same kind which was brought from Norway, the relic being in his possession; but he adds, that the fossil horn which he saw, (the discoverer of which would not part with it,) exactly resembled in form the one which he has represented by the pencil. This, at a single glance, will be found to be perfectly unlike that of the large fossil Irish elk. †

* In Lancashire, where the bones of the Irish elk are more rarely met with, they have been discovered under no other circumstance. Whittaker, in his History of Manchester, records, that in the commencement of the seventeenth century, remains of the elk were dug up in the low flat country through which the Ribble flows, as at Larbreck near Preston, and at the Meales, which form the mouth of this river. A very large elk was also fished out of the sea in the year 1727 at Cartmel. There has been here much low land, that, at comparatively a recent period, has been invaded by the ocean.

† See Plate II. Fig. 3.

As it is now evident that the remains of two animals, each bearing the name of elk, are to be found in the marl pits of the Isle of Man, it is of importance to attend to their distinction. This will be immediately seen, by comparing Mr Burman's beautiful delineation of the head of the fosil Irish elk, (see Plate II. Fig. 1,) with his outline of the horn of the Norwegian elk. But Cuvier has been the most successful in pointing out the difference that subsists between these animals. He remarks, that the head of the Irish elk resembles that of the *Cervus*, rather than that of the recent elk, which still exists in the north of Europe, and in America; for, among other distinctions, he adds, that the former has from sixteen to twenty antlers only, while that of the latter generally amounts to thirty or more. Again, in noticing the branch of the Irish elk, he observes, that the antler at the base of it descends from thence to the forehead, while this peculiarity is not to be detected in the recent elk. The wood of the Irish elk likewise surpasses, in all its dimensions, that of any other animal bearing the same name.

Such being the difference that subsists between the fossil Irish and the Scandinavian elk, it is of importance that the former should have a distinctive appellation, especially since the remains of each are liable to be found associated together, as in the Isle of Man. Whittaker has conceived that the Irish elk was the *Segh* of the ancient Britons, a word that has been interpreted as significant of an animal not only of the ox, but of the moose kind. But as this view is very conjectural, and as the term *segh* is not a convenient one, the appellation may, with propriety, be abandoned. A name for the Irish elk may, with more advantage, be sought for in the works of the learned Aldrovandus. This naturalist was evidently much puzzled regarding a gigantic animal, known, as he conceived, to the ancients, that resembled the stag in the shape of its head, and the fallow-deer in that of its horns. While he, therefore, distinguishes this animal from the Scandinavian elk, he adds, that besides our common fallow-deer, there was what may be described as a *palmated stag*, of which mention is made by Julius Capitolinus, in these words: "Gordiani sylva memorabilis picta in domo rostrata Cn. Pompeii picturas animalium diversas continet, inter quas sunt *cervi palmati* ducenti mixtis Britannis." The passage thus cited is a remarkable one, particularly in reference to the term *mixtis Britannis*, the large extinct elks being most abundantly found in the British islands. But in carefully examining the general tenor of the sentence quoted from Capitolinus, without any view to theory, we must acknowledge that the allusion is very ambiguous. Aldrovandus is, at the same time, doubtful to what animal certain ancient horns were to be referred, which had previously engaged the attention of Bellonius, adding, "suspicorque cornua illa ingentis magnitudinis, quæ in gradibus et ascensu Ambrosianæ arcis conspiciuntur, non vulgaris damæ, ut Bellonius existimat, fuisse, sed vel alcis vel alterius." But he concludes, with regard to the *Cervus palmatus* of Capitolinus, that it referred to some large animal, the horns of which equalled, or exceeded in length and thickness, those of the stag, and in width those of the fallow-deer—a description that, he conceives, may answer to the ἐυρύκερως of Oppian; and hence he gives to the animal in one place the name of *Euryceros*. Now, I would submit, that this appellation be retained, as significant of the fossil *Irish elk*, in contradistinction to the still existing elk of Sweden and other places. It may be at the same time doubtful, if by the wide-horned stag of Oppian was really meant the Cervus palmatus of Capitolinus, or even the gigantic fossil elk of the British Islands;—for although the Euryceros is carefully separated from the Ιορκοί, and although it is said to exceed the Βέβαλος in size, and to be still larger than the Δόρκος, * yet unfortunately for this description, it is still a question with naturalists, what particular animals Oppian had subjected to this comparison?† It is certain, however, that under the term *Euryceros*, he meant the most eminent of the tribe of Ελαφοί:

Α῎λλες δ' αὖ καλέεσι βροτοὶ πάλιν ἐυρυκέρωτας
Πάντ' ἔλαφοι τελέθεσι· φύσιν κεράων δ'έφύπερθεν
Οἵην τ'ὔνομα θηρσὶ κατηγορέει, φορέεσι.

* ΟΠΠΙΑΝΟΥ ΚΥΝΗΓΕΤΙΚΩΝ, lib. ii. 291, et seq.
† *Ossemens Fossiles*, par M. Cuvier, tome iv. p. 30.

The poet also makes use of the expression ἐυρυκερωτας αἰγαιὰς in distinguishing this race of Cervi from all others of the deer kind. Hence, the propriety of giving the appellation, which I have recommended, to the gigantic, yet elegant, fossil elk. Likewise, in connection with the speculations and allusions of older naturalists, the term *Cervus Euryceros* may, with much advantage, be used instead of the unscientific name *Irish Elk*, which leads to the erroneous notion, that the remains of this animal had been found only in the sister kingdom.

When engaged in these antiquarian considerations, I shall add little more relative to the Cervus Euryceros, (as I would now name the Irish Elk,) than that this animal is said to have been alluded to in the 12th century, by Giraldus Cambrensis, in his topographical account of Ireland. He describes certain of the deer kind, as, " *Cervos* præ nimia pinguedine minus fugere prævalentes, quantoque minores sunt corporis quantitate, præcellentius efferuntur capitis et cornuum dignitate." But it is difficult to admit, that this passage has in it the entire force that the cautious historian would require; for although it corresponds in the description given of the horns and head, the alleged shortness of the body is still the puzzling circumstance. Yet, according to the calculation of Dr Knox, the animal has in its dimensions been overrated, its height to the withers being only about five feet.* Hence, when the body is contemplated, in connection with its amazing display of horns, it is by no means unlikely that it would be regarded as comparatively short. This is, in fact, the impression of a spectator, when he sees for the first time the skeleton in the Museum of Edinburgh, notwithstanding it has been set up much too high.† Giraldus's other remark, that the animal was little calculated for flight, because of its extreme bulkiness, points to a circumstance, regarding which we

* This I learn from a conversation with Dr Knox, who has suspended, for the present, publishing any details on the subject.

† Although this specimen was certainly not perfect, yet there is so much of the osteology of the animal to be learned from it, that we must consider it as one of the most interesting relics of the Cervus Euryceros that has yet been preserved. It was the munificent donation of His Grace the Duke of Atholl.

can certainly have very little information. But it may be asked, if the disproportionate weight of the horns would not have had a tendency to impede the motion of the animal, and thereby induce obesity, and that, on this account, it might have trusted to its means of escape from pursuers, less to the swiftness of its footsteps, than to the marshes to which it was evidently accustomed to resort?* According to this view, the extinction of the Cervus Euryceros in the British Islands, would keep pace with the obliteration of the ancient pools and lakes, where its remains are now found.†

These are all the observations that I have at present to offer on the Cervus Euryceros, or Irish Elk. They have been suggested by the interest which the important researches of Professor Buckland have imparted to every circumstance connected with the history of the extinct animals of the British islands. But it is now incumbent upon me to observe, that my dissertation does not materially affect the general conclusion to which this justly distinguished geologist has arrived. The diluvial deposit of Europe, which has formed the

* There is a Runic monument at St Michael's, in the Isle of Man, that, in reference to this speculation, acquires some degree of interest: An animal of the deer kind, with *broad horns*, and represented as extremely large, in comparison to other animals engraved on the same monument, is in the act of being worried by a dog.

† In connection with this view of the comparatively recent origin of the Cervus Euryceros, I hasten to communicate the following most remarkable intelligence, which I received from a scientific friend in Edinburgh, Dr Milligan, though too late to be inserted in the body of this paper, which had already gone to press. "You may feel interested to know, that in Ireland, about nine months ago, there were dug up the skeletons of three great elks, which have been recently articulated by Mr Hart of Dublin. One of them measures eleven feet between the tips of the horns. Near them, in a three feet stratum of marl, were found the skeletons of three dogs, and at a little distance, were discovered the skeletons of several men. My informer is an expert chemist. He analysed the bones, and found them to consist of very nearly the same proportion of animal and earthy matter as in hartshorn, only a *little* fluate of lime. The marrow was still in the bones, and burnt brightly at the flame of a candle." It is to be hoped that some further details may be published relative to so extraordinary a discovery, particularly with regard to the circumstances under which the human skeletons were found.

main subject of his researches, is not referable to any ordinary cause with which we are familiar at the present day; it is, therefore, one of the most interesting objects of the naturalist, either to confirm the views which would refer the origin of it to the Mosaic Deluge, or to show that it may have arisen from some convulsion of a less general nature, yet sufficient to account for the immense distance to which large boulders have been removed from their native beds. And although the Cervus Euryceros has undoubted claims to a postdiluvian origin, we are by no means entitled to suppose, that there may not exist the relics of other animals, which, being found under perfectly different circumstances, may justify an opposite conclusion. In short, the whole subject admits of further investigation. I am, &c.

SAMUEL HIBBERT.

EDINBURGH, *May* 20, 1825.

ART. XXVII.—*Notice of Mr Christie's Discoveries respecting the Effect of Rotation on the Magnetic Forces.*

IN a valuable paper in the last part of the *Philosophical Transactions* "*On the Effects of Temperature on the Intensity of Magnetic Forces, and on the Diurnal Variation of the Terrestrial Magnetic Intensity,*" of which we have given the leading results in our Scientific Intelligence, Mr Christie has mentioned the curious fact, that iron acquires peculiar magnetic properties by simple rotation, which we understand he discovered and communicated to a friend more than three years before this paper was written. Mr Christie has since drawn up an account of the numerous experiments which he made in order to discover the laws according to which the rotation of iron affected a magnetic needle under its influence, which has been lately read before the Royal Society. The first observations which he made established the fact, that if a plate of iron be made to revolve about an axis passing through its centre, then, when it is brought to rest, a magnetic needle in its vicinity will be found to deviate differently, according as the plate has been made to revolve in one direction or the contrary, previously to being stationary, every point in the plate being in precisely the same position, when at rest, in the two cases. In order to discover the laws according to which the rotation of the iron affected the needle, he conceived a sphere to be described about its centre, and the centre of the iron to be in the surface of this sphere; calling the diameter of the sphere in the direction of the dip, the axis, and the great circle having its plane at right angles to this axis, the equator, the situation of the centre of the iron would be determined by its latitude and longitude. When the centre of the iron plate was in the meridian, and its plane a tangent to the sphere, if the plate revolved so that its upper edge moved from west to east, then, when it was stationary, it was found that the rotation had caused a deviation of the north end of the needle towards the east; and if the upper edge of the plate had been made to move from east to west previously to the plate being brought to rest, in precisely the same position as before, a deviation towards the west was caused by the rotation. When the plane of the plate was in the plane of the equator, or parallel to it, the rotation caused no deviation of the needle. If the plane of the plate was in the plane of the secondary to the equator and meridian, then when its centre was in the equator, either to the east or to the west of the needle, the deviation due to rotation would be in a direction different from that in which it took place when the centre of the plate was in the pole, the direction of rotation being the same in all cases. Thus, supposing the upper edge of the plate to have revolved from west to east, then, when the centre of the plate was in the equator, the deviation of the north end of the needle due to rotation would be towards the west, whether the plate were to the east or to the west of the needle; but if the centre of the plate were in either pole, then the deviation under the same circumstances of rotation would be towards the east.

After making a great variety of experiments, Mr Christie was enabled to connect all the phenomena arising from the rotation under one general law, and he has found, that the supposition of the mass of the iron acting from its centre, and the rotation polarising it in a direction at right angles to the dip, will not only account for the phenomena in general, but that the deviations deduced from such a supposition will very nearly correspond with those actually observed.

Some singular circumstances attend the effects which Mr Christie has described as arising from rotation: these effects appear to be nearly independent of the velocity of rotation; a single revolution of the plate, or even less, is sufficient to produce the whole effect; and the effect is permanent, so long as the plate remains perfectly stationary after having revolved.

Since making these experiments, Mr Christie has, we understand, tried the effect of rapid rotation, and has found, that the deviations of the needle *during* the rapid rotation of an iron plate, are in the same direction as those which take place after the rotation, whether slow or rapid, has ceased, the plate revolving in the same direction in the two cases; but the extent of deviation during rapid rotation is greater than that after rotation, which appears to be permanent, nearly in the ratio of three to two. It appears, therefore, that the same polarising of the iron will account for the deviations in the two cases, but that *during* rapid rotation the intensity of the poles is increased.

As the magnetic phenomena, arising from the rotation of different bodies at present excite a considerable degree of interest, we have no doubt that this brief sketch of those which Mr Christie first observed more than four years ago, (and we are not aware that such had ever been observed, or even hinted at before,) will be acceptable to our readers.

Art. XXVIII.—*Analysis of a Mica from Cornwall.* By Edward Turner, M. D. F. R. S. E. &c. Lecturer on Chemistry, and Fellow of the Royal College of Physicians, Edinburgh. Communicated by the Author.

Having accidentally in my possession some of the rose-coloured mica from Chursdorf in Saxony, in which Professor Gmelin has detected the presence of lithia,* and being struck with the characteristic appearance it exhibits when heated by

* See his Analysis in the last Number of this Journal.

the blow-pipe flame, I was induced to examine other varieties of mica in the expectation of observing similar phenomena. Through the kindness of Dr Brewster I was supplied with specimens of twenty different varieties, among which were several from Scotland and Greenland, besides others from Coromandel, Massachusets, Connecticut, Labrador, and Zinnwald. All of these micas, with the exception of the last, were very infusible, requiring the strongest heat of the blow-pipe to produce even imperfect fusion, the chief effect being loss of lustre. But the variety from Zinnwald, on the contrary, fused readily, frothed up during the continuance of the heat, and communicated a fine rose tint to the flame. The only difference, indeed, between it and the Chursdorf mica is, that the latter gives a white, the former a black bead by fusion. This observation led me to examine the black mica of Altenberg, which accompanies Pycnite; and it also was found to possess the characters assigned by Professor Gmelin to the Lithion-micas. I now mentioned these circumstances to my friend Mr Haidinger, requesting him to examine the micas in the superb collection of Mr Allan; and he very soon succeeded in discovering several which possess similar characters when heated before the blow-pipe. Every specimen from Zinnwald, and several from Cornwall, he found to be of this nature, and Dr Anderson of Leith possesses a specimen from the Uralian Mountains, which bears the closest resemblance to that from Chursdorf, both in colour and fusibility. These facts render it probable, that the Lithion-micas are by no means uncommon in nature, and, to all appearance, several different species of them exist. The comparison of their composition must, therefore, throw considerable light upon the micas in general, and I have, on this account, undertaken the analysis of a series of these minerals.

The subject of the present paper is a liver-brown coloured mica from Cornwall. As far as regards the indications before the blow-pipe, it is the most unpromising mica I have examined; but from not having a sufficient supply of other varieties at the moment, I have been obliged to begin with it. Though its texture is highly lamellar, like that of mica in general, its laminæ are small, possess little transparency, and are inclined to break rather than bend when force is applied to them. Its density is very considerable, being 3.066 when first put into water, and 3.081 after being boiled in distilled water to expel air from between its laminæ.

When a thin layer of it is exposed to the blow-pipe flame it fuses, an appearance of ebullition ensues, as if from the escape of gaseous matter, and a black shining enamel is left. It communicates at the same time a red tinge to the flame, but which is so slight as to escape observation unless considerable care be taken.

Analysis.—When heated to redness in a platinum crucible it lost only $\frac{17}{10000}$ of its weight, its lustre being rather improved than diminished by the operation. 47.39 grains, reduced to fine powder by continued friction in an agate mortar, were intimately mixed with six times their weight of carbonate of baryta, and exposed to a white heat for one hour. The mass had shrunk greatly, had a semi-vitrified appearance, did not adhere to the sides of the crucible, and was of a dark green, near black, colour. By digestion in water, a pink solution formed, and on adding a small quantity of muriatic acid, brown flocculi of manganese separated. The ignited mass was readily attacked by diluted muriatic acid, being wholly dissolved, except a small quantity of what appeared to be silica in a gelatinous state. The solution was coloured strongly by iron. It was carefully evaporated to dryness, and the silica separated in the usual manner. It rather exceeded 42 per cent., but was obviously impure, since it was coherent instead of being a light powder. I therefore resolved to devote the present analysis solely to the determination of the alkalies, and to examine a separate portion for fluoric acid.

The baryta was precipitated by sulphuric acid, the iron, alumina, and manganese, by ammonia, and after concentrating the solution, hydrosulphuret of ammonia was added to separate the last traces of manganese. The salts were then heated in a platinum crucible to expel the sulphate and muriate of ammonia. After the addition of a little sulphuric acid, to decompose any muriate of potash, the alkaline sulphates were fused. A colourless salt was obtained, a part of which was of sparing solubility, and which, by the addition of oxalate of ammonia, proved to be sulphate of lime. The pure alkaline sulphates, when again fused, amounted to 4.8 grains, which dissolved completely in water. Muriate of platinum was then added, and the solution evaporated to dryness, to separate the muriate of platinum and potash as perfectly as possible. The dry mass was digested in a little cold water, and the soluble portion examined for lithia. After separating the excess of platinum, I found that the residual salt was composed almost entirely of potash, which had passed over with the washings, and that the quantity of lithia was too small to be appreciated correctly. I have, in consequence, been unable to ascertain its presence with absolute certainty, though the following circumstance renders its existence highly probable. The supposed sulphate of Lithia was decomposed by acetate of lead, the excess of lead removed by sulphuretted hydrogen, and the filtered solution brought to dryness. The acetate thus obtained was decomposed on platinum foil, and an alkaline carbonate procured, which, though potash could still be detected in it, was far more fusible than the carbonates either of soda or potash, and discoloured the surface of the metal.

To determine fluoric acid and the other constituents of the mica, 28.11 grains were ignited with four times their weight of sub-carbonate of soda, and the method recommended by Berzelius in his analysis of the topaz was adopted. The alkaline solution, when neutralized by muriatic acid, gave a white precipitate with muriate of lime, which yielded 2.73 grains of dry fluate of lime, corresponding to 0.76 grains, or 2.706 per cent. of fluoric acid. That it was fluate of lime, was proved by its corroding glass when the acid was set free by concentrated sulphuric acid.

The matter which was not soluble in water, together with a small quantity of silica separated from the alkaline solution, dissolved completely in dilute muriatic acid. The solution was evaporated to dryness, and after due digestion in diluted acid, the silica was collected, ignited, and weighed. It yielded 36.54 per cent. of pure silica.

The peroxide of iron and alumina were precipitated in the cold by sub-carbonate of soda, and were separated from one another in the usual way. The peroxide, after ignition, weighed 7.607 grains, equivalent to 27.06 per cent., and was quite pure. The alumina, after being strongly ignited, amounted to 7.16 grains, or 25.47 per cent.

After separating the iron and alumina, sub-carbonate of soda was added to the solution at a boiling temperature, and a precipitate subsided, from which I obtained 0.26 grains, or 0.93 per cent. of lime, and 0.54 grains, or 1.92 per cent. of the red oxide of manganese.

The Mica is thus composed of—

Silica, - - - -	36.54
Peroxide of iron, - - -	27.06
Alumina, - - -	25.47
Fluoric acid, - - -	2.706
Lime, - - - -	.93
Red oxide of manganese, - -	1.92
Potash, (calculated from 4.8 gr. sulphate of potash,)	5.475
	100.101

I have examined this mica for titanium in the way recommended by Vauquelin, without obtaining satisfactory evidence of its existence; nor did the fluate of lime, when decomposed by sulphuric acid, yield a trace of phosphoric acid.

I have been greatly assisted in the execution of this analysis by my able and zealous pupil Mr William Gregory, and, as I still enjoy his valuable assistance, I expect to give the analysis of several species of lithion-mica in the ensuing number of this Journal. That they will form several distinct species, when farther examined, seems highly probable from the difference in their specific gravity, which, in the brown variety from Cornwall, analysed above, is far beyond the limits of any of the other varieties of mica. The regular forms of it have not yet been ascertained. Mr Haidinger has found that those of a Siberian variety of lithion-mica belong to the hemi-prismatic system, being oblique-rhombic prisms, with the terminal plane inclined to the obtuse edge of the prism, at an angle of about 99°. The plane angle of the terminal face is nearly =119° 30′, from which, and the inclination of the axis, the transverse section of the prism follows, =120° 7′. The faces of this prism are very rough, but those parallel to its short diagonal, which change it into an hexagonal prism, are generally smooth, and possess a distinct vitreous lustre. The plane of the resultant axes of double refraction is parallel to this face. This variety occurs along with crystals of topaz, quartz, and felspar. It is deserving of notice, as Mr Haidinger remarks, that most of the lithion-micas are attended by topaz and other minerals which generally accompany tin-ore. The lepidolite from Moravia is associated with white topaz; the dark grey mica from Zinnwald includes Pycnite, which is a compound variety of topaz; the Cornish variety, from St Michael's Mount, is found along with topaz and tin-ore; another Cornish variety from Carclaze, of a greyish-white colour, contains granular masses and small crystals of white topaz; the brown variety, which I have analysed, is mixed with quartz and apatite. Topaz has also been discovered at Zinnwald, but the mica of that place is commonly associated with tin-ore, quartz, wolfram, and tungstate of lime. It occurs in fine crystals, and was selected for analysis by Klaproth as being a characteristic variety. My analysis of it is in progress, and I have already obtained unequivocal proof of the existence of lithia in it. The solution of the mixed sulphates of lithia and potash, after the addition of muriate of platinum, was brought to perfect dryness, and the soluble parts taken up by a little cold water. A white salt was procured, after removing the excess of platinum, which fused readily when heated, and afterwards dissolved easily in cold water. It was decomposed by acetate of lead, and an acetate of lithia was formed in the way already described. When a particle of this salt was brought into contact with the flame of a spirit-lamp, it instantly communicated a fine red colour to it. When decomposed by heat a white carbonate was procured, which was characterized by its singular fusibility, its sparing solubility in water, by acting upon the surface of platinum when fused upon it, and by causing a brown stain when placed on moistened turmeric paper.

Art. XXIX.—ZOOLOGICAL COLLECTIONS.

1. *Conybeare on the Plesiosaurus.*

From an examination of detached bones, procured even from distant localities, the late Mr Conybeare had collected a number of facts which induced him to publish in the *Trans. of the Geolog. Soc.* for 1821, an account of a new fossil genus of reptiles, which he named Plesiosaurus. The accuracy of his views have been confirmed by the discovery of an almost perfect skeleton, which has corroborated his opinions in every essential particular. The most remarkable circumstance in the osteology of this animal, is the number of cervical vertebræ, amounting to thirty-nine, or including the anterior dorsal, which are placed before the humerus, forty-one. By the philosophical naturalist, this extraordinary elongation of neck will be considered with great interest, as it assimilates its structure less to fishes, in which the sternum is thrown forwards, though destined to move in the same element with them, than to birds, in which this part of the skeleton is brought forwards.

Mr Conybeare conjectures from the form of its paddles, that it may have swam on the surface of the ocean, with its long neck arched backwards like that of a swan, ready to dart at the prey that came within reach ; or it may have lurked in shoal water, hidden from the attacks of its enemies, and deriving, from the flexibility of its neck, a compensation for that want of agility indicated by its organization.

2. *Discovery of the Megalosaurus.*

Fossil zoology has received a very interesting addition by the discovery of an enormous nondescript animal at Stonesfield, near Oxford. The remains are very imperfect, but Professor Buckland has been enabled to ascertain, that they have belonged, like the Plesiosaurus, to an animal of the Saurian order of reptiles. The most important fragment that has yet been found, consists of a portion of the lower jawbone, nearly one foot in length, which is interesting as developing its mode of dentition, and from which it is obvious that this part must have terminated in a flat, straight, and very narrow snout. From the proportions of a thigh-bone, found at Cuckfield, Sussex, Professor Buckland estimates the length of this reptile to have been upwards of sixty feet, and its bulk to have equalled that of an elephant seven feet high. It, therefore, fully merits the name of Megalosaurus, which he has applied to it. *Geolog. Trans. Second Series*, vol. i. part ii.

3. *Gigantic Fossil Coral.*

This remarkable fossil, the *Astrea dendroidea* of Lamouroux, was described by that author, from an irregular fragment a few centimetres in height. M. Le Sauvage has, however, been so fortunate as to discover a magnificent specimen, *several feet in height*, imbedded in the coralloid limestone of the *Falaise* of Bénnerville. The fine preservation of this specimen, has furnished M. Le Sauvage with characters sufficiently distinct to constitute a new genus, which, from its habit, he has named Thamnasteria. The generic characters are: Polyparium petrosum, ramosum; superficies ramorum stellis lamellosis, sessilibus, obtecta; lamellis linearibus, rotundatis. It consists of a considerable bundle of branchy stems, from ten to fifteen lines in diameter, simply contiguous, and presenting to view from one end to the other regular series of rounded dilatations and circular contractions. The branches are terminated in rounded points of unequal heights, and their entire surface is covered with lamellar, rounded, contiguous and almost superficial stellae. The very perfect state of so prodigious a fossil, would indicate that it has not undergone any displacement, but that it has been enveloped in the limestone that surrounds it, in the place of its growth.—*Mém. de la Soc. d'Hist. Nat.* tom. i.

4. *Enormous Orang-Outang found in Sumatra.**

We have been favoured by a correspondent in India with the following particulars respecting this animal:—" The greatest curiosity at present is the skin and the lower part of the face of an enormous monkey, stated to have been *seven feet high*. Dr Abel is now drawing up an account of it for the Asiatic Society. I endeavoured to obtain some particulars from the officer of the ship in which the skin was brought here, but I could not learn more than what has appeared in the public papers. The following is an extract of a letter from Mr Burton of Tappanooly, in Sumatra, to Mr H. Wood of Bencoolen:—' I must not omit to mention, that Messrs Craygman and Fish, of the Mary Anne Sophia, have lately killed, near Taruman, an immense orang-outang, measuring in height *six feet*; its foot is 14½ inches in length. I have seen its skin, which is covered with bright shining brown hair, mostly resembling that of a horse's mane, about a foot long. Its face was quite human, with a long beard, beautifully curled. You may imagine the size and power of the animal, when I tell you, that I measured one of its eye-teeth, and found it three inches and a fourth in length, and that it lived many hours after five balls were lodged in its body, and a spear run through it. The body was well proportioned, with no protuberance of the stomach.'

" In this account, it is stated to be *six feet high* only. Mr Fish who killed it, described it as being much taller than himself, and as having mustachios as well as a beard. The head was given to the cook of the ship to boil and clean off the flesh; but, by some mismanagement, the upper part was spoilt, and the lower jaw only preserved. The hands and feet, however, have been brought here—preserved in spirits; and I hope Dr Abel will give a full account of what remains of this extraordinary animal. The place where it was killed lies between Tappanooly and Acheen, on the north-west coast of Sumatra."—*Letter to the Editor from a Friend in Calcutta.*

* " The specimens of this animal which have been brought into Europe, were mostly young individuals, seldom exceeding three feet in height; but it is alleged, that when they have attained to maturity, they equal or even surpass man, both in stature and strength."—*Edinburgh Encyclopædia*, Art. MAZOLOGY, vol. xiii. p. 398.

5. Aranea domestica, possessed of a Natural Diving-Bell, to assist it in crossing Water.

A house-spider was placed by Mr Bell on a small platform, in the middle of a rummer full of water, the platform being about half an inch above the surface. It presently made its escape, as was anticipated, by suffering a thread to be wafted to the edge of the glass. Mr Bell, suspecting it might have been assisted by the water being so nearly on the same level, poured some of the water away, and placed the spider as before. It descended by the stick that supported the platform, till it reached the water, but finding no way to escape, it returned to the platform, and for some time, employed itself in preparing a web, with which it loosely enveloped the abdomen, by means of the hinder legs. It now descended, without hesitation, to the bottom of the water, when Mr B. observed the whole of the abdomen to be covered with a web containing a bubble of air, probably intended for respiration, as it evidently included the spiracles. The spider enveloped in this little diving-bell, endeavoured on every side to make its escape, but in vain, on account of the slipperiness of the glass; and, after remaining at the bottom for about thirteen minutes, it returned, apparently much exhausted, as it coiled itself closely under the little platform, and remained afterwards without motion.—*Zoological Journal*, vol. i. 283.

6. Mode of Catching Fish by Diving, peculiar to the Gulf of Patrasso.

The diver being provided with a rope, made of a species of long grass, and which floats near the surface, has only to move his canoe where he perceives there is a rocky bottom; this done, he throws the rope out so as to form a tolerably large circle; and such is the timid nature of the fish, that, instead of rushing out, it never attempts to pass this imaginary barrier, which acts as a talisman, but instantly descends, and endeavours to conceal itself under the rocks.

Having waited a few moments till the charm has taken effect, the diver plunges downwards, and not unfrequently returns with four or five fish, weighing from two to six pounds each. As they seldom find more than the heads concealed, there is the less difficulty in bringing forth their rich prizes; and when the harvest is good, the divers are so dexterous, that they have a method of securing three or four fish under each arm, beside what they can take in their hands. The fish greatly resembles the John Dory.—Blaquiere's *Second Visit to Greece*. Lond. 1825. Part ii. p. 40.

7. Rapidity of the Effects of the Poison of some of the New Holland Snakes.

In a letter which we have received from His Excellency Sir Thomas Brisbane, he mentions that one of the snakes which he has at home bit two of his pointers, one of which died in *three minutes*, and the other in about *thirty minutes*. Sir Thomas observes, that the venom of these reptiles can be compared in its effects only to the prussic acid.

8. *On Changing the Residence of Fishes.*

Mr Nicholas Mill having caught with a fly some of the fry of the salmon, as they were retreating to the sea, preserved them alive, in order to transport them into a fish pond, which was about thirty yards square, with a clay bottom, covered with mud. The depth of the water was from three to four feet, and it was supplied with a running stream. When the salmon fry were first caught they measured four inches from the tip of the nose to the tip of the tail. About twelve months afterwards, the pond was overflowed, when some of the fish, together with some trout, were left dry. They now measured in length eight inches, and assumed the shape and appearance of a lean salmon. Mr Mill thence concludes, that the salmon might attain its usual size in large ponds, and he suggests that the ova, or spawn, might be removed from rivers, and be bred in the pond in as nearly as possible the same situation.—*Ann. of Phil.* vol. ix. p. 380.

9. *Structure of the Hind-Foot of the Walrus.*

Sir Everard Home has discovered that the hind-foot of the walrus has an apparatus like that of the foot of the fly, by which it is enabled to carry on a progressive motion against gravity. In its operation it resembles that of a cupping-glass, or rather that of a sucker of leather, with which boys amuse themselves in lifting stones. In its bony structure it has a striking resemblance to the human hand.—See *Phil. Trans.* 1824. Part. II.

Art. XXX.—DECISIONS ON DISPUTED INVENTIONS AND DISCOVERIES.

1. *The Rediscovery of the Comet of Encke due to Mr Rumker and not to Mr Dunlop.*

In a paper published in the *Transactions of the Royal Society of Edinburgh,* (Vol. x. p. 112, 113,) by Sir Thomas Brisbane, the merit of rediscovering the remarkable comet of Encke has been ascribed to Mr Dunlop. On the authority of that paper, and of a private letter from Sir Thomas Brisbane, we afterwards contradicted a statement of Baron Von Zach, who attributed the discovery to Mr Rumker. We have received, however, recent letters both from Sir Thomas and Mr Dunlop, in which all the merit of the discovery is attributed to Mr Rumker. Two comets had made their appearance at the same period in New South Wales, one of which was discovered by Mr Dunlop, and the other by Mr Rumker. It was, therefore, a natural mistake to attribute the discovery of the comet of Encke to Mr Dunlop, and that of the other to Mr Rumker, when it was exactly the reverse; the other comet of September 1822 having been discovered by Mr Dunlop. We regret to learn, that the health of that able and active astronomer, Mr Rumker, has been so much impaired, as to deprive the observatory of Paramatta of his valuable services.

2. *The Composite Structure of the Bipyramidal Sulphate of Potash not discovered by Mr Brooke.*

Our mineralogical readers are, no doubt, aware of the bipyramidal form in which sulphate of potash often crystallizes. Count Bournon considered this as the primitive form of the salt. In a paper in the *Annals of Philosophy,* Mr Brooke has described this form of the salt, and shows that it is a composite form, consisting of rhomboidal prisms, combined in the manner which he has represented in a diagram.

This composite form of the bipyramidal dodecahedron of sulphate of potash had been discovered long before by the agency of polarised light, and the combination distinctly described in the first paper of the first number of the *Edinburgh Philosophical Journal,* a work to which Mr Brooke was a contributor. As Mr Brooke has made no reference whatever to that paper, it might have been presumed that he had not read it; but we find that he has actually read and quoted it in his lucubrations on the structure of Apophyllite, with which he has favoured the public; and which have already shared the same fate as his rhombohedral speculations on the primitive form of the sulphato-tri-carbonate of lead.

3. *The apparent immobility of Spectral Impressions; their Singleness by Distorted Vision; and the Reference of the Phenomena of Vision to Voluntary Muscular Action, first discovered and proposed by Dr Wells, and not by Mr Charles Bell.*

In the observations which were some time ago made on spectral impressions in this *Journal,* the author conceived, from reading Mr Charles Bell's paper, that that gentleman had the sole merit of discovering the apparent immobility of ocular spectra, and the fact of their remaining single by distorted vision; and that he had been the first who referred these and other phenomena of vision to the voluntary actions of the muscles. This opinion was founded on the circumstance of Mr Bell not having mentioned any other author as having preceded him in these views; and upon looking again at Mr Bell's paper, it is obvious that every reader must consider him as the discoverer of these facts, and the author of these views. We find, however, that these facts and views are all contained in Dr Wells' *Essay upon Single Vision with Two Eyes,* Lond. 1792, p. 65, 66, 67, 70; and are stated with a degree of philosophical precision very different from that which they wear in their revived form. Our inference from these facts is, that Mr Bell was not acquainted with the work of Dr Wells, otherwise he would not have failed to do justice to the previous labours of that able and ingenious philosopher. In a future number we shall discuss this subject with Dr Wells, and give a full account of the experiments we have made upon it. Having overthrown the doctrine of the involuntary motion of the eye-ball by optical arguments, we shall leave the physiology of that part of the subject to Dr Knox, who, in a paper lately read before the Royal Society of Edinburgh, has demonstrated the incorrectness of Mr Bell's reasonings, and the fallacy of his results.

4. *Professor Leslie's Hygrometer, invented by the late Dr James Hutton.*

An account of Mr Leslie's hygrometer was first published in Nicholson's *Philosophical Journal*, 4to, vol. iii. p. 461, and it appears from that description, that the principle of the instrument, as well as the construction and application of it, are claimed as the sole discovery of the author, as the following quotations will show :—

" My attention was first directed to the subject of hygrometry by the perusal of the late Dr Hutton's very ingenious *Theory of Rain.*"—" To discover the dryness or humidity of the air, we have only to find the change of temperature induced on a body of water insulated or exposed on all sides to evaporation. This principle I first established in 1790.

" Two thermometers, therefore, filled with any expansible fluid, with quicksilver, alcohol, or air, *the ball of the one being wetted and the other dry*, will, *by their difference, denote the state of the air in respect to humidity.* Nothing was wanted but to combine those instruments in such a manner as that they should indicate their differences of temperature."

It appears, from these passages, that Mr Leslie considers himself as having discovered and established the principle of the hygrometer in 1790; and yet he regards this principle as carried into effect by the use of two thermometers, so contrived as to indicate merely their difference of temperature.

It appears from Professor Playfair's life of Dr Hutton, in the *Edinburgh Transactions*, vol. v. pp. 67 and 106, that such an instrument had been invented and used by Dr Hutton himself, though he had not described it in any of his publications. The following is the passage :—

" To one," says Professor Playfair, " who considers meteorology with attention, the want of an accurate hygrometer can never fail to be a subject of regret. The way of supplying this deficiency, which Dr Hutton practised, *was by moistening the ball of a thermometer, and measuring the degree of cold produced by the evaporation of the moisture.* The degree of cold, *cœteris paribus*, will be proportional to the dryness of the air, and affords, of course, a measure of that dryness."

It is very obvious that, by means of a double thermometer and a moveable scale, the difference of the indication of the two thermometers may be observed at once. Mr Leslie applied the same principle to Sturmius's differential thermometer; and, consequently, he has done nothing more than use an air thermometer in place of a mercurial one, though it does not appear from Mr Playfair's account what kind of thermometer was employed by Dr Hutton.

We believe it is now universally admitted, that the hygrometer, as manufactured by Mr Leslie, is not an accurate instrument, and we know that it is not in repute in France, and has not been used by any of the eminent French philosophers who have carried on hygrometrical researches. They have invariably preferred the hair hygrometer of Saussure.

Those who prefer the employment of Dr Hutton's principle ought to use the two thermometers in place of the differential one, as the temperature of the air is obtained at the same instant with its dryness, and the observation is less liable to be affected by errors of construction.

Although we have not used Mr Daniell's very ingenious hygrometer, yet we understand, from good authority, that it is an admirable instrument. It has been employed, we observe, by Professor Moll and Dr Van Beek, in their valuable experiments on the velocity of sound, printed in the *Phil. Trans.* for 1824, p. 424.

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

1. *British Invention and Discovery Association.*

At a time when the improvement of the useful arts is an object of national importance, and when no security is held out by our patent laws to inventors or discoverers, the establishment in London of a "British Invention and Discovery Company for the assistance, encouragement, and protection of native genius," must be considered as a great event in the history of our country. The capital is L. 750,000, which is already subscribed.

The business of the establishment will consist of three great branches:

1st, The taking out of patents, both at home and abroad, for original inventions and discoveries, and the manufacture and sale, or granting of licences for the manufacture and sale, of patent articles.

2d, The promotion of such new processes or arts as can be safely carried on without patents.

3d, The sale, not only of those patent articles and exclusive manufactures in the property of which the company may acquire a share, but generally all patent and privileged commodities.

The company propose not only to make all the pecuniary advances necessary in each case, but to promote, by an active and extensive agency, the interests of those who may confide in them. The remuneration they will look for will be such an equitable proportion of the ultimate profits as may previously be agreed upon; and in no event, not even of the greatest ultimate failure, will persons, contracting with them for the prosecution of any supposed invention or discovery, be liable to the smallest share of the expences incurred.

We understand that there are already many valuable plans waiting the acceptance of the Association.

2. *Mr Bryce's Stomach or Moveable Branch Syphon.**

One of the most valuable applications of the Syphon with which we are acquainted, has been recently made by Mr Bryce, surgeon in Edinburgh. The object of this invention is to throw fluids into the stomach, and to extract fluids from it, in cases where poison has been swallowed, &c. In order

* This Syphon is made and sold by Mr Macleod, surgeon's instrument-maker in Edinburgh.

to apply the Syphon to this purpose, in place of syringes and pumps, Mr Bryce conceived the idea of making the longer branch of the Syphon moveable, so that, when the shorter leg was in the stomach, the moveable leg could be raised above the mouth, or placed in the usual position below it. To the common œsophagus tube, about 26 inches long, a tin tube of the same calibre is accurately fitted, by making the one pass about an inch into the other. This tin tube is about three feet long, or to be more portable, it may consist of two pieces, each 18 inches long, to be accurately fitted to each other, as above mentioned, and the joinings made air tight, by being neatly and firmly wrapped round with slips of wetted bladder. A bladder holding about a quart of liquid is then to be firmly fixed to the extremity of the tin tube, and this bladder fitted with a ring and stopper at the end farthest from the tin tube, for the purpose of emptying or pouring liquids into it. In using this instrument, the œsophagus tube must be introduced through the nose or mouth into the stomach, so as nearly to reach its bottom. The extremity of the tin tube is then to be joined to the œsophagus tube, and the joining made air tight. The bladder being then filled with tepid water, or any other fluid, the extremity of the tin tube, with the attached bladder, is then raised towards a perpendicular over the patient's head, and the fluid instantly descends into the stomach; and in order to extract it again, it is only necessary to depress the bladder and tin tube below the level of the stomach so as to form a Syphon.

It will be obvious to our readers that a Syphon upon the same principle may be conveniently used for any other purpose, and may be appropriately called a *moveable branch Syphon*. The two branches may in that case be of metal, glass, or any substance joined by an air tight joint. In cases of exigency two glass tubes, or pieces of any tube might be joined into a Syphon, by making the joint of bladder as above described.

3. Mr Shiell's *Triangle for Elevating the Jet of Fire Engines.*

This very ingenious contrivance, which was used with great success in the late fires in this city, is shown in Plate I., Fig. 5., where ABC is the triangle or tripod, consisting of beams of wood.

A is 40 feet long, and 5 inches diameter at the middle.
B and C 30 feet, do. do.
D the Yard, 12 feet.
E the Swivel turning in the end of A.
F the Jet or Director moving in the Swivel E.
G the Lathe Hose connected with the Engine.
H Three ropes attached to the end of the Director, one comes down direct to the Frame J, and the other two pass through holes in the extremities of the Yard, and thence to the Frame J. The first rope serves to give a vertical motion to the Director, and the latter two serve to guide it to the right or left, so that by these ropes any power may direct the Jet in any required direction.

This sketch is not exactly Mr Shiell's plan, (in which the legs of the triangle were of equal length,) but is taken from a triangle executed for the police establishment of this city.

4. *Account of an improved Hydropneumatic Lamp, which can be constructed at a small expence.* By WILLIAM DYCE, M. D. F. R. S. Edin.

This lamp consists of a cylindrical glass jar, open at the top, A B Plate I. Fig. 6.; into this jar is placed a bottle, C D, of the same kind of glass, which nearly fills it in point of circumference. With respect to the inner bottle, it is to be cut in two, so that when placed again in the outer jar, it only occupies one-half its space in altitude, which space, however, must be made up by means of a piece of leaden pipe, E F, of such size as will easily grind into the neck of the bottle, projecting, at the same time, about an inch above the upper part of the outer jar, which passes through an opening in the centre of a covering of mahogany, turned for that purpose. Into the upper part of the leaden tube is ground a small brass cock F, which can be procured from braziers at from 10d. to 14d., according to the size. Now the upper part, or that from which a fluid would flow, is to be filed or cut away, so as to admit of a piece of brass tube, about $\frac{3}{8}$ of an inch in diameter and $\frac{3}{4}$ in length, being soldered to the nozle, into which is fitted a piece of glass tube, drawn into a point, and bent downwards so as to be parallel with the stem, and, of course, to blow downwards, whereby the stream of hydrogen gas is directed upon the spongy platinum in a small box, G, moveable up and down through the wooden cover, by a spring-tube made fast to the cover; at the same time that this small box has a cover or top fitted to it, and easily moveable by means of a joint, so as to be accessible in darkness as well as light.

Every person knows, that rags on being burnt, so as to be in a complete state of incandescence without flame, are fit for tinder, and that this tinder may be inflamed by a spark, nearly as soon as gun-powder. Now, if these rags, of which the tinder is to be made, be immersed in the solution of platinum, dried and then burnt, the product will answer quite as well as Dr Fyfe's instrument for inflaming sulphur. On most occasions, indeed, it will inflame the gas without any farther trouble, yet, it must be allowed, at a much greater expence of gas before the inflammation takes place; but if the tinder only is required to be set on fire, then a very small portion of gas will be needful for that purpose, and a common brimstone match will produce the flame required. On certain occasions, I have found this method preferable to the spongy platinum when the column of water was not of sufficient altitude to force out the gas with sufficient rapidity to be inflamed, and yet was quite equal to the inflammation of the tinder, from which a match could be lighted, and that without any hurry, as it keeps ignited for a very long time.

In like manner, common charcoal answers the same purpose. If any quantity of powdered, fresh made, charcoal be moistened with the solution, and then submitted to a red heat, or nearly so, it possesses the power of inflaming the gas, if a jet be directed to it for a considerable length of time; yet it must be allowed, that its power of inflammation is not equal to the tinder, although it most readily takes fire, and, of course, is quite equal to the purpose of igniting a match.

With regard to the tinder, I may mention that I once prepared a small portion (by chance) that inflamed the gas as easily and quickly as the spongy platinum; but having no time, at that period, to prosecute any farther experiments on the subject, I must be content with merely mentioning the fact as it occurred. At the same time I may add, from recollection, that this piece of rag was used in wiping the vessel in which the ammoniacal precipitate had been prepared, and consequently may have imbibed a portion of the precipitate that was unavoidably left in the bason. I think the instrument, with this very cheap method of preparing the substance, or tinder, will prove a most useful appendage to a bedroom, seeing that it has elegance, cheapness, and compactness to recommend it.

When the impregnated tinder is employed, it may be proper to remark, that a larger jet is required at first to ignite it, and then a continuance of a very small stream is needful for the inflammation of the gas. The same precaution is necessary with one that I forgot to mention, that is paper. If the filtering paper, on which the precipitate is washed and dried, be burnt to redness, and then covered so as to exclude the access of common air to it, then it forms, when cold, as good an article for the inflammation of the gas as that prepared from rags. But if the charcoal preparation be had recourse to, a considerable waste of gas must be expected before inflammation takes place; yet if that is not required, ignition may be produced with a small portion indeed. All these preparations have a great advantage over the spongy platinum, for when they are once ignited, they continue for a very long time to be so, whereby time is afforded to apply a match, if a light is all that is required; whereas the spongy mass goes out instantly when the gas is stopt; and, on several occasions, when the gas was nearly expended, or, in other words, the pressure was so small as not be sufficient to produce flame by the platinum, on substituting the tinder it was ignited instantly, and by it a match kindled, which may answer the purpose for the time.

5. *On the Use of Granite for Railways.* In a Letter from John Gibb, Esq. Civil Engineer, to John Robison, Esq. F. R. S. E.

Sir,

I trust you will excuse me for addressing you on the subject of railways. But the unprecedented demand, and consequent high price of cast-iron, occasioned, perhaps, partly by the vast quantity required for the distribution of gas, together with the increasing prosperity of the country; having created an extraordinary demand for new manufacturing establishments, will, I fear, greatly retard the progress, and increase the expence of the numerous railroads now contemplated in various districts of Great Britain. I have, therefore, been induced to turn my attention to this subject, and I beg to submit the annexed sketch, Plate I. Fig. 8, for your consideration, which, according to my estimate, will have the advantage over the present plan of railroads in general, of 6s. per yard, or L. 528 cheaper per mile on a single railroad, and 12s. per yard, or L. 1056 per mile of a double railroad viz. calculating for the vicinity of London, and in many other districts still cheaper, as I shall afterwards show.

Agreeable to the annexed sketch, I propose, for a simple railroad, to lay two continuous lines of kirbing of granite, or other strong, hard, durable stone, close jointed on the ends; four to five inches broad on the top; ten inches deep, and ten to twelve inches broad at bottom; and on the top of each row, to lay wrought-iron bars, in length about twelve feet, one inch broad by one-half inch deep, with a cross T, welded on the under side at every four feet, checked down a little, and fixed into the stone. The wheels of the waggon to run on the top of the iron bar, in the usual way of common iron rails. The stone kirbing will be kept in its place by the road-stuff on each side, and the ironrail acting as a tie-bar, will make a perfectly smooth railroad, not liable to derangement.

In situations, where railways had to pass public roads or streets, it would perhaps be best to lay the space between the kirbing with small paving-stone. As the iron bars would be very little raised, and lie perfectly close on the stone, no breakage could take place, as is the case with cast-iron rails. As the stone kirbing would be more than sufficient to carry any weight that could be brought upon them, the iron bar on the top is only intended to give a smooth surface, and offer the least possible friction.

With regard to branches, turnings, and passings, it is evident they can be formed with the kirbing with the greatest facility. I have laid down the width as five feet between the rails, which is greater than usual; but perhaps it would be better to make the rails still wider, which would allow the body of the waggon a greater area, and less depth, and admit of higher wheels, requiring less power to move them on the rails; more accommodation would also be afforded, in the event of locomotive engines being applied. Square bushes would be a great improvement for waggon axles, which would only have to touch in four points, in place of embracing the whole circumference, as they have to do by the present mode.

The labour of forming the railroad, embanking, metalling, &c. &c. being the same in both schemes, I shall not enter into the expence of that department, but confine myself to a comparative estimate of what I propose to substitute.

Estimate by the present plan of Cast-Iron Railways, similar in weight to the one on Dartmoor.

To 92 lbs of Cast-Iron in a yard of length of a common single railroad, including 2 chairs, one for the end of each rail, which at the lowest quoted prices at present is 18s. 8d. per cwt. or 2d. per lb -	L. 0	15	4
To 2 Stones for fixing do. including boring - -	0	3	0
To 4 Buts for Chairs, exclusive of Plugs - -	0	0	6
	L. 0	18	10

New Scheme by Kirbing of Stone.

To 12 lbs of Welsh Bar of Wrought-Iron of dimensions as per Sketch in a yard, or including both sides together, with the cross T, and bolt at every four feet in length, which, although it requires no labour, but only welding the T at every four feet, and the quoted prices at present are only 14s., I have here estimated at double that, viz. 28s. per cwt. or 3d. per lb. - - - - - -	0	3	0
To Granite Kirbing, delivered in London, for both sides, at 4s. 6d. per yard, - - - -	0	9	0
To Boring and Setting, at 5d. per yard, - -	0	0	10
	0	12	10
Difference in favour of Kirbing per yard, - -	0	6	0

There are no doubt many districts, through which roads may have to pass, where hard, strong, durable stone may be procured, which would render this plan still cheaper, as the stones only require to be straighted on the top, and one edge, with square joints, and the bottoms blocked work, and may be in length one foot six inches to three or four feet.

In districts of the country where strong durable stone cannot be reasonably procured, it may be advisable to give a greater body of stone, and cut a groove an inch deep for the flanch of the waggon-wheel, and fix the bar of iron in the middle of the stone; but this will not be necessary when granite, or good whin-stone, or limestone can be procured, as they will be sufficiently strong on the edges, agreeable to annexed sketch.

I am, Sir, respectfully,

Your obedient servant,

Aberdeen, 14*th February* 1825. John Gibb.

6. *Description of a Single Valve Sluice, invented by* Robert Thom, Esq. *Rothesay.*

The construction of this sluice (Plate I. Fig. 9,) is partly similar to that described in our last Number; but it is applicable to cases where the reservoir is on high grounds above the works requiring the water, and where, of course, the water passes down a declivity.

AB, part of the tunnel of a reservoir.

B, a sluice that turns upon pivots a little above its centre of pressure.

CD, The rivulet that carries the water from the reservoir down to FG, part of a level canal or aqueduct.

EH, a hollow cylinder.

KL, a cylinder, water proof, of rather less specific gravity than water, which moves freely up and down within cylinder EH.

M, a pulley. BMK, a chain, &c.

I, a small cistern, kept always full of water by the waste from the sluice, or by a small hole in it.

HI, a small pipe, communicating between cistern I and cylinder EH.

EN, a small pipe communicating under ground, between EH, and

N, a valve at the lower end of pipe EN, which, when open, is capable of passing more water than the pipe HI can receive.

R, a float, placed within a small pool of water, on the same level as, and communicating with, the canal.

The water in the canal is here represented at its greatest height, and the valve N shut by the float R pressing up the spindle: the cylinder EH is therefore filled by water from the cistern I, and the sluice B shut by the pressure of the water in the reservoir, there being a little more pressure below than above the pivots. When the surface of the water falls in the canal, the float R falls with it, and then the valve N (falling by its own weight) opens and empties the cylinder EH, when cylinder KL falls and opens sluice B, and gives the supply required.

It is therefore of no consequence in regard to regulating the supply of water, how far the reservoir is from, or how high above, the level of the works requiring the water; provided that the length of the pipe EN corresponds with the distance, and its strength with the height or pressure of the water. It is necessary, however, that the bore of this pipe should be small, particularly where its length is considerable, in order that sluice B may open or shut very soon after valve N opens or shuts, and at the same time require only a small supply of water. Suppose, therefore, the opening into the pipe EN at I to be only a half inch bore, and that the valve N is shut when that pipe is empty, it is evident that the sluice B will not shut, till both that pipe and cylinder EH be filled with water; and that the smaller the diameter of that pipe be, the sooner will it be filled. The time, therefore, that sluice B takes to shut after valve N shuts, will always be the same as the time that pipe EN and cylinder EH take to fill when valve N is shut; and to make sluice B take an equal length of time to open after valve N opens, the aperture of that valve must be such as to take an equal length of time to run off the water to the bottom of cylinder EH, while the water is still flowing into the aperture at I, as that aperture takes to fill both cylinder and pipe when valve N is shut.

7. *Description of a Chain Sluice, invented by* ROBERT THOM, Esq. *Rothesay.*

This apparatus (Plate I. Fig. 10,) answers exactly the same purpose as the last, only the construction is different.

In this figure, the relative situations of the reservoir and canal are the same as in Fig. 6; and the cylinder and valves the same as those in Fig. 4, with the addition of RS, a lever, SP, a chain, and U a weight.

One end of the lever RS is connected with the valve spindle NO, and the other end with the chain SP. The other end of this chain is connected with the float P on the canal XY below.

When the water in the canal XY rises, float P also rises and slackens the chain SP; the weight U, then falling, shuts valve O and opens valve N; then the water, passing down tube KCLD, raises cylinder FG, and the pressure of the water in the reservoir shuts sluice A. When the water in the canal falls, float P falling with it, lifts the weight U, and shuts valve N, and opens valve O; and then the cylinder FG, falling with the water in ED, opens sluice A, &c.

This construction may, perhaps, be adopted with advantage on account of its cheapness, where the reservoir is very near the level canal, but a considerable height above it; for a brass wire, one-tenth of an inch diameter, will be strong enough for the chain where the distance is short, it having, in any case, little more to lift than twice its own weight. Figure 9, however, seems better adapted to general purposes.

8. *Description of a Breathing-Pump, invented by William Van Houten, junior, Rotterdam.*

Fig. 11, 12 of Plate I. show the interior of two pump cylinders, *a* and *b*, joined together, so that they make one body; in each of these cylinders is placed a piston *c*, which are both by the piston-rod *d*, (passing through the lid *e*,) attached to the handle *f*, by means of the small screws *g*; *h* is a discharging, *i* an introduction pipe, with an opening *k*; *l* are two leather elastic tubes, with a horn-band *m*, in which band is attached a small Indian-rubber pipe *n*; *o* is an injection-pipe, with a moveable shield *p*, and *q* the screw to fix it; *r* a blade.

As soon as the body is taken out of the water the nose and mouth must be properly examined, and, if necessary, cleaned of mud, &c; meanwhile, the two elastic tubes *n* are dipped for a moment in warm water, bent, as may be found necessary, and then placed to such a depth in the nose, that the horn-bands *m* are half in the nostrils, these bands being necessary to prevent the circulation through the pipes being stopped, when the nostrils are held close by the hand of the operator. The pipe *o* is then put into the mouth, until the shield *p* is close to the lips; the latter is shifted according to the size of the sufferer, and fastened by the screw *q*, so that the pipe may go the required depth into the mouth, with the blade *r* upon the tongue.

As soon as the Breathing-Pump is placed in this position by the operator, who holds it in the left hand, another person *B* must hold the nose and mouth air-tight round the pipe and tubes; the handle of the piston is drawn upwards by the right hand of the operator, and immediately both pistons rise to the top of the cylinders; upon this movement the valves *s u* shut, and *t v* open; and while the cylinder *a* is filled, through the nose, with foul air from the lungs, the cylinder *b* is filled with fresh or atmospheric air through the introduction pipe *i*, the pistons being pressed downwards, the valves *s u* are opened, and *t v* shut, and while the foul air from the cylinder *a* is discharged through the pipe *h*, the atmospheric air, by which the cylinder *b* was filled, is pressed through the pipe *o* in the mouth, and consequently into the lungs, and breathing will be immediately restored.

The operator ought to make the strokes as regular as the breath is usually drawn, and proper care must be taken that the stomach and breast be pressed every time the piston rises in the cylinder, in order to assist the discharge of the foul air.

If, at the commencement of the operation, there is reason to believe that the lungs are too heavily charged with foul air, the elastic Indian-rubber tubes ought alone to be brought into the nose, and, while keeping the mouth air-tight with the hand, a few strokes will immediately remove and discharge it. This operation will give room immediately for the fresh air to act with success by means of the pipe *o*, which must then be put into the mouth. Should it be wished to make an experiment to draw the foul air out by the mouth, and to introduce the fresh air through the nose, unscrew the pipe *o* and the tubes *l*, then turn the pump, so that the cylinder *b* is up, and *a* downwards, the pipes and tubes are then replaced, so that *l* is joined to the cylinder *b*, and *o* to *a*.

The valves are placed in such a manner between the screws at the bottom of the cylinder, that they may easily be taken out and turned another way, as is shown in the drawing, so that they have different directions, and may act in either way, as is judged necessary. If it be wished to make a trial of purified air, the apparatus containing the air must be screwed into the opening *k* of the introduction pipe *i*, the gas will immediately, by drawing the handle of the pumps upwards, float out of the apparatus into the cylinder *a*, and in consequence, by the re-action of the pistons downwards, be introduced into the lungs; and should the room, where the operation is performed, be too close, and filled by foul air, then take a long tube, and place the funnel either out of the window, or into the next room, where the air is cool and fresh.

9. *Professor Amici's Improved Camera Lucidas.*

In using the ingenious camera lucida, invented by Dr Wollaston, and described in several English works,* a practical difficulty has been experienced arising from the alternate appearance and disappearance of the point of the pencil by which the outline is traced. In order to understand this, says Professor Amici, let ABCD, Plate I. Fig. 15, be Dr Wollaston's quadrangular prism. The eye at O, perceives by means of two reflections from DC, CA, the object Q, and refers it to P. The pencil held in the hand at P is seen by one-half of the pupil, and the object by the other half, so that, by a slight motion of the eye, the pencil, or the ray, is seen indistinctly, according as the part of the pupil by which they are viewed becomes greater or smaller. In order to avoid this evil, M. Amici adopted the construction in Plate I. Fig. 16, where ABC is a metallic mirror, whose polished surface AB, is inclined 135° to the plain surface BD, of a piece of glass DCFE, with parallel faces. The eye at O, now sees the object R and Q, by the rays RMPO, reflected at M and P. As both the pencil and the rays are seen with the whole pupil, the object may be drawn with the greatest facility. When lenses are used in this construction, a concave one should be placed before the mirror ABC, and when a convex one is used, it should be placed

* See the *Edinburgh Encyclopædia*, Art. CAMERA LUCIDA.

below the glass towards the paper at Q. By these lenses, a copy larger or smaller than the object may be drawn. The camera lucida used by Professor Amici is fitted up as in Fig. 18, which is half its real size. In order to get rid of the reflection from the second surface of the glass, as shown in Fig. 17, by the ray CDFC, which enters the glass, M. Amici removes the polish from the part DM, so that no light is reflected at D.*

In order to prevent a reverse image of the objects produced by the metallic mirror from being seen, a small plate AB of blackened copper is placed as in Fig. 18, which stops the upper rays which a single reflection would bring to the eye. A rectangular aperture, to which the eye is applied, is made in the copper, the smallest sides of the rectangle being larger than the pupil, and the other sufficient for seeing enough of the objects.

Another construction which M. Amici thinks better than that of Fig. 16, is shown in Fig. 19, where RMNO is the progress of the ray from the object, being reflected at M from the polished surface FG, of the metallic mirror EDFG inclined 45° to BD. In this combination, the second reflection from the glass plate cannot be removed by grinding the face AC, but this image may always be prevented from reaching the pupil, by giving a proper thickness to the glass.

In order to make the two faces of the glass perfectly parallel, in which case distant objects will not appear double, M. Amici constructed a triangular prism of glass, and having cut it in two, he united the parts ACD, ADB, Fig. 19, so as to form a parallelopiped. By giving one of the prisms a slight motion of rotation, a position was easily found in which the two faces were parallel.

A third species † of camera lucida has been formed by Amici, with a small metallic mirror inclined to the great one, at an angle of 45°. The small mirror, which is elliptical, and smaller than the pupil, is supported and insulated by a small steel wire. The pencil is, in that case, seen by the outer ring of the pupil.

A fourth kind of camera lucida is shown in Fig. 20, where ABC is an isosceles right-angled prism of glass, having its face, BC, parallel to the metallic mirror MN, with an aperture in it XY, Fig. 2, less than the pupil RS; the ray from Q, follows the progress of the dotted lines to the eye at P, which sees the pencil through the opening XY, while the object is seen in the circular segments at R and S.

The last and the best construction is shown in Fig. 22, where ABC is an isosceles prism of glass, whose base, AB, forms an angle of 45° with MN. The

* We have constructed these with plates of topaz, which often split with surfaces perfectly polished, and always mathematically parallel. An inclined edge, as at DE, Fig. 16, can always be got, and often a rough water-worn edge.

† In place of a metallic mirror, we have found small and perfect crystals of ruby silver, blende, specular iron, and oxide of tin, much better fitted for this purpose, and much easier obtained. If the crystal used is extremely thin, a variation of the position of the eye enables us to vary the relative illumination of the pencil of the tinge.—Ed.

ray then proceeds in the direction PQSO, to the eye at O. The angle at C should be a little less than a right angle, in order that when the eye advances to B, it may not see objects directly reflected from AB. A plate of copper CN, pierced with a longitudinal aperture, as in Fig. 21, is then placed from C to N. In this construction, and indeed in all, the prism ABC, is greatly superior to a metallic mirror. M. Amici points out the great utility of the camera lucida in lithography, as the drawing from nature may be made at once upon the stone.

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

1. *The English Flora.* By Sir James Edward Smith, President of the Linnean Society. 2 vols. 8vo. Vol. I. 370 pp. Vol. II. 470 pp.

It is now time that we should execute the agreeable task which we, some time ago, promised to ourselves, of noticing more at large the two first volumes of *Smith's English Flora,* the appearance of which was announced in the first number of our Journal.

There are, perhaps, few countries of so limited extent that comprise such a variety of plants as the British Islands; particularly if we take into account its marine productions; although we must, at the same time, confess that there are, comparatively, few vegetables that are peculiar to these countries, few that are not found either in France, Germany, Denmark, Sweden, Norway, and Lapland. The variety of British productions to which we allude may, we think, be attributed to the extent of the island from north to south, across 60° of latitude. Hence the plants of the southern districts will be found to have many species in common with France and Germany; those of Scotland again, with the productions of Sweden and Denmark; whilst the great elevation of the hills in some parts of the country induces a vegetation that may most aptly be compared with that of Norway and Lapland. Parallels of longitude seem to affect, or to produce a difference in vegetation, much less than those of latitude. Hence, the degree of elevation above the level of the sea being the same, the plants of England and Scotland will equally be seen on the continent of Europe in the same parallel of longitude: and Ireland again, will be found to have a vegetation scarcely different from those parts of England and Scotland opposite to which it lies. The exceptions to this rule are very few in number. The beautiful *Menziesia polifolia,* or *St Patrick's Heath,* and the *Saxifraga Geum,* with its numerous varieties, are, we believe, only found truly wild in Ireland; and the same may be said of the *Euphorbia Hibernica;* but the two former are principally confined to the western extremity of that island. We cannot satisfy ourselves that the *Arbutus* is an aboriginal native of Killarney, where it grows with such luxuriance; but are rather inclined to annex some credit to the tradition of its having been introduced by the monks of Mucross Abbey, from France or Spain. Few trees (for the *Arbutus* becomes a tree at Killarney) are found to be so isolated as this is, in a state of nature.

Much as we owe to our insulated situation, in a political point of view, we are forced to allow, that, in another respect, in what concerns the extent and number of the species of its vegetable productions, Great Britain must yield the palm to the continent; extent of country and elevation, above the level of the sea, being the same. Plants cannot, or they can but rarely, by means of their seeds, cross over the ocean, so as to become naturalized in other countries. On the continent, they are continually migrating and extending the circle of their stations. Thus, we find that we no sooner pass the channel, and wander by the roadsides, or into the corn-fields of France, than we see many plants to which our eyes have only been accustomed as inhabitants of the garden. This is peculiarly the case with the *Eryngium campestre,* (now, we believe, quite extinct in Britain,) *Cirsium oleraceum, Alyssum calycinum, Anemone pratensis, Campanula speculum.* It is the same in Germany and Holland, and a slight glance at the figures in the *Flora Danica* will suffice to show how many plants there are, even in those northern climates, which we cannot call ours. The Alps of Switzerland, and the mountains of Norway, separated as they are by very great distances, have many plants in common, which we do not include in the Flora of our alpine regions; while, on the other hand, we can boast of very few plants which are peculiar to our islands. Sir James Edward Smith is inclined to consider the *Ligusticum cornubiense* as exclusively of British origin, though we must confess, that our own observations have led us to a different conclusion. *Brassica monensis* has not yet been found in any other part of the world than the Western Isles, and upon the opposite shores of England and Scotland. But the most interesting of our peculiarly British plants is the *Eriocaulon septangulare,* very nearly allied, indeed, to the *E. pellucidum* of America. In no other part of Europe is any one individual, even of the genus, to be found; and what is very remarkable, although the greater number of the species are inhabitants of the tropics, or of warm climates bordering upon the tropics, yet our species is found in one of the most northern of the Hebrides; and in a lake so cold, that the bare recollection of our wading into it, in pursuit of this rarity, seems to cast a chill over our whole frame.

Amongst the Cryptogamia, rich as Britain has proved to be in that extensive family, very many of them have been long known to exist equally upon the continent of Europe, and in North America. Indeed, it is a certain fact, that the lower we descend in the scale of vegetation, the more universally are the individuals of those tribes dispersed over the surface of the globe. We have received from North and South America, and from New Holland, a Lichen which we cannot distinguish from the *Cenomyce rangiferina* of our heaths and moors. Schweinitz, who has collected and described, with much care, the *Fungi* of Upper Carolina, (where, let it be observed, there is scarcely a phænogamous plant common to Europe,) has remarked that a very large proportion of them are the same with those of France and Germany: and we may add, that the *mosses* which we have received from the higher parts of North America, and from Kamtschatscka, are almost identical with those of Europe; whilst, with regard to the *Jungermanniæ* of the two countries now mentioned, although we have had the opportunity of examining many species, there is not one that has not been also detected in England and Scotland.

Britain, nevertheless, from the very circumstance of its being an island, and having its vegetation circumscribed within certain limits, must be allowed to possess much that is interesting in what concerns its botany; and it yields to no country in the successful manner in which its vegetable productions have been investigated.

Sir James Smith, in his preface to the *English Flora,* has given a general and admirably written view of the works which have been published on the Botany of Britain; but which, (since the book is in the hands of every one at all concerned in the subject,) as we have not space to copy entire, so we shall not injure, by any attempts to curtail. Our principal object, in this place, will be to show how much Sir James Smith has himself effected during a long period of years, and with a constitution which has, we fear, suffered by close application to his favourite pursuit; and what further accession may be expected to be made to the Flora by some of the most zealous promoters of British Botany, whom we have, at this time, the pleasure of numbering among our acquaintance.

It was at an early period of his botanical career, that Sir James Smith became possessed of the invaluable Linnæan Collection, which alone would have afforded him advantages over every other naturalist, in whatever Systematic work he might have undertaken. Happily this, great as it might be, was not the only qualification possessed by our author. To his extensive botanical acquirements are added the high attainments of an elegant scholar, and a talent at composition which has rendered his writings universally popular, and has been the means of throwing a charm over his botanical writings, scarcely known to the science before. We could here, were it necessary, appeal to almost every page of the English Botany in confirmation of our assertion; to the Introductory Discourse which was read at the opening of the Linnæan Society, and which was printed in the first volume of the Transactions of that body; to the lives of the various botanists in Rees' Cyclopædia, and the several botanical articles in that work from the same pen; and lastly, not to mention others, the preface to the Introduction to the Study of Botany, and that of the work before us; every where displaying the science in its most amiable point of view; recommending it for the pleasure and delight it affords, whether in the field or in the closet; but above all, as a means "of enlarging the understanding by a perpetual display of the power and wisdom of God, and encouraging our best hopes by sure testimonies of his goodness:" whilst, on the other hand, he tells us, that "none but the most foolish or depraved could derive any thing from the pursuit but what is beautiful, or pollute its lovely scenery with unamiable or unhallowed imagery."

Possessing these qualifications then, and these feelings, the publication of the *English Botany* could, to no person, with so much propriety, have been confided as to Sir James Smith. It was commenced by him in 1790, with the figures, as is well known, drawn and engraved by Sowerby; and the work extended to thirty-six volumes, with 2592 excellent plates. This publication may safely be pronounced unique of its kind, and rarely will there be found such an union of talents, both of writer and of artist, as have combined to form this book. In other countries, something of the kind has been attempted, in France, we believe in America and in Germany; but all have failed, and the inferiority, both of the designs and descriptions, is most striking.

It may easily be conceived, that such a work as *English Botany* must have tended very materially to encourage the progress of this science, not only by the valuable information which, for the space of twenty-three years, it periodically imparted, the book being published in monthly numbers; but also, because it necessarily proved a sure receptacle for every new botanical discovery that was made during its progress. The experienced naturalist made his communications and his remarks, for which full credit was given him; while the more humble botanist, and the young aspirant after fame, had his acquisitions, and his name, recorded in a manner that could not fail to urge him to renewed ardour in his pursuits. We, ourselves, will not forget, while memory shall last, the sensations excited by the first appearance of our name in print, when the *Buxbaumia aphylla* was announced as having been detected in Britain, "by a young naturalist of great promise." It gave a fresh stimulus to our exertions, and, aided by other circumstances occasioned by that discovery, induced that bias in our pursuits, which has now made botany the study and the pleasure of our life.

There is scarcely a botanist of eminence of that period who did not communicate something to this valuable work. We may here enumerate, amongst the most important contributors to the English Botany, the names of Sir Thomas Cullum, Mr Crowe, Mr Dawson Turner, Mr Borrer, Mr Dillwyn, Mr E. Forster, Mr G. Anderson, the Reverend G. R. Leathes, Mr Griffith, Mr Templeton, Mrs Griffiths, and Miss Hutchins;—and, during the long period of its publication, it was frequently the painful task of the author to record, in his own feeling language, the loss of some or other of his friends. The conclusion of the work, with the 36th volume, in 1814, when it included all the then known British plants, with the exception of the Fungi,* left a void which every cultivator of indigenous botany must have felt throughout the kingdom; but which, we hope, will not long exist. Mr J. D. Sowerby, the son of the late Mr Sowerby, who possesses the same excellent talents with his father as an artist, has many subjects ready for a continuation of the work, and he has written to us for some of the recently discovered Scottish plants.

It was not enough, however, that the Flora of our country should be

* Of these Mr Sowerby commenced a work, with most excellent figures, in small folio. It extended only to three volumes.

given in an English dress by the hands of such a master. Sir James Smith undertook an arrangement of our native plants in Latin; and there is, we are sure, but one opinion of the excellency of the *Flora Britannica,* which has been republished, verbatim, in Germany, and which, besides the correct and extended descriptions made upon the plants themselves, has the merit of settling a great deal of synonymy which was previously in a state of utter confusion. This is a talent, requiring great patience as well as judgment, that Sir James Smith possesses in a very high degree. Many authors, indeed, have benefitted their writings by his amendments, although few have acknowledged the obligation which they owe to him.

A systematic work, similar in its general plan to that of the *Flora Britannica,* was now required in the English language; and the eagerness with which the various editions of Withering were bought up, notwithstanding that none of them attempted to keep pace with the advanced state of science, was a convincing proof how gratefully would an *English Flora* be received from the pen of so eminent a writer. Want of necessary leisure had, hitherto, we know, retarded its appearance: but, by this delay, the public has been no sufferer; for every useful improvement in the science, down to the present period, has been adopted and combined with the author's own knowledge, and long experience on the subject, and hence have arisen the two volumes under the title of *the English Flora.*

These extend as far as to the end of the class *Icosandria.* The artificial system of Linnæus is adopted, the first object of the book being to furnish the students with means for the easy and accurate determination of our species of native plants, "so that any botanist, by reducing a plant to its class and order, according to the perspicuous and easy rules of that system, may next compare it with the short essential characters of the genera at the head of each class, which genera are there artificially disposed according to those characters. Having determined the genus, he will then find it, amongst its allies, in the body of the work, where its full characters, with all needful observations, and references to figures of the fructification, are given; the natural order, according to Linnæus, Jussieu, or others, being indicated. For a history of the natural order, and a view of the other genera belonging to it, the student may then turn to the *Grammar.* Having become acquainted with what relates to the genus of his plant, he will next compare his specimen with all the specific characters under that genus, till he ascertains its species, and confirms his determination of its name by reading the particular description, and consulting as many of the synonyms, or authors quoted, as he may have within his reach; thus finally becoming acquainted with all that is recorded concerning the plant he has gathered." The author has likewise headed each genus by the name of the natural order to which it belongs, and to each genus he has annexed a compendious view of its natural habit, characters, and qualities. The language of the present work is that which is recommended in the same writer's *Introduction* to, and his *Grammar* of, *Botany*; and certainly, with a few very trifling exceptions, it is such as we shall be anxious to adopt. Free from all vulgarism, he has used pure English words whenever they were applicable; and in other cases has, either by giving the Latin appellation an English termination, or by adopting the Latin itself, established a phraseology which is, perhaps, as classical as Botanical English can be rendered.

We shall offer a few observations on the genera and species in the work.

Zostera is still retained in the class *Monandria*, as is *Chara*, which to us would appear with more propriety to rank among the *Cryptogamiæ*.

The *Salicornia fruticosa* is considered by Smith as probably a variety of *S. radicans*. We may observe that our specimen of *S. fruticosa*, given to us by Professor De Candolle, and gathered on the shores of the Mediterranean, is quite different from the British plant so called; and, as Linnæus quotes *Sauv. Monspel.*, it is probable that he had the Mediterranean individual in view when he established the *S. fruticosa*.

Callitriche autumnalis of Linnæus, which, in Fl. Brit. and Engl. Bot., was considered but as a variety of *C. aquatica*, is now separated from it, and its former old name is restored. We are of opinion that the difference merely arises from locality. The specimens from which Sir James Smith appears to have drawn up his description grew a foot deep under water.

We have a new station for the exceedingly rare *Veronica fruticulosa*, given at p. 18, Vol. I.; it having been found upon Ben Lawers by Mr R. Brown, whose accuracy, as the author observes, is beyond all doubt or "supposition." We feel quite provoked with ourselves, that after having, as we had believed, scoured almost every rock upon Ben Lawers, and sometimes at the risk of a broken neck, we should not have met with this plant; but we know from experience how very local are many of these alpine species. We have gathered V. *saxatilis* in plenty on Ben Lawers.

Sir James Smith observes of the *V. serpyllifolia β humifusa*, that it is scarcely even a lasting variety. In the Botanic Garden of Glasgow, it has been cultivated for seven or eight years, and it retains all its characters. Nor do we, upon its native mountains, find any intermediate state of it to exist.

The genus *Cladium* is adopted for *Schœnus Mariscus*.

Schœnus albus and *S. fuscus* are referred to *Rhynchospora*, a genus of which we have several species from North America. *Isolepis* of Brown is united with *Scirpus*, as it differs only in the want of bristles around the germen. *Eleocharis* is kept distinct.

A new species of *Eriophorum* is added to the British list, viz. *E. pubescens*, the *E. angustifolium* of Poiteau and Turpin, *Fl. Par.*, but not of other authors. It belongs to the division of the genus with many spikes; and it must be confessed that the species are very difficult to be discriminated from each other.

Under the head of *Gramineæ* are some excellent observations upon that extensive and natural family. We shall quote one passage in illustration of our author's style. "Grasses (he observes) yield more sustenance to man and to the larger animals, than all the rest of the vegetable kingdom together. Their herbage, so perpetually springing, and so tenacious of life, accommodated, in one instance or other, to almost every climate, soil, and situation, affords to nature her most welcome clothing, and to the cultivator of the soil his chief riches. Nothing poisonous or injurious is found among them, if we except the intoxicating quality attributed to the seeds of *Lolium* ; but many are gratefully aromatic. Their farinaceous *albumen* supplies man with the staff of life, in Wheat, Rye, Barley, Rice, and Maize,* and makes a great part of the food of many birds and small quadrupeds. As man cannot live on tasteless unmixed flour alone, so neither can cattle, in general, be supported by mere grass, without the addition of various plants, in themselves too acid, bitter, salt, or narcotic, to be eaten unmixed. Spices, and a portion of animal food, supply *us* with the requisite stimulus or additional nutriment ; as the *Ranunculus* tribe, and many others, season the pasturage and fodder of *cattle.*"

Several of the recently formed genera are adopted among the grasses. An important division is also made of the genus *Poa,* by separating *P. aquatica, distans, maritima, procumbens,* and *rigida,* and uniting them with the *Glyceria fluitans* (the old *Festuca* or *Poa* of that name.) They agree in the linear oblong spikelets, and the shape of the corolla, which is cylindrical, not compressed, furrowed, ribbed, and not keeled. Mr Brown founded his character of *Glyceria* principally upon the compound stigmata, and the single fleshy, half-scutellate hypogynous scale. These marks do not hold good with all the present *Glyceriæ.* The *Poa procumbens* had been removed to *Sclerochloa* by P. de Beauvois, and *P. rigida* to *Megastachya,* by the same author.

Poa decumbens is made a *Triodia, Br.* ; *Dactylis stricta* is referred to *Spartina* ; *Avena planiculmis* of *Engl. Bot.,* is, we think, correctly determined to be different from the original *A. planiculmis* of Schrader, and the name of *alpina,* which Smith had previously assigned to it in the *Linn. Trans.* v. 10., is inserted.

Under the genus *Galium, G. Witheringii* is preserved ;—*G. diffusum* of Don, in Hooker's *Fl. Scot.,* is ascertained to be the *G. cinereum* of Allioni. *G. aristatum* of Linn., *Sp. Pl.,* is added, a species new to Britain, detected in Scotland by the late Mr G. Don.

Another *Potamogeton* is introduced, the *P. cuspidatum* of Schrader.

Two new *Myosotides* are given ; *M. cæspitosa* of Schultz, and *M. intermedia* of Link. Seven species of this genus are now enumerated.

Under *Primula Scotica,* Smith quotes, but with a mark of doubt, the *P. stricta* of *Fl. Dan.* t. 1385. We are well acquainted with this species, having received it from Professor Hornemann, and we can answer for its being *totally* distinct. With regard to the specific names, which are derived from particular countries, we must confess that we do not see the objection to these which our excellent friend has expressed. It may be thought, perhaps, that we are anxious to exonerate ourselves from blame for having applied the name in question ; but really we have always considered that appellations, taken from particular countries, had much to recommend

* To which *we* are authorized in adding *Oats.*

them, if they were not too hastily and indiscriminately appropriated. It is true, they are generally given from a presumption that the plant so denominated belongs exclusively to that country; to which the objection is, that it may afterwards prove to be a native of others. Even when this is the case, there is still an important fact recorded, namely, that it was first discovered in the district from which it derives its name, or that there its characteristic marks were originally detected.

A new *Viola* is given at p. 304, v. 1., *V. flavicornis,* found in Surry, and about Norwich. It is said to be allied to *V. canina,* and to have been neglected for it.

We have, under the genus *Erythræa,* a new species, *E. latifolia;* discovered by Mr Shepherd and Dr Bostock in sandy ground near the sea at Liverpool.

Gentiana acaulis should have been omitted altogether. It has assuredly never been found *wild* in Britain.

If we were to point out one part in the present volumes, in which the author has more successfully amended what has been done by former writers than in another, we should fix upon what concerns the *Umbelliferæ,* a family of plants the most natural, and, at the same time, the most difficult of investigation of any in nature. Much, indeed, had previously been effected by Hoffman and Sprengel, particularly the latter, in laying the foundation of a new arrangement. Our able friend has adopted all that is worthy of being adopted, from the latter author especially, and he has, in many instances, corrected and altered him for the better. We have already had occasion, with specimens in our hands, to make the comparison, and we have no hesitation in giving the most decided preference to Smith's arrangement; and in pronouncing it the most clear and simple that has yet appeared. The bracteas are by him only considered as of secondary importance, and he discards the term involucre, which, according to Linnæus, must properly be a part of the flower. The fruit, of course, affords the most material points of distinction, but all the hard names which Sprengel has applied to the ribs, furrows, and point of union of the double fruit, (or naked seeds,) are rejected as worse than useless. The base of the style and the floral receptacle are taken into account, and thus the genera of this great natural family are characterized, like other genera, solely by their flowers and fruit. Nor are these changes made to rest only upon examination of the British species, the author has held all the exotic kinds in view, and carefully studied almost all that are known in other countries.

We could have wished to have seen *Ligusticum cornubiense* kept distinct from that genus. We have stated in the *Flora Scotica,* under the head of *L. scoticum,* that the *L. cornubiense* of English Authors is the *Danae aquilegifolia* of De Candolle. We did so from an examination of a Piedmontese specimen, given us by Professor Balbis of Turin. This individual now lies before us, by the side of our Cornish plant; and again we must observe that we cannot detect the slightest mark of specific distinction between them. In both there are many barren flowers, sometimes entire partial umbels are so; sometimes whole umbels, especially those low down upon the stem. The young fruit is alike in both specimens. We have had perfect fructification sent to us by our friend, the Rev. Mr Bree, which was produced at his garden at Allesley, near Coventry, from Cornish plants. These were consigned to our garden, without making any notes upon their precise form and structure; but we were struck with their remarkably inflated appearance, and the scarcely prominent ribs, as being so different from the fruit of the acknowledged *Ligustica.* The re-examination of our specimen has, if possible, more strongly confirmed their identity in our estimation.

Anethum Fœniculum, though not much allied in habit, we find united to *Meum;* nor do *Bupleurum* and *Hydrocotyle* rank naturally between *Cnidium* and *Selinum.*

We are pleased to observe that Sir James Smith is doubtful of the permanent distinction between *Drosera anglica* and *longifolia:* for we have expressed the same opinion in a late number of the *Flora Londinensis.*

The *Junci* are described with great care; and some valuable corrections made in the species.

Luzula of De Candolle is kept distinct from Juncus, and altered to *Luciola,* for reasons which we will state in Smith's own words. "The establishment of this genus, so different in habit from *Juncus,* and now so well determined by the character of its *capsule,* and the number, as well as insertion of its *seeds,* can hardly be controverted. I only beg leave to make an indispensable correction in the orthography of the name. The hairy heads of flowers, wet with dew, and sparkling by moon-light, gave the elegant Italians an idea of their *luccioli,* or glow-worms; sometimes written *luzziole,* but this is a provincial corruption. Hence, however, John Bauhin got the name of *Gramen luzula,* or glow-worm-grass, for he never called it *Luzula,* which would have been the same as actually calling it a glow-worm from a similar derivation (*luces,* to shine) a Latin name, *Luciola,* has been given to the Adder's-tongue, *Ophioglossum;* whether from the shining hue of that plant, or rather perhaps from its resemblance in form to a lamp with its wick, is of no consequence. The name so applied by Gesner and Dodonæus, extant in Ambrosinus and even in Ainsworth, is now superfluous for the *Ophioglossum,* and is, in fact, the Latin of *Luzula,* this latter being altogether corrupt,—neither Latin nor good Italian."

Luciola congesta, the *L. campestris β,* with compact heads, is kept distinct: but we fear without sufficient grounds.

The Genus *Oxyria* is adopted, and some excellent remarks upon it are introduced.

Calluna is separated from *Erica.*

Elatine Hydropiper is considered not to be the true *Hydropiper* of Linnæus, and is called *E. tripetala.*

The Genus *Saxifraga* has undergone a very considerable revision. Fourteen species were enumerated in the *Flora Britannica;* twenty in the English Botany; and here we find twenty-five. We are really sorry to see the number of species so much increased; for we feel assured, that, unless new species are made upon very substantial grounds, the difficulty attending their study is made greater to the young Botanist. We know from our own experience among the native mountains of many of them, that they are exceedingly liable to vary. Our old friend *S. hypnoides*, which we used to know well, and to find on almost every hill in England, Ireland, and Scotland, is now hardly to be recognized in any station. If we show a specimen to one friend, it is named *S. hirta*, (which, except in the presence of its lateral shoots, borders very closely upon *S. cæspitosa*), to another it appears to be *S. affinis*, to a third *S. platypetala*, to a fourth *S. denudata*, to a fifth *S. elongella*, to a sixth *S. leptophylla*, to a seventh *S. læte-virens*. Indeed, the learned author himself, in his concluding observations upon the genus says, "I have thus endeavoured * to furnish the British Botanist with materials, at least, towards the History of this most difficult genus, correcting my own mistakes, but not presuming to reject, or to decide upon any thing I have not examined. It cannot but be remarked that many of the specific characters are two indefinite and not discriminative, the cause of which is that we are not, as yet, well acquainted with what constitutes a species in *Saxifraga*, nor how to define their differences." In this latter opinion we most cordially agree; but then we differ as to what our mode of acting should be on this confession. If the character of one presumed new species be so slight as not to be capable of clear definition or discrimination, it is surely better to include it under that already established species to which it bears the closest affinity, and to notice it among its varieties. These, however, are mere matters of opinion, and we have perhaps dwelt too much upon them. Haworth and Don have laboured greatly among the Saxifrages, and the latter has well described many new and excellent Exotic species. Sincerely do we wish that Count Sternberg might be induced to continue

* In our *Flora Scotica*, note, at p. 13. P. 1, a passage runs thus: "Since the above remarks were written upon this most intricate family of the *Saxifrages*, it was with much satisfaction that I saw, in the article on *Saxifraga* in Rees' Cyclopædia, that Sir James Smith has, with that degree of candour which *so often* accompanies his writings," &c. With much concern we learn that the words here printed in italics were understood to imply that Sir James Smith was *not always* candid in his writings, an assertion which it was so far from being our intention to make, that we really meant to pay a high compliment to our valued friend. We are, however, quite sensible of our mistake, and of the construction which may be put upon it, and can only say in our defence that the passage in question was, like too many other parts of the *Flora Scotica*, written hastily, and overlooked in our own correction of the press. If the erroneous idea is removed from the minds of our readers, no harm will have ensued from this unintentional mistake. On our parts it has led to a long-continued correspondence with Sir James Smith, which has but increased the regard that we have always felt for him, which we believe to be mutual, and has given us unquestionable proof that his public character is only equalled by his private virtues.

his admirable figures of *Saxifragæ,* which would tend, more than any thing, to a right knowlege of the species, in so truly difficult a genus.

Cucubalus baccifer is omitted, as not of really British origin.

Arenaria peploides:—this is observed to be the *Houkenya* of Ehrhart. The habit surely separates it from the other *Arenariæ,* and we have lately heard that some intelligent botanist at Edinburgh has ascertained that this plant is constantly diœious.

Euphorbia is, with great propriety, removed to the Class *Monoecia.*

Rosa and *Rubus* are entirely remodelled: the former is made to include 22 species: the latter 14. Upon these intricate genera, we dare not presume even to offer a remark. We are quite in despair upon the subject, and in a study " of so much conjecture and uncertainty," as Sir James Smith justly terms it, it may be well supposed, that the opinions will be as various as are the Botanists who devote their attention to the subject.

Potentilla aurea, Engl. Bot. is ascertained not to be the plant of Linnæus, but the *alpestris* of Haller, jun. and Seringe: and *Fragaria sterilis* is removed to *Potentilla.*

We are glad to find, that the author confirms an opinion which we have sometime ago expressed, that *Dryas integrifolia* of *Fl. Dan.* may be only a variety of *D. octopetala.*

We must now take leave of our learned author for the present. He has still an arduous task before him, in the continuing of the work, and we know that he labours at it incessantly, and with so earnest a desire for correctness of execution, that he sometimes employs a whole day in describing and collecting the synonymy of a single species. We have many active botanists in the kingdom, who are smoothing the way for his introduction of the *Cryptogamia,* with every improvement of the continental botanists. In England Mr Purton, well versed in the Fungi, is zealously collecting materials for a new edition of his interesting *Midland Flora.* * Mr Hobson has published two volumes of specimens of mosses, found in the neighbourhood of Manchester. Mr Baxter, chief gardener at the Oxford Botanic Garden, is editing Fasciculi of the species of Cryptogamous plants, gathered in the vicinity of that classical city. We have elsewhere, in this Journal, spoken of the labours of Dr Greville, Mr Arnott, Captain Carmichael, and Mr Drummond in Scotland. All and each of these able botanists will have the honour of contributing largely to the completion of the labours of the learned President of the Linnæan Society, and which will, we are confident, when the materials are properly digested by the able author, combine to form a work, which, of its kind, will not find its equal in any age or country.

* *Midland Flora,* or a *Botanical Description of the British Plants in the Midland Counties, &c. by T. Purton, Surgeon, Alcester;* in 2 vols. 12mo, to which have been added two volumes of supplement. The Fungi here hold a very conspicuous place.

II. *On the Effects of the Density of Air on the Rates of Chronometers.* By George Harvey, Esq. F. R. S. E., &c. From the Philosophical Transactions for 1824, Part II.

In the first number of this Journal, we gave a brief notice of Mr Harvey's investigation of the remarkable alterations of rate produced in Chronometers, by changes in the density of the medium in which they are placed, and we purpose now offering to our readers an analysis of the entire memoir.

The subject was undertaken by Mr Harvey, in the four following points of view:—

First, By subjecting different Chronometers to a less pressure than that afforded by the ordinary state of the atmosphere at the level of the ocean.

Secondly, By submitting them to a greater pressure than that afforded by the atmosphere under the same conditions.

Thirdly, By removing Chronometers from condensed into rarified air, and *vice versa.*

And *Fourthly,* To determine how far the rates of Chronometers are affected by the ordinary aberrations of atmospheric pressure at the level of the sea.

To estimate the effects produced by the first of these conditions, the Chronometers were placed beneath the capacious receiver of a large double-barrelled air-pump, the pressure being indicated by an excellent mercurial guage; and for the second, the time-keepers were introduced into a condensing engine, furnished with an appropriate guage. To prevent any irregular effects from the unequal action of terrestrial magnetism, the position of each Chronometer, with respect to the meridian, was preserved *constant* during the whole course of experiments.

The first Chronometer, selected by Mr Harvey, was an eight-day one of the box kind. Its rate for ten days previous to the experiments was steady and uniform, amounting to — 3.″1, the mean pressure of the atmosphere being 30.1 inches; but when placed beneath the receiver of the air-pump, under a constant pressure of 20 inches of the mercurial column, the mean of four days' observation gave an equally steady rate of — 1.″3. the Chronometer having gained 1.″8, by diminishing the density of the air in the ratio of 3 to 2. A proportional effect was produced under a twenty inch pressure, and an alteration of + 9.″7 was effected, by diminishing the density in the ratio of 30 to 1.

The next experiment was with three pocket Chronometers, and the increments to the rates, by diminishing the density in the ratio of 60 to 1, were respectively + 18.″8, + 18.″3, and + 19.″9.

In another set of experiments, the density of the air was uniformly diminished by decrements represented by two inches of quicksilver, and which was accompanied by changes in the rates of two Chronometers, (abstracting the occasional aberrations displayed by most time-keepers,) increasing proportionally as the density of the air was diminished. From the nearly equal uniformity of temperature also, that prevailed during the experiments, and from the positions of the Chronometers, with respect to the magnetic meridian being constant, there can be no doubt, as Mr Harvey remarks, but the different alterations of rate are due to alterations of pressure. As the results relating to the last mentioned Chronometers are very interesting, we subjoin them.

EXPERIMENTS WITH TWO POCKET CHRONOMETERS.

Mean Temp.	Pressure.	Number of Days.	Mean Daily Rate.	Mean Daily Rate.
	Detached			
46°	29.1 Ins.	4	+ 2.″5	+ 4.″0
46°	27	4	+ 3.″0	+ 5.″2
47°	25	4	+ 3.″4	+ 6.″1
46°	23	4	+ 4.″7	+ 7.″2
45°	21	3	+ 6.″4	+ 9.″4
42°	19	4	+ 7.″6	+ 11.″3
43°	17	3	+ 10.″5	+ 13.″4
44°	15	4	+ 11.″7	+ 14.″4
45°	13	4	+ 13.″4	+ 15.″8
49°	11	4	+ 14.″5	+ 17.″1
48°	9	4	+ 16.″0	+ 18.″2
48°	7	3	+ 19.″0	+ 20.″4
50°	5	4	+ 18.″6	+ 22.″1
49°	3	4	+ 19.″9	

One of the most interesting parts of this paper, however, is the inquiry respecting the probable alteration of rate that would be produced in a Chronometer, by transporting it to any place elevated considerably above the level of the ocean, as from London to Geneva, or from the shores of the Mediterranean to the lofty plains of La Mancha and the Castiles, or from Vera Cruz, on the shores of the Pacific Ocean, to the Table Land of Mexico, where the mean atmospheric pressure is denoted by 23 inches of the barometer, or to the still loftier elevation of Quito, where the density of the air is denoted by only 21 inches of the mercurial column. The following table contains a few of the very interesting results obtained by different Chronometers.

	Increment to Time-Keeper A.	Increment to Time-Keeper H.	Decrement to Time-Keeper F.
From London to Geneva.	0.″6	+ 1.″8	— 1.″5
London to Madrid.	+ 2.″1	+ 2.″2	— 2.″3
	Increment to Time-Keeper K.	Increment to Time-Keeper L.	
Vera Cruz to Mexico.	+ 1.″9	+ 5.″0	
	Increment to Time-Keeper C.	Increment to Time-Keeper H.	
Level of the ocean to Quito.	+ 3.″2	+ 6.″2	

For the lofty summit of Chimborazo, four time-keepers gave alterations of rate, represented respectively by + 6.″1, + 7.″0, — 5.″3, and 9.″1 ; and for the elevation attained by *Gay Lussac* in his magnificent aerostatic ascent, when the barometer sunk to 12.95 inches, Mr Harvey found alterations of rate denoted respectively by + 13.″2, and +19.″2.

In the second branch of the experiments, relating to the influence of condensed air, Mr Harvey found the results to be precisely the reverse of those produced in rarefied air ;—that is, if a Chronometer *gained* by being placed in air of a *less* density than that afforded by the ordinary state of the atmosphere, it *lost*, by being subject to air of a *greater*. This was verified by many experiments, with the same Chronometers as employed under the receiver of the air pump. We select, by way of illustration, the time-keeper, of which the results produced under the receiver of the air pump, are contained in the fourth column of the first table of this abstract.

Mean Temp.	Mean Pressure.	Number of Days.	Mean Daily Rate.
47°	30 in.	6	+ 1.″2
47°	45 in.	5	— 4.″4
46°	60 in.	5	— 8.″2
45°	75 in.	5	— 9.″5
46°	30 in.	5	+ 0.″6

And which, it will be perceived, are all *decrements*, whereas in the experiments performed in the rarified air with the same Chronometer, they were uniformly found to be *increments*. The almost perfect restoration of the detached rate, after the great changes produced by so considerable an augmentation of density as that corresponding to the mercurial column of 75 inches, is a very remarkable circumstance.

The third division of the paper also contains some valuable and important results, one of which we select. An opportunity was taken, observes Mr Harvey, when two Chronometers had been under the diminished pressure of 23 inches for five days, to remove them for a like period into the condensing engine, containing air of a double density. The result of this application was, that the rate of one of the time-keepers received a decrement of 9.″5, and the other a diminution of 10.″4. Knowing, continues Mr Harvey, the merits of these Chronometers, I ventured to predict, that if the two Chronometers were removed from the condensed air into an atmosphere corresponding in density to 21 inches of quicksilver, the transition would produce rates greater than those corresponding to 23 inches. The result verified the conjecture; the average rate of the first time-keeper being found to be + 5.″0, and of the second +12.″0.

We must, however, hasten to the fourth and last division of Mr Harvey's paper ;—relating to the question, How far the ordinary changes in the density of the air are likely to exercise an influence on the rate of a time-keeper? This branch of the investigation is enriched by many delicate experiments, relating to small changes in the atmospheric density, and we regret our limits will not permit us to insert the results. Mr Harvey, however, found, that a difference in the density of the air, represented by a quantity less than an inch of quicksilver, if continued for a day, was capable of affecting all the Chronometers employed; and this is an atmospheric change by no means uncommon in this variable climate. Nor is it indeed necessary, continues the author, that the alterations of density should even continue for twenty-four hours, since, from the change of rate being instantaneous, as he afterwards proves, six hours will be sufficient, in some instances, to disclose it. In cases, however, where the variations of the mercurial column are but small, and its transition from one state to another marked by a gradual character, the effect on the generality of Chronometers is scarcely if at all perceptible.

With a difference in the mercurial column of an inch and three-quarters, or two inches, Mr Harvey has little doubt but all time-keepers must be influenced; and it is moreover known, he remarks, that from a species of reaction in the atmospherical columns, the greatest depression of the barometer succeeds to a considerable elevation of it, and *vice versa,* so as to exhibit a difference of this kind. Mr Harvey, accordingly, endeavoured to obtain the rates of some good Chronometers during the remarkable depression of the barometer in December 1821, but without success; and he farther observes, that there can be little doubt but, had the rates of some good Chronometers been carefully attended to, during this singular alteration of atmospheric density, variations of rate, at least equivalent to that produced by transporting a time-keeper from London to Geneva, would have been found.

Another curious part of the paper is, the consideration of the question, Whether the alterations of rate observed by Mr Harvey during his experiments, were *immediately* acquired, the moment the change of pressure took place, or whether it was an effect which the air gradually produced on the machine.

To determine this, a pocket and box Chronometer, possessing detached rates of + 9.″0, and + 1.″9 were placed under the receiver of the air pump, in air denoted in density by 2 inches of the mercurial column; and which great degree of exhaustion was employed in order that, by producing considerable alterations of rate, the changes during very small intervals of time might be perceptible.

At the expiration of an hour, the increment produced in the rate of the pocket Chronometer, by a mean of three observations, was found to be + 1.″33; whereas the detached rate, in the same time, would have amounted only to + 0.″37, being a clear increase of 0.″96 in consequence of the diminished pressure. At the end of the second hour, the mean rate was found to be + 1.″23, at the third 1.″35, at the fourth 1.″30; and the observations were continued through the entire twenty-four hours, the mean of the horary observations from noon to midnight being + 1.″12, and the latter + 1.″10. The entire rate for the twenty-four hours amounted to + 26.″6, being an increase on its detached rate of 17.″6. By a series of similar experiments with the box Chronometer, the mean of the horary rates for the first twelve hours was + 0.″92, and of the last

+0.″72; the entire rate for the whole period being + 20.″4, or an increment to its detached rate of 18.″5.

The succeeding day, the two Chronometers were restored to the full pressure of the atmosphere; and the first hour after their restoration, an attempt was made to discover the same increments as existed under the receiver, but without effect; the rate for the entire twenty-four hours of the pocket Chronometer being + 10.″08, and of the other + 1.″0. Hence, Mr Harvey infers, that the change produced in the rate of a Chronometer by *diminishing* the density of the air, is *immediate* and *uniform* in its effects; and so also is the effect produced by *increasing* it.

We confess we thought, when considering the remarkable differences of density to which the chronometers were subjected during these experiments, that considerable derangements must result to their ordinary rates; but we were happy to observe that Mr Harvey has furnished many examples, illustrative of the power which most time-keepers possess, of regaining their original rates, or very nearly so, after they have been subjected to pressures, both considerably above and below the mean density of the air. Mr Harvey furnishes one most remarkable example of a chronometer, which possessed the power of immediately altering its rate with every new circumstance in which it was placed, and also of regaining its original rate, after being again restored to its primitive condition. During the course of observations, and which embraced a period of four months, this time-keeper was subjected to pressures from 60 inches to 3 inches, and the power it possessed of regaining its original rate, may be observed in the next table.

Detached	+	7.″9	Detached	+	7.″8	Detached	+	8.″0
28.6 Inches	+	9. 7	60 Inches	—	6. 6	5 Inches	+	26. 6
Detached	+	8. 0	Detached	+	8. 7	Detached	+	7. 5
21 Inches	+	14. 2	3 Inches	+	28. 0	5 Inches	+	26. 9
Detached	+	7. 9	Detached	+	7. 2	Detached	+	7. 9
15 Inches	+	17. 0	34 Inches	+	5. 3	40 Inches	—	3. 0
Detached	+	8. 2	Detached	+	7. 0	Detached	+	7. 7
12 Inches	+	19. 0	38 Inches	+	2. 3			

During the investigation, Mr Harvey attended to the changes of temperature, always accompanying sudden alterations in the density of the air; and, following the opinion of Mr Dalton, that it is the effect of a degree of heat amounting probably to 40 or 50 degrees, yet only allowed to exercise its influence for a few seconds, in consequence of the immediate effort made by the receiver and the surrounding objects, to restore the primitive temperature, the effect on a delicate thermometer is only that of two or three degrees. Hence Mr Harvey introduced a very susceptible time-keeper, into an atmosphere 50° warmer than the ordinary state of the air for ten seconds, but found no alteration of rate to result from it.

In accounting for these curious and singular alterations of rate, Mr Harvey availed himself of the admirable paper of Mr Atwood, contained in the Philosophical Transactions for 1794, and by an extension of that very learned philosopher's formula for representing the daily aberration of a chronometer, he has been enabled to account for the whole series of changes in the clearest and most satisfactory way. The formula in question is

$$24^{h}\left\{\left(\frac{a}{a'}\right)^{\frac{1-n}{2}}-1\right\},$$

where a denotes the primitive arc of vibration, a' the arc resulting from the action of a disturbing force, and n the exponent, denoting the ratio between the elastic force of the spring, and the angular distances from the point of quiescence.

By considering the way in which the value of this formula must be modified, by assigning different values to the elements a' and n, according as we conceive the elastic force of the spring to vary *directly* with the angular distances from the point of quiescence, or in a *less* or a *greater* ratio, he has been enabled to explain why some chronometers *gained* by *diminished* pressure, and *lost* by *increased*, whilst others possessed properties precisely the reverse. This paper occupies above forty pages of the transactions.

Art. XXXIII.—PROCEEDINGS OF SOCIETIES.

Proceedings of the Royal Society of Edinburgh.

March 21, 1824.—A Paper, entitled Observations on the Motions of the Eye-ball, by Mr Charles Bell, was read.

There was also read, Farther Observations on the Vision of Impressions on the Retina.

April 4.—The following gentlemen were elected Ordinary Members:

The Right Honourable Lord Belhaven.

Dr Reid Clanny, Physician, Sunderland.

Sir James Hall read a Paper " On the Consolidation of the Strata," of which we have given a full abstract in this Number, p. 1.

April 18.—A Paper on the Construction of Oil and Coal Gas Burners, &c., by Dr Christison and Dr Turner, was read.

May 2.—The above paper was concluded at this meeting.

At the same meeting was read the Description of an Instrument for Registering the Indications of Meteorological Instruments, in the absence of the Observer. By H. H. Blackadder, Esq.

May 16.—Dr Knox read a paper, entitled Observations on the Motions of the Eye-ball. The object of this paper was to demonstrate, in opposition to the opinion of Mr Charles Bell, that the eye had no upward involuntary motion in a state of repose.

At this meeting Dr Turner exhibited to the Society the Experiment of Condensing the Gases into Liquids by their own pressure.

There was laid before the Society a paper on the Refractive Power of the two new Fluids in Minerals, with Additional Observations on the Nature and Properties of these Substances. By Dr Brewster.

There was also laid before the Society Astronomical Observations made at Paramatta, and communicated by his Excellency Sir Thomas Brisbane.

The Society adjourned its meetings till November.

Art. XXXIV.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Pastorff on the Solar Spots and Clouds.*—In examining the sun's disk with a fine six feet achromatic telescope of Frauenhofer, with powers varying from 25 to 400, M. Pastorff of Buchholtz, near Frankfort on the Oder, has observed several interesting phenomena relative to the spots on its surface, their penumbræ, and the phosphoric clouds. He observes that the penumbræ of the spots resemble a mass of the empty eggs of the *Bombix neustria*, which surround the black spots concentrically and with different breadths. These apparent eggs are contiguous, and, as it were, agglomerated the one to the other, with openings extremely small. M. Pastorff considers it quite certain, that these spots with the penumbræ are on the surface of the solar globe, and that they disappear when the phosphoric clouds cover them, principally when they are near the margin of the sun, and, he thinks, that it is probably these phosphoric clouds which, in the interval of some hours only, form this great variety of spots. On the 1st December 1823, M. Brioschi of Naples observed a large spot, equal to 1½ our globe, surrounded with an irregular and branching elevation, into which there seemed to be precipitating great masses of fire. The whole surface of the sun he saw like an ocean on fire agitated by a storm. M. Pastorff saw this same spot on the same day, when the phosphoric clouds were in great motion, but though he has often seen the agitation of the phosphoric clouds much greater, he did not consider it as resembling an ocean on fire. Almost always when the spots approach the margin of the sun's disk, they divide themselves into several groupes, or they reunite if they have been previously subdivided. Very near the margin, the spots appear totally altered, and they almost always appear as if they were dissolved and changed into luminous clouds, though that dissolution is only apparent; for it is quite evident, that, in proportion as these spots approach the margin of the disk, the penumbra or the nebulosity which encircles them, covers them more and more till they totally disappear. There is then only seen the luminous nebulosity which is sometimes surrounded with phosphoric clouds. The sun always appeared more bright at its centre than towards its edge.

2. *Comet seen on the Sun's Disk.*—On the 26th June 1819, M. Pastorff observed a nebulous spot and three black ones. The nebulous spot was

perfectly round and slightly luminous; and he supposed that it was the comet, which, according to the calculations of Dr Olbers, ought to pass over the sun's disk on the 26th June 1819, at 5^h 47′ A. M. The roundness, the nebulosity, and the luminous point in its centre, appeared to M. Pastorff so remarkable, that he made an accurate drawing of it. At 8^h 26′ A. M., its diameter was 84″.5, and its distance from the S. E. margin 6′ 10″. On the 27th June at 9^h A. M. the round spot and one of the black spots had disappeared.—See *Zach's Corr. Astron.* vol. xi. p. 550.

3. *Singular Appearances in the Comet of* 1824.—In this Journal, Vol. II. p. 172, we have already noticed the curious fact observed by M. Carlini, that *the light of the comet increased while its distance was increasing.* This remarkable fact has acquired more importance from the analogous observation of M. Pons. On the 18th December 1829, M. Pons observed the comet distinctly. On the 19th, he could not discover a trace of it; but on the 25th he again saw it. M. Carlini considers, that the photometrical phenomena of that comet are explicable, by supposing that its light varies inversely as the cube of its distances from the sun and the earth.

4. *Encke's Hyperbolical Elements of the Comet of* 1824.—We have already given (Vol. II. p. 172.) Encke's first elements of the comet, but he has since obtained more accurate ones from the combination of *ten* mean places, from 27th July to 26th October 1824. These are as follows:

Passage of Perihelion, 1824, Sept. 29th Mean Time at Seeberg,	.08813
Long. of Perihelion, Equin. Sept 29th	4° 31′ 7″.3
Long. of Ascending Node, ditto	279° 15′ 39″
Inclination of Orbit	54° 36′ 58″.6
Log. of Perihelion Distance	0.0212469
Excentricity	1.0017346

This hyperbola, M. Encke remarks, represents the observations much better than any parabola or ellipsis.

5. *Comet of* 1824 *discovered at Paramatta.*—This comet, which has excited much interest in Europe, was discovered at Paramatta by Mr Rumker. The observations of this able astronomer will appear in the Edinburgh Transactions, vol. x. part ii. The following are the elements, computed from these observations by a Correspondent.

Time of Perihelion Passage Mean Time at Paramatta	September 29th	7^h 25 10″
Long. of Perihelion		4° 22′ 21
Perihelion Distance		1.048739
Long. of Ascending Node		279° 19′ 13″
Inclination of Orbit		54 22 22

6. *Sir Thomas Brisbane's Catalogue of the Stars in the Southern Hemi-*

sphere.—Great progress has been made in this important catalogue. In July next 12000 observations will be sent home by Sir Thomas Brisbane, and 6000 more are nearly ready.—*Letter from Sir Thomas Brisbane.*

7. *Mr Herschel and Mr South on Double Stars.*—The valuable memoir containing the observations of these two able astronomers on double stars has just reached us, but too late to enable us to avail ourselves of it in this Number. It forms the third part of the *Phil. Trans.* for 1824, and has been deservedly honoured with the annual astronomical prize of the institute of France. Mr South has continued these observations at Passy, and in the *Transactions* of 1825 we may expect his observations on at least 400 more double stars.

8. *Miss Caroline Herschel's Catalogue of Stars.*—We understand that this lady, already highly distinguished in the history of astronomy, has occupied herself since her residence in Hanover, in revising and reducing into a general catalogue, in zones, all the twenty feet sweeps of her illustrious brother, the late Sir William Herschel. This is a work of immense labour, and will be an extraordinary monument of the unextinguished ardour of a lady of seventy-five in the cause of abstract science.

OPTICS.

9. *Lateral Refraction.*—The phenomena of lateral or azimuthal refraction have been occasionally observed by astronomers in their geodetical observations. M. Schubert, in August 1823, while measuring from Toksova the angle between the spires of the church of St Peter and St Paul in Petersburgh, and the signal of Agalotowa, rain began to fall at Agalotowa at $2\frac{1}{2}^h$ P. M. and advanced to Toksova, and during this interval, the angle alluded to increased from 88° 1′ 11″0, to 88° 1′ 31″2.

10. *Mr Dunlop's Reflecting Speculum.*—We learn from Sir Thomas Brisbane, that his assistant, our countryman Mr Dunlop, has succeeded in polishing a speculum, which bears a power of 2000 times, and Sir Thomas expects that many valuable results will be made with this instrument on the Magellanic clouds, and on the nebulæ and clusters of stars.

MAGNETISM.

11. *Effects of Temperature on the Magnetic Forces.*—In a very able paper on this subject, just published in the *Phil. Trans.* for 1824, Part II. Mr Christie has given the following results:

1. From 3° of Fahrenheit, and even much lower, up to 127°, the intensity of the magnets decreased, as the temperature increased.

2. With a certain increment of temperature the decrement of intensity is not constant at all temperatures, but increases as the temperature increases.

3. From a temperature of about 80°, the intensity decreases very rapidly as the temperature increases, so that if, up to this temperature, the

differences of the decrements are nearly constant, beyond that temperature the differences of the decrements also increase.

4. Beyond the temperature of 100°, a portion of the power of the magnet is permanently destroyed.

5. On a change of temperature, the greatest portion of the effect on the intensity of the magnet is produced instantaneously, which proves that the magnetic power resides on or very near the surface.

6. The effects produced on unpolarised iron, by changes of temperature, are directly the reverse of those produced on a magnet, an increase of temperature causing an increase in the magnetic power of the iron, the limits between which Mr Christie observed, and they were 50° and 100°.

12. *Diurnal Variation of the Terrestrial Magnetic Intensity.*—The following interesting table, given by Mr Christie in the paper above mentioned, shows the diurnal variation of the magnetic intensity in May and June, according to his own observations, and those of Hansteen's :

Intensity according to Hansteen's Observations in 1820.			Intensity according to Mr Christie's Observations in 1823.		
Hour.	May.	June.	Hour.	May.	June.
8^h 0′ A. M.	1.00034	1.00010	7^h 30′ A. M.	1.00114	1.00061
10 30	1.00000	1.00000	10 30	1.00000	1.00000
4 0 P. M.	1.00299	1.00251	4 30	1.00175	1.00223
7 0	1.00294	1.00302	7 30	1.00220	1.00239
10 30	1.00191	1.00267	9 30	1.00231	1.00209

13. *Influence of Copper on the Oscillations of Magnetic Needles.*—We have already mentioned in our third number Mr Arago's discovery of the influence of copper on magnetic needles which it enclosed. When a horizontal needle, suspended in a ring of wood by a thread or fibre, was moved 45° from its natural position, it performed 145 oscillations before the amplitude of the arc of oscillation was reduced to 10°. When the needle was suspended in a ring of copper, and was moved 45° from its natural position, it only performed 33 oscillations before the amplitude of the arc was reduced to 10°. In another ring of copper of less weight the needle performed 66 oscillations before the amplitude was reduced to 10°.

14. *Effect of Copper in motion on a Magnetic Needle.*—M. Arago has more recently discovered, that if a plate of copper revolves under a magnetised needle contained in a closed vessel, the needle will deviate from the magnetic meridian, the deviation increasing with the velocity of the copper. If the velocity of the copper is sufficiently great, the needle will turn continually round the wire on which it is suspended.—*Ann. de Chim.* See this Number, p. 135.

METEOROLOGY.

15. *Daniell's Improvement on the Barometer.*—Mr Daniell has found that air insinuates itself into the vacuum of the best made barometers, in

time, by creeping up between the mercury and the glass, and that it will insinuate itself between any fluid and any solid, when it has not attraction enough for the former to cause it to wet it. If any gas be confined in a glass jar for a length of time over mercury, it will make its escape, and its place be occupied by atmospheric air; whereas the same gas, if confined by water, will be preserved unmixed. Hence the best made barometers are often studded with air bubbles. The cure which Mr Daniell has provided for these evils is to weld a narrow ring of platinum to the open end of the tube, which is immersed in the cistern. Boiling mercury amalgamates itself with platinum, and adheres to it when cold, *wetting it, but not dissolving* it, so that, by this means, the passage of the air is cut off as effectually as if the whole tube were wetted by it.—Shumacher's *Astron. Nachrichten,* No. 73, p. 15.

16. *Hygrometric Properties of insoluble Compounds.*—The following results were obtained by Mr T. Griffiths. The bodies, after being accurately weighed, were exposed for a month to a moist atmosphere, and then weighed. The increase is given in the following table, which we have arranged in the order of their absorptive powers:

Oxide of zinc,	29.0	Sulphate of antimony, lime,	.9
Foolscap paper,	18.0	Carbonate of lime, chalk,	.8
Charcoal from Wilmot,	17.3	Oxide of bismuth,	.7
Cartridge paper,	17.1	Tartrate of lead,	.7
Sulphate of lime,	16.2	Chloride of silver,	.6
Charcoal tulip wood,	15.4	Carbonate of lead,	.6
—— ash,	15.3	Oxide of iron, soda,	.5
Brown paper,	15.3	Chloride of lead,	.5
Charcoal, Botany Bay wood,	15.2	Chromate of lead,	.5
—— lance wood,	13.7	Phosphate of lead,	.5
—— cedar,	13.4	Carbonate of zinc,	.5
—— American pine,	12.6	Clay ironstone,	.5
—— willow,	12.1	Sulphate of lead,	.4
—— birch,	12.0	Sulphuret of antimony, black,	.4
—— rose wood,	12.0	—— mercury, cinnabar,	.4
—— lime tree,	11.8	Fluor spar, blue,	.4
India paper,	11.6	Sulphate of baryta,	.3
Charcoal, king wood,	11.5	Zeolite,	.3
Oxide of chrome,	10.0	Oxide of lead, red,	.2
Charcoal, zebra wood,	6.6	—— mercury by nitric acid,	.2
Serpentine,	5.2	Bisulphuret of iron,	.2
Filtering paper,	5.0	Carbonate of baryta nat.	.2
Plumbago,	4.5	Aurum musivum,	.2
Oxide of iron, calc spar,	3.1	Granite,	.2
—— manganese, black,	2.5	Silica, powdered quartz,	.2
Cornish clay,	2.4	Oxide of copper, black,	.1
Smalt,	2.1	—— tin, putty,	.1
Submuriate of copper,	1.8	Chromate of mercury,	.1
Oxide of lead, litharge,	1.7	Sulphate of strontia,	.1
Mica slate,	1.1	Carbonate of strontia,	.1
Drawing slate,	1.0		

Journ. Roy. Inst. vol. xix. p. 93.

17. *Highest and Lowest Temperature on the Earth's Surface.*—M. Gay Lussac has stated,—1. That in no place on the earth's surface, nor at any season, will the thermometer, a few yards above the ground, and sheltered from reflections, reach the 114°.8 of Fahrenheit. 2. That, on the open sea, the temperature of the air will never attain the 87°.8 of Fahrenheit. 3. That, the greatest cold in the air has been —58° of Fahrenheit. 4. That, the temperature of the ocean never rises above 86° of Fahrenheit.

18. *Remarkable Auroral Arch on the 19th March.*—A very beautiful auroral arch was seen in Edinburgh on the 19th March, between 10 and 11 o'clock, P. M. Pollux and most of the large stars of the Great Bear were included in it. It extended both to the east and west horizon, and passed as far to the south of Orion's belt as the length of the belt itself. The arch, which passed over that zenith, was widest there, (about the breadth of Orion's belt,) and became narrower as it approached the horizon; but about 20° above the western horizon, the arch bent towards the north, and at the place of bending, the auroral light contracted, and was more intense. The light was for a long time perfectly steady; but when it began to break up, it exhibited the irregular motion of the aurora. The usual aurora appeared at the same time in the north, but formed no connection with the arch now described. The barometer stood at 30.4 inches, and the thermometer at 30° Fahrenheit.

19. *Bosson's Observations on Waterspouts.*—The particulars of this phenomenon seem to have been carefully observed by M. Bosson. One of the most remarkable effects which he noticed, was that in the direction taken by the waterspout, the trees put out new blossoms, a circumstance which he attributed to the privation of leaves, an elevation of temperature, and the humidity of the atmosphere. The following conclusions are deduced by M. Bosson:

1. The action of the waterspout showed itself in a valley.
2. Its direction continued always the same, in spite of the hills and vallies over which it passed.
3. The elevation of the ground rendered its effects more remarkable.
4. Whenever it met heights of a conical form it moved round them.
5. It crossed the river Le Vegre without following its course.
5. It developed heat to such a great degree, that some persons experienced a sensation analogous to that of burning.
7. It displayed all the ordinary phenomena of a terrestrial waterspout, by exhibiting a mass of vapours similar to a dense cloud of a conical form, making a dreadful noise, throwing out flashes of lightning, spreading an odour like that of thunder, and scattering all round it a great quantity of water.—*Journal de Pharmacie*, March 1825, p. 147.

II. CHEMISTRY.

20. *Cold produced by the Combination of Metals.*—According to M. Dobereiner, the fusible metal consists of one atom of lead, one of tin, and two of bismuth; and it becomes fluid when exposed to a heat of 210.° If the

fusible metal, formed of 118 grains of filings of tin, 207 grains of filings of lead, and 286 grains of pulverised bismuth, be incorporated in a dish of calendered paper, with 1616 grains of mercury, the *temperature will instantly sink* from 65° to 14.° M. Dobereiner thinks, that it might fall so low as the freezing point of mercury, if the experiments were made at a temperature a little under 32.°—See Schweigger's *Neue Journal*, xii. p. 182.

21. *Refrigerating Salt.*—If we mix 57 parts of muriate of potash, with 32 of muriate of ammonia, and 10 of nitrate of potash, a refrigerating salt will be produced. This salt, put into four parts of water, and quickly agitated, will make the thermometer descend from 20° to 5° below zero, in Reaumur's thermometer.—Vauquelin, *Journal de Pharmacie.*

22. *On the Pectic or Coagulating Acid.*—This new acid has been discovered by M. H. Braconnot, and receives its name from πεκτις, *coagulum*, in consequence of its resembling a jelly or gum. It is found in all vegetables. It is sensibly acid. It reddens turnsole paper. It is scarcely soluble in cold water, but more so in hot water. It is coagulated into a transparent and colourless jelly by alcohol, by all the metallic solutions, by lime-water, water of barytes, the acids, muriate and sulphate of soda, and nitre, &c. It forms, with potash, a very soluble salt, consisting of 85 parts of lead, and 15 of potash. This salt has the remarkable effect of communicating to large masses of sugar and water the property of gelatinising, which renders it of great use to the confectioner. M. Braconnot, in this way, prepared aromatised jellies, perfectly transparent and colourless, and very agreeable to the taste and the eye. He also made, with rose-water, coloured with a little cochineal, rose-jelly of exquisite taste.—*Ann. de Chim.* tom. xxviii. p. 173.

23. *Iodine in Mineral Waters.*—Iodine was first discovered in mineral waters by M. Angelini, who found it in the salt water of Voghera, and in the water of Sales in the Voguerais. M. Cantu, Professor of Chemistry at Turin, surprised at the wonderful effects of the sulphurous water of Castel Nova d'Asti, in the treatment of goitres, and other glandular maladies, examined it chemically, and found it more rich in iodine than any other.—*Mem. de Torino,* tom. xxix. p. 221.

III. NATURAL HISTORY.

MINERALOGY.

24. *Apatite in Salisbury Crags, Edinburgh.*—Apatite has been lately found in Salisbury Crags. It occurs in the greenstone near the southern extremity, in a mixture consisting chiefly of white calcareous spar, red albite, and a blackish-green soft substance, nearly allied to serpentine. Particularly in the latter, the plain asparagus-green crystals of apatite are very distinct, and possess a high degree of lustre. Their form is that of a regular six-sided prism, terminated by a plane perpendicular to the axis, and having frequently also the lateral edges replaced by another six-sided prism. The length of these prisms is rarely so much as two lines, but their thickness

is very inconsiderable. They allow, however, of being measured by the reflective goniometer, and as they are perfectly transparent, their refraction appears to be the same as that of apatite, nearly 1.64. Besides these, the rock contains also octahedral crystals of magnetic iron-ore, and the combination of the hexahedron and octahedron of hexahedral iron-pyrites.

25. *Withamite.*—This new and interesting mineral, which we described in our last number, is found in Glenco, on the property of Robert Downie, Esq. of Appin, M. P. Mr Sommerville, lapidary in Edinburgh, has recently discovered some specimens of it of an olive-green colour, and others in which it occurs in botryoidal groupes. Mr Sommerville has now obtained several fine specimens of the mineral, which, we believe, he means to dispose of.

26. *School of Mines in Cornwall.*—A very excellent plan of a school of mines in Cornwall has been drawn up and printed by Mr John Taylor. The object of that plan is to have the mines properly wrought by intelligent and well-instructed miners, and with this view it is proposed to establish at Redruth three professors to teach the arts and sciences connected with mining. It is proposed also to collect the necessary funds by a small assessment of a penny per ton on the metals raised from the different mines, and from other sources. We anxiously hope that this admirable plan will meet with the support which it so well merits.

BOTANY.

27. *Codium tomentosum, and Targionia hypophylla.*—Two interesting additions have been recently made to the Cryptogamic Flora of Scotland; one in the discovery of the curious *Codium tomentosum,* on the shores of the island of Iona, by M. J. Berkeley, Esq. of Christ College, Cambridge: the other in the finding a new station for the rare *Targionia hypophylla,* which had never been met with since the days of Lightfoot, who detected it near Tarbet in Cantyre. It is now found upon the turf-coping of walls in the island of Lismore, Argyleshire, by Captain Carmichael.

28. *Trichomanes elegans.*—We find by an article in "*Taylor's Philosophical Magazine,*" that M. Bory de St. Vincent, has declared the figure published by Mr Rudge, in his "*Icones et Descriptiones Plantarum Rariorum Guianæ,*" of the *Trichomanes elegans,* to be incorrect, and composed of two different species; or, according to M. Bory's ideas, of two distinct genera. This has given rise to considerable discussion among the botanists in London; and, in justification of the fidelity of the figure, our testimony is brought forward; we having given, in the fifty-second plate of *Exotic Flora,* a figure of the *Trichomanes elegans,* and having spoken of the figure of Mr Rudge as excellent. This term of approbation, however, was only meant to apply to such of the figure as represented that state of the plant which we had ourselves represented, that is, the barren fronds and those fertile spikes which have *separated* involucres. The other spikes with *united* involucres, we had never seen; but having, *then,** only a

* We say, *then,* because we have since had the opportunity, through the liberality of the same gentleman as sent us the first individual, the Rev. Lansdown Guilding,

single specimen to examine, we did suppose that those spikes which have the involucres united by a membrane, might belong to a younger state of the fructification. On the specimen, however, from which Mr Rudge's figure was made, (and which was gathered in Guiana by Mr Martin,) being submitted to a careful examination, it was found to be composed of two individuals; thus, as it were, tending greatly to strengthen the opinion of M. Bory.

It is, however, not a little remarkable, that Kaulfuss, in his work on the *Ferns,* which we shall notice in the next number of this Journal, and who appears, from his manner of describing it, to be well acquainted with this plant, not only quotes the figure of Rudge, without questioning the correctness of it, but absolutely describes the *two* kinds of fructification represented by Rudge; first, in his specific character, "*Indusiis spicatis disticke connatis, tandem liberis pedicellatis;*" and afterwards in the description, "*Indusia disticha, coarctata, primum membrana pellucida connexa, tandem distincta pedicellata spicam densam disticham subsecundam referentia.*" As a further evidence of his being well acquainted with the *Trichomanes elegans,* he corrects Willdenow, who, he says, only knew the plant from Rudge's figure, and who particularly described the fertile fronds otherwise than he would have done had he described from the plant itself.

(H.)

ZOOLOGY.

29. *Say's American Entomology.*—The first volume of a very handsome work under this title has made its appearance in the United States, from the Philadelphia press. It is perhaps the most splendid work in a large octavo form hitherto published in that country; and whether we consider the contents, the fineness of the paper, the style of engraving, or the highly respectable manner in which the plates are coloured, it does America infinite credit. The present volume contains 18 plates, in which 41 species are figured, of which 34 are first described by Mr Say.

30. *Annals of the Lyceum of Natural History of New York.*—The Lyceum of Natural History of New York has put forth its first half volume of Transactions, and it gives us much pleasure, in being able to bestow our cordial approbation on this specimen of its meritorious labours, especially, as it is mainly owing to the spirited exertions of a few of its members, who have devoted no small share of time, money, and talent to the cause of Natural History in New York. The present half volume is composed of thirty-five articles, in various departments, connected with the Natural History of North America, illustrated with thirteen well executed plates.

31. *American Fauna.*—Dr Harlan is engaged in preparing a *Fauna Americana,* the first part of which, containing the *Mammalia,* is nearly ready

of examining very many other specimens. All have the involucres *separated,* as represented in our plate, and as represented in the left hand spike of the entire plant in Mr Rudge's representation, and at Fig. 2. of the magnified portion.

for publication. We understand Dr De Kay of New York had also been collecting materials for a similar work, but has now transferred them to his friend, Dr Harlan.

IV. GENERAL SCIENCE.

32. *Remarkable Dissection of a Female Mummy.*—This dissection, performed by Dr Granville, was exhibited before the Royal Society. After depriving the body, by ebullition and maceration, of the bees-wax, myrrh, gum, resin, bitumen and *tannin*, with which it had been impregnated and preserved, the parts resembled recent preparations; and though the body must have lived 3000 years ago, Dr Granville was enabled to ascertain the age at which the lady died, and also that she had borne children, and had died of ovarian dropsy. Dr Granville has also given the dimensions of its various parts, and it is truly singular, that these happen to be precisely those of the Venus de Medicis.

33. *Discoveries in Nova Zembla.*—The Russian officer, Captain Lilk, has returned from his third Expedition to Nova Zembla. He has discovered the Bay of Matorsky in 69° 44′ of N. lat. by 8° 33′ of W. long. He advanced as far as 76° 48′ of N. lat., but was stopped by the ice, and a storm, which damaged his vessel, prevented him from examining the island completely.—*Journal des Voyages*, tom. xxv. p. 257.

34. *Hazel Nuts found in a singular state at a great depth.*—We have been kindly presented, by Sir John Hay, Bart. of Smithsfield and Hayston, with a packet of hazel nuts, found upon one of his farms at Bonnington, about one mile south from Peebles. The nuts were found in a bog, about eight feet below the surface. The top soil was three feet of meadow clay, beneath which was a layer of greyish coloured gravel about four and half feet thick. The bottom of the bog consisted of a mixture of grey sand and brown moss, with some branches of stumps of trees, quite rotten. The nuts were found nearest the bottom of this substance. The bog is part of a meadow about 1500 yards long, by about from 300 to 600 feet broad, having a declivity of about one foot in 400.

Upon opening these nuts, we were surprised to find, that *the kernel in all of them had entirely disappeared, though the membrane which enclosed it, and the nut itself, were as entire as if the nut had been fresh and ripe.* By opening the nut carefully, the membrane could be taken out in the form of a perfect bag, without the least opening. The substance of the kernel must therefore have escaped through the membrane and the shell in a gaseous form, or must have passed through them, when decomposed or dissolved by water, In some of the nuts, that had not arrived at maturity, the bag was very small, and was surrounded, as in the fresh nut, with the soft fungous substance, which had resisted decay.

35. *The Menai Bridge near Bangor, Carnarvonshire.*—On Tuesday, the 26th of April 1825, the *first* chain of this stupendous work was thrown over the Straits of Menai, in presence of an immense concourse of persons

of all ranks. At half-past two o'clock, about half flood tide, the raft, prepared for the occasion, stationed on the Carnarvonshire side, which supported the chain intended to be drawn over, began to move gradually from its moorings, towed by four boats, with the assistance of the tide, to the centre of the Strait, between the two grand piers; when the raft was properly adjusted, and brought to its ultimate situation, it was made fast to several buoys, anchored in the channel for that specific purpose. The whole of this arduous process was accomplished in twenty-five minutes. The end of the chain, pending from the apex of the suspending pier on the Carnarvonshire side, down nearly to high water mark, was then made fast by bolts to that part of the chain lying on the raft, which operation was completed in ten minutes. The next process was fastening the other extremity of the chain (on the raft) to two immense powerful blocks, for the purpose of hoisting the *entire* line of chain to its intended station, the apex of the suspending pier, on the Anglesea side. When the blocks were made secure to the chain (comprising twenty-five ton weight of iron) two capstans, and also two preventive capstans, commenced working, each propelled by twenty-four men. To preserve an equanimity in the rotatory evolutions of the two principal capstans, a fifer played several enlivening tunes, to keep the men regular in their steps, for which purpose they had been previously trained. The chain rose majestically, and the gratifying sight was enthusiastically enjoyed by each individual present. At fifty minutes after four o'clock, the *final* bolt was fixed, which completed the whole line of chain. From the casting off of the raft, to the uniting of the chain, took up only two hours and twenty minutes.

This splendid specimen of British architecture will be a lasting monument to the discernment of the present government, for having called into requisition the transcendent talents of Mr Telford, who was present on the occasion.

Upon the completion of the chain, three of the workmen had the temerity to pass along the upper surface of the chain, which forms an inverted curvature of 580 feet. The versed sine of the arch is 43 feet.

The following is a summary account of the dimensions of the bridge:—The extreme length of the chain, from the fastenings in the rocks, is about 1600 feet. The height of the road-way from high-water line, is 100 feet. Each of the seven small piers, from high-water line to the spring of the arches, is 65 feet. The span of each arch is 52 feet. Each of the two suspending piers is 52 feet above the road. The road on the bridge consists of two carriage-ways, of 12 feet each, with a footpath, of 4 feet, in the centre. The carriage-roads pass through two arches, in the suspending piers, of the width of 9 feet, by 15 feet in height to the spring of the arches. To counteract the contraction and expansion of the iron, from the effect of the change of the temperature in Winter and Summer, a set of rollers are placed under cast-iron saddles, on the top of the suspending piers, where the chains rest. The vertical rods, an inch square, suspended from the chains, support the slippers for the flooring of the road-way, the rods being placed 5 feet from each other. The chains, 16 in number, contain 5 bars each; length of the bar 9 feet 9 inches, width 3 inches by

1 inch square, with 6 connecting lengths at each joint 1 foot 6 inches, by 10 inches, and 1 inch square, secured by two bolts at each joint, each bolt weighing about fifty-six pounds. The total number of bars, in the cross section of the chains, is eighty.

A second chain was drawn over on Thursday morning, the 28th ult.; and there are fourteen other chains in readiness to be drawn over, when the tide will serve, which will complete the line of suspension.

36. *Number of Steam-Engines in Glasgow and its neighbourhood in April* 1825.

	No. of Engines.	Horse Power.
Steam-Engines used in Manufactures,*	176	3000
Collieries,	58	1411
Stone quarries,	7	39
Steam-boats,	68	1926
Clyde Iron-Works,	1	60
Total	310	6436

Average power of engines $20\frac{664}{1000}$ horses.

Cleland's *Hist. Account of the Steam-Engine.*

37. *Number of Steam Boats on the Clyde in* 1825.—On the 11th of April 1825, there were on the Clyde 53 steam-boats, having 68 engines, and a power of 1926 horses. Four of these steam-boats are each driven by two engines of 50 horse power each, viz. the Majestic, the City of Glasgow, the Superb, and the Ailsa Craig.—*Id.*

38. *Poisonous Effect of White Bread upon Dogs.*—Dr Magendie is said to have found, that when he fed dogs with white bread and water they all died within 50 days. When the bran was left in the bread no bad effects ensued.

39. *The Goitre cured by Subcarbonate of Soda.*—M. Peschier of Geneva has performed many surprising cures in cases of goitre, by administering a solution of subcarbonate of soda, more or less disguised by other substances. In the case of a girl fourteen years old, he gave 2 gros, or 118 grains every day, From two grains to half an ounce of the alkali is dissolved in eight ounces of water, and a table-spoonful of the solution taken twice a-day, in half a glass of wine, or sugar and water.—*Bibl. Univ.* vol. xxiii. p. 146.

40. *Artificial Production of Pearls.*—The invention of forcing the production of pearls by fresh water bivalves, is said to belong to the Chinese. For that purpose rounded pieces of mother-of-pearl are introduced into the shells. Mr Gray introduced thirty or forty pieces into the shells of the *Anodonta cygneus*, and *Unio pictorum*. Only two were pushed out again, the rest being placed by the animal in a convenient situation.—*Ann. of Phil.* ix. p. 27.

* In 1824, there were upwards of 200 steam-engines in Manchester.

ART. XXXV.—LIST OF PATENTS FOR NEW INVENTIONS SEALED IN ENGLAND FROM OCTOBER 7, 1824, TO JANUARY 1, 1825.

Oct. 14. For Improved *Water-Proof Cloth*, and Materials for Bonnets. To W. P. WEISE, Southwark.

Oct. 14. For Improved *Water-Closets*. To H. MARIOTT, London.

Oct. 19. For Improved *Power Looms*. To J. TETLOW, Manchester.

Oct. 19. For Improved *Steam-Boilers*. To H. MAUDSLAY and J. FIELD, Lambeth.

Oct. 21. For an *Artificial Stove*. To J. APSDEN, Leeds.

Oct. 21. For *Fire Extinguishers*. To G. DODD, Westminster.

Oct. 21. For a *Placard Machine*. To G. S. HARRIS, Knightsbridge.

Nov. 1. For *Lace Machinery*. To J. LINGFORD, Nottingham.

Nov. 4. For *Safety Guns*. To Rev. J. SOMERVILLE, Currie.

Nov. 4 For a Contrivance *for Insuring the Egress of Smoke*. To J. CROSSLEY, Middlesex.

Nov. 4. For Improved *Masting of Vessels*. To T. R. GUPPEY. Bristol.

Nov. 4. For *Boot Cords, &c.* To J. HEAD, Banbury.

Nov. 4. For Improved *Augers*. To WILLIAM CHURCH, Birmingham.

Nov. 4. For Improvements in *Propelling Vessels*. To H. BUSK, London.

Nov. 6 For an Improved *Air Furnace*. To J. WHITE and T. SOWERBY Bishop Wearmouth.

Nov. 6. For Improved *Steam-Engine Apparatus*. To J. MOORE, Bristol.

Nov. 6. For an Improved *Percussion Gus-Cock*. To T. CARTMELL, Doncaster.

Nov. 11. For an Improved *Lime and Coak Kiln*. To C. HEATHORN, Maidstone.

Nov. 11. For Improved *Brick Machinery*. To W. LEATHY, Southwark.

Nov. 11. For a New *Furnace*. To P. BRUNET, London.

Nov. 20. For Improvements in *Dressing Cloth*. To J. C. DANIELL, Stoke.

Nov. 20. For a *New Cock or Tap*. To J. TAYLOR, Chipping Ongar.

Nov. 20. For Improved *Clamps for Burning Bricks*. To W. RHODES, Middlesex.

Nov. 23. For Improvements in the *Paper Manufacture*. To L. LAMBERT, London.

Nov. 25. For *Diaphane Stuffs*. To S. WILSON, Streatham.

Nov. 25. For Improved *Ship's Tackle*. To W. S. BURNETT, London.

Nov. 29. For *Improved Healds*. To J. OSBALDISTON, Lancashire.

Nov. 29. For a *Substitute for Leather*. To T. HANCOCK, Middlesex.

Dec. 4. For Improvements in the *Salt Manufacture*. To W. FURNIVAL, Anderton.

Dec. 4. For Improvements in the *Salt Manufacture*. To W. W. YOUNG, Glamorganshire.

Dec. 4. For a *Thermophore or Portable Bath, and Linen Warmer*. To J. H. SUWERKROP, London.

Dec. 4. For *Improved Saddles*. To G. WYCHERLEY, Whitchurch.

Dec. 8. For a Improved *Air-Chamber*. To R. DICKENSON, Southwark.

Dec. 9. For Improvements in the *Cast-Steel Manufacture.* To J. Thompson, Pimlico.

Dec. 9. For *Elastic Stoppers to Regulate Chains and other Cables.* To R. Bowman, Aberdeen.

Dec. 9. For Improvements in *Water Wheels.* To W. Moult, Lambeth.

Dec. 14. For an Improved *Gas-Meter.* To Sir W. Congreve, London.

Dec. 18. For Improved *Guns, &c.* To S. Davis, London.

Dec. 18. For Improved *Wheel Carriages.* To D. Gordon, London.

Dec. 18. For Improvements in the *Plated Manufacture.* To S. Roberts, Middlesex.

Dec. 18. For Improved *Looms.* To P. Gosset, Middlesex.

Dec. 18. For Improved *Cloth Shearing Machines.* To J. Gardner and J. Herbert, Gloucestershire.

Dec. 18. For a *New Wheelway.* To W. T. Snowden, London.

Dec. 18. For Improvements on *Pumps.* To J. Weiss, London.

Dec. 23. For Improvements in the *Button Manufacture.* To J. Deykin, and W. H. Deykin, Birmingham,

Dec. 24. For *Improvements* on *Carriages.* To D. Stafford, Liverpool.

Art. XXXVI.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE MARCH 7, 1825.

13. March 11. For a New *Composition of Malt and Hops.* To George Augustus Lamb, Sussex.

14. March 11. For an Improved Method of *Generating Steam.* To John Maccurdy, Middlesex.

15. March 12. For a New Method or Methods of *Making or Manufacturing Hats, Bonnets, and Caps.* To Patrick Mackay and Thomas Cunningham, Edinburgh.

16. March 25. For Improvements in the *Art of Dyeing and Calico-Printing, &c.* To James Hanmer, Middlesex.

17. March 25. For an Apparatus for giving *Motion to Vessels* employed in Inland Navigation. To Samuel Brown, Middlesex.

18. April 5. For Improvements applicable to the *Mule Billy Jenny Stretching-Frame, &c.* To Richard Roberts of Manchester, Lancaster.

19. April 5. For Improvements on *Square Piano-Fortes.* To Francis Melville of Argyle Street, Glasgow.

20. April 13. For Improvements in the Construction of *Forges, &c.* To William Halley, Surrey.

21. April 13. For a New *Step* or Steps, to Ascend or Descend from *Coaches* and other Carriages. To Ross Corbett, Glasgow.

22. April 27. For a New Method of Constructing a *Roasting-Jack.* To John Thin, Edinburgh.

23. May 3. For Improvements in the Construction of Apparatus for *Distilling* Spirituous Liquors. To William Grimble, Middlesex.

24. May 13. For Improvements in Machinery for *Hackling, &c.* To Edward Garseed of Leeds, York.

25. May 17. For a New Process for Making *Steel.* To Charles Macintosh, Lanark.

26. May 25. For Certain Improvements in Manufacturing *Tubes for Gas,* and other Purposes. To Cornelius Whitehouse, Stafford.

Art. XXXVII.—CELESTIAL PHENOMENA,

From July 1, *to September* 1, 1825, *calculated for the Meridian of Edinburgh.* By Mr George Innes, Aberdeen. Communicated by the Author.

These calculations are made for Astronomical time, the day beginning at noon. The Conjunctions of the Moon and Stars are given in Right Ascension.

JULY.

D.	H.	M.	S.	
1	13	36	5	☌ ☿ ♂
1	16	31	55	☌ ☽ β ♑
7	19	19	35	☾ Last Quarter.
8	11	50	4	☌ ☽ η ♓
9	18	55	—	Sup. ☌ ☉ ☿
10	2	48	14	☍ ☉ ♅
10	12	37	30	☌ ☽ δ ♈
10	17	53	55	☌ ♀ 1 δ ♉
11	2	31	24	☌ ♀ 2 δ ♉
11	12	42	0	☌ ☽ A ♉
11	20	51	52	☌ ☽ ♀
11	21	44	51	☌ ☽ 2 χ ♉
12	16	52	20	☌ ☿ ε ♉
12	17	7	28	☌ ☽ ♄
13	19	46	14	☌ ☽ η II.
13	23	5	15	☌ ☽ μ II.
14	9	18	45	☌ ☽ ♂
14	12	36	—	☌ ♀ a ♉
14	16	8	53	☌ ☽ ζ II.
15	10	17	40	● New Moon.
15	23	7	25	☌ ☽ ☿
16	16	34	11	☌ ☽ 2 a ♋
17	4	1	31	☌ ☽ ♃
17	11	14	20	☌ ☽ o ♌
17	19	41	12	☌ ☽ π ♌
21	16	8	20	☌ ☽ i ♍
22	3	27	44	☽ First Quarter.
22	17	31	24	☉ enters ♌
24	8	32	20	☌ ☽ δ ♏
25	19	40	50	☌ ☽ B Oph.
25	20	45	30	☌ ♂ δ II.
26	9	27	—	☌ ♀ ♄
27	13	20	8	☌ ☽ o ♐
27	15	36	38	☌ ☽ π ♐
27	19	9	20	☌ ☽ d ♐
27	23	36	56	☌ ☽ ♅
29	9	49	53	○ Full Moon.
29				♀ Greatest Elong.

AUGUST.

D.	H.	M.	S.	
6	12	6	25	☾ Last Quarter.
6	21	3	50	☌ ☽ δ ♈
7	12	24	47	☌ ☽ A ♉
8	6	37	22	☌ ☽ 2 χ ♉
9	7	43	28	☌ ☽ ♄
10	5	21	0	☌ ☽ η II.
10	7	42	30	☌ ☽ ♀
10	8	42	10	☌ ☽ μ II.
11	1	52	34	☌ ☽ ζ II.
11	23	18	—	☌ ♀ ν II.
12	3	22	30	☌ ☽ ♂
13	2	2	10	☌ ☽ 2 a ♋
13	18	49	25	● New Moon.
13	23	25	16	☌ ☽ ♃
15	2	54	—	☌ ☿ τ ♌
15	16	22	—	☌ ☽ ☿
17	5	36	11	☌ ☉ ♃
17	22	23	30	☌ ☽ i ♍
18	2	19	12	☌ ☿ v ♌
19				☿ Greatest Elong.
19	17	38	50	☌ ♀ ζ II.
20	9	23	12	☽ First Quarter.
20	13	54	17	☌ ☽ δ ♏
22	1	8	10	☌ ☽ B Oph.
22	23	53	56	☉ enters ♍
23	19	16	0	☌ ☽ o ♐
23	21	30	30	☌ ☽ π ♐
24	1	6	10	☌ ☽ d ♐
24	2	1	44	☌ ☽ ♅
25	6	4	9	☌ ☽ β ♑
25	20	24	33	☌ ♂ δ ♋
27	23	50	24	○ Full Moon.
31	0	16	—	☌ ♃ a ♌

SEPTEMBER.

D.	H.	M.	S.	
3	4	20	22	☌ ☽ δ ♈
4	3	54	10	☾ Last Quarter.
4	5	5	48	☌ ☽ A ♉
4	14	30	18	☌ ☽ 2 χ ♉
5	20	8	36	☌ ☽ ♄
6	14	26	49	☌ ☽ η II.
6	17	40	42	☌ ☽ μ II.
7	11	30	—	☌ ☽ ζ II.
9	2	48	13	☌ ☽ ♀
9	12	29	55	☌ ☽ 2 a ♋
9	20	33	18	☌ ☽ ♂
10	2	23	37	☌ ♀ δ ♋
10	6	54	18	☌ ☽ o ♌
10	15	9	10	☌ ☽ π ♌
10	19	17	47	☌ ☽ ♃
12	2	43	4	● New Moon.
12	15	15	—	☌ ☽ ☿
14	7	0	0	☌ ☽ i ♍
16	0	30	—	Inf. ☌ ☉ ☿
16	20	30	48	☌ ☽ δ ♏
18	18	9	55	☽ First Quarter.
19	2	51	14	☌ ☽ 1 μ ♐
20	3	9	0	☌ ☽ π ♐
20	6	44	30	☌ ☽ d ♐
20	7	17	30	☌ ☽ ♅
21	12	20	43	☌ ☽ δ ♑
22	20	21	22	☉ enters ♎
26	15	48	30	Im. III. Sat. ♃
26	15	51	39	○ Full Moon.
27	23	46	12	☌ ♀ ♂
28	11	13	26	☌ ♂ α ♌
28	6	12	3	☌ ♀ α ♌
30	10	27	52	☌ ☽ δ ♈

Times of the Planets passing the Meridian.

JULY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1.	23	23	21	6	23	20	2	31	22	15	12	40
5.	23	44	21	2	23	16	2	19	22	2	12	24
10.	0	7	20	57	23	11	2	3	21	45	12	3
15.	0	34	20	54	23	6	1	37	21	27	11	43
20.	0	53	20	53	23	1	1	29	21	10	11	22
25.	1	12	20	52	22	56	1	16	20	53	11	1

AUGUST.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1.	1	29	20	52	22	48	0	55	20	29	10	33
5.	1	35	20	54	22	43	0	43	20	14	10	18
10.	1	41	20	56	22	38	0	26	19	55	9	57
15	1	44	20	92	22	31	0	11	19	38	9	36
20.	1	42	21	2	22	24	23	56	19	21	9	15
25.	1	36	21	5	22	19	23	41	19	3	8	55

SEPTEMBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1.	1	19	21	11	22	10	23	17	18	37	8	25
5.	1	11	21	14	22	4	23	4	18	22	8	12
10.	0	33	21	17	21	57	22	48	18	4	7	52
15.	23	53	21	22	21	50	22	33	17	45	7	32
20.	23	12	21	26	21	42	22	17	17	27	7	12
25.	22	55	21	29	21	35	22	2	17	7	6	52

ART. XXXVIII.—REGISTER OF THE BAROMETER, THERMOMETER, AND RAIN-GAGE, *kept at Canaan Cottage.* By ALEX. ADIE, Esq. F. R. S. Edin.

The Observations contained in the following Register were made at Canaan Cottage, the residence of Mr Adie, by means of very nice instruments, constructed by himself. Canaan Cottage is situated about 1½ mile to the south of Edinburgh Castle, about 3 miles from the sea at Leith, and about 1¼ of a mile N. of the west end of Blackford Hill. The ridge of Braid Hills is about 1 mile to the south, and the Pentland Hills about 4 miles to the west of south. The height of the thermometer is about 260 feet above the level of the sea. The morning and evening observations were made about 10 A.M. and 10 P.M.

MARCH 1825.

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.
T.	1	40	39	39.5	32	47	39.5	29.20	28.96	
W.	2	36	33	34.5	34	41	39	28.93	28.93	.26
T.	3	38	32	35	28	44	36	29.06	29.31	
F.	4	33	35	34	25	42	33.5	29.60	29.90	
S.	5	38	35	36.5	30	47	38.5	30.01	29.95	
S.	6	37	38	37.5	26	45	35.5	29.75	29.30	.05
M.	7	43	34	38.5	34	47	40.5	29.41	29.67	.05
T.	8	43	49	46	29	48	38.5	29.67	29.62	
W.	9	51	52	51.5	46	54	50	29.81	29.76	
T.	10	48	41	44.5	47	52	49.5	29.91	29.95	
F.	11	46	42	44	42	50	46	29.81	29.81	
S.	12	46	42	44	38	51	44.5	29.98	29.95	.07
S.	13	45	38	41.5	40	49	44.5	29.95	29.93	
M.	14	38	34	36	32	42	37	29.95	29.93	
T.	15	36	32	34	31	43	37	30.06	30.13	
W.	16	36	35	35.5	30	41	35.5	30.20	30.12	
T.	17	37	33	35	30	44	37	30.17	30.06	
F.	18	35	42	38.5	31	43	37	30.01	30.08	
S.	19	45	36	40.5	39	51	45	30.20	30.30	
S.	20	40	40	40	29	51	40	30.37	30.36	
M.	21	45	39	42	31	51	41	30.41	30.31	
T.	22	44	40	42	35	49	42	30.27	30.14	
W.	23	41	31	36	37	46	41.5	30.15	30.01	
T.	24	41	39	40	26	46	36	29.83	29.56	
F.	25	43	38	40.5	37	50	43.5	29.60	29.80	
S.	26	42	41	41.5	29	46	37.5	29.85	29.85	
S.	27	48	45	46.5	40	60	50	29.82	29.83	
M.	28	52	44	48	35	58	46.5	29.85	29.80	
T.	29	52	43	47.5	40	55	47.5	29.78	29.89	
W.	30	45	37	41	41	53	47	30.06	30.16	
T.	31	43	35	39	31	50	40.5	30.26	30.30	
	Sum,	1307	1191	1250.5	1055	1499	1277	925.93	925.71	.43
	Mean,	42.16	38.52	40.34	34.03	48.35	41.19	29.868	29.862	

APRIL 1825.

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	50	37	43.5	27	54	40.5	30.30	30.31	
S.	2	51	45	48	28	59	43.5	30.26	30.13	
S.	3	49	44	46.5	41	55	48	30.08	30.00	
M.	4	55	42	48.5	40	60	50	29.98	30.08	
T.	5	57	40	48.5	30	61	45.5	30.06	30.13	
W.	6	57	45	51	31	63	47	30.18	30.18	
T.	7	60	46	53	34	67	50 5	30.21	30.21	
F.	8	57	46	51.5	34	64	49	30.16	30.08	
S.	9	54	41	47.5	34	56	45	29.98	30.07	
S.	10	51	49	50	34	56	45	30.02	29.73	
M.	11	53	43	48	41	57	49	29.62	29.57	
T	12	43	33	38	39	46	42.5	29.61	29.72	.01
W.	13	42	39	40.5	31	48	39.5	29.78	29.82	.07
T.	14	56	52	54	33	58	45.5	29.56	29.59	
F.	15	53	51	52	50	55	52.5	29.66	29.51	
S.	16	53	37	45	45	59	52	29.66	29.98	
S	17	44	38	41	33	53	43	30.08	30.13	
M.	18	43	33	38	27	49	38	30.06	30.04	
T.	19	47	44	45.5	25	55	40	30.01	29.88	.19
W.	20	51	50	50.5	42	59	50.5	29.70	29.63	
T.	21	56	49	52.5	46	62	54	29.48	29.26	
F.	22	56	40	48	40	62	51	29.32	29.18	.20
S.	23	44	40	42	34	49	41.5	29.48	29.48	
S.	24	43	40	41.5	32	47	39.5	29.46	29.53	
M.	25	44	41	42.5	34	49	41.5	29.55	29.52	
T.	26	47	44	45.5	39	60	49.5	29.46	29.29	.06
W	27	50	42	46	41	61	51	29.14	29.08	.37
T.	28	49	48	48.5	41	56	48.5	29.12	29.24	
F.	29	45	43	44	44	58	51	29.33	29.47	.40
S.	30	55	43	49	42	65	53.5	29.46	29.58	.08
		1515	1285	1400	1092	1703	1397.5	892.77	892.77	1.41
		50.5	42.83	46.67	35.4	56.77	46.58	29.759	29.759	

MAY 1825.

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.
S.	1	44	44	44	42	48	45	29.56	29.45	
M.	2	46	45	45.5	41	58	49.5	29.35	29.33	.16
T.	3	57	47	52	42	62	52	29.33	29.38	.11
W.	4	56	49	52.5	41	63	52	29.53	29.68	
T.	5	51	47	49	45	65	55	29.66	29.59	.18
F.	6	63	53	58	46	71	58.5	29.57	29 51	.05
S.	7	56	50	53	47	69	58	29.47	29.50	
S.	8	63	52	57.5	46	70	58	29.52	29.71	.23
M.	9	59	45	52	48	62	55	29.87	29.95	
T.	10	52	47	49.5	38	62	50	29.95	29.90	
W.	11	47	45	46	44	52	48	29.85	29.79	
T.	12	50	45	47.5	44	54	49	29.75	29.89	
F.	13	48	41	44.5	42	54	48	30.03	30.15	
S.	14	48	45	46.5	32	60	46	29.15	30.08	
S.	15	51	45	48	43	62	52.5	30.03	29.95	
M	16	50	45	47.5	44	60	52	29.96	29 96	
T.	17	54	42	48	37	67	52	30.02	30.09	
W.	18	55	51	53	35	72	53.5	30 02	30.05	
T.	19	53	39	46	35	60	47.5	30.15	30.10	
F.	20	50	47	48.5	35	65	50	30.07	29.97	
S.	21	57	51	54	39	69	54	29.86	29.78	
S.	22	49	46	47.5	45	59	52	29.75	29.66	
M.	23	47	44	45.5	45	50	47.5	29.57	29.52	.35
T.	24	45	42	43.5	45	47	46	29.46	29.35	1.58
W.	25	42	45	43.5	42	48	45	29.41	29.55	.07
T.	26	50	43	46.5	44	58	51	29.68	29.77	
F.	27	49	38	43.5	41	58	49.5	29.76	29.72	.33
S.	28	46	42	44	32	54	43	29.68	29.63	
S.	29	49	42	45.5	39	58	48.5	29.68	29.78	.19
M.	30	51	42	46.5	39	67	53	29.92	30.07	
T.	31	55	49	52	31	69	51.5	30.09	29.97	
		1593	1408	1500.5	1272	1873	1572.5	921.70	922.83	3.25
		51.39	45.42	48.40	41.03	60.42	50.73	29.732	29.769	

THE

EDINBURGH

JOURNAL OF SCIENCE.

ART. I.—*On the Limits of the Retina in the Eye of the Sepia Loligo, one of the Cephalopodous Mollusca.* By Doctor KNOX, F.R.S.E. Lecturer on Anatomy and Physiology, and Conservator of the Museum of the Royal College of Surgeons. (Read to the Royal Society of Edinburgh.)

IT is well known to those acquainted with the Anatomy of the Mollusca, and with the inestimable writings of Cuvier, that a dark coloured pigment assuming the form of a membrane, is interposed between the vitreous humour and retina; and that this, together with other peculiarities in the eyes of the larger species of the cephalopodous mollusca, viz. their great size, the absence of a cornea and aqueous humour, the peculiar structure of the crystalline humour, the vast number of nerves contributing to form the retina, &c. has excited strongly the attention of all comparative anatomists since the publication of the celebrated *Biblia Naturæ* by Swammerdam. But, of all these peculiarities, there is none so remarkable as the interposition of this thick dark pigment between the vitreous humour and the retina, presenting as it were a physical obstacle to the passage of the rays of light, on their way to reach the sensitive membrane. This supposed exception to the general laws, agreeable to which the eyeball of all known vertebral animals has been constructed, appeared to me on a first examination quite extraordinary, and induced me to revise the subject with the greatest care.

I am far from thinking that I have removed the difficulties which the anatomy of the eye presents in the cuttle-fish; but I entertain hopes that this brief memoir may induce those to resume the scalpel, who are better qualified for the investigation.

Some imagine that the retina in the cuttle-fish terminates anteriorly in a number of delicate striae, which may with propriety be compared to the ciliary processes of vertebral animals; which striae are firmly fixed all round the crystalline lens, passing in betwixt the segments into which the lens of these animals is readily divisible. Now, were this the case, little difficulty could occur in explaining the mode by which the rays of light reach the retina in the eye of the cuttle-fish, for the anterior surface of these so named ciliary processes, being covered by parts of no great depth, the rays of light might impinge directly on this expansion of the retina. But this is by no means accordant with the views I have adopted of the anatomy of the part. I shall endeavour to describe the distribution of the membranes of the eye of the loligo, such as they have appeared to me after the most careful dissection.

The interior of the eye-ball is filled by the lens anteriorly, and by the vitreous humour, and its capsule posteriorly. The hyaloid capsule, which is very delicate, does not form septa as in the eyes of vertebral animals, for, on being punctured, the whole of the vitreous humour suddenly escapes; the humour is colourless, and perfectly transparent. When its retaining capsule is detached from the posterior surface of the lens, to which it adheres very slightly, it retains the coloured impressions of the ciliary processes. Between the capsule of the vitreous humour, and the retina, there is a thick layer of a pigmentum of a very dark purplish colour, and sometimes even blackish, which, covering the whole of the inner aspect of the retina, renders it difficult to imagine how the rays of light reach and affect the sensitive membrane, in the way in which they usually do, viz. by traversing the humours. The retina is formed by the expansion of the optic nerves, but the mode is altogether peculiar. It is well known, that shortly after the optic nerve has escaped from the cartilaginous cranium of the cuttle-fish, it expands into a ganglion or medullary mass of great magnitude, much exceeding the brain in size. This ganglion divides as it were into two before reaching the posterior part of the sclerotic, and from each of these two masses of nervous matter arises a set of nerves, which, penetrating the sclerotic, pass into the eye-ball to form, or at least to be connected with, the retina. At the point where they penetrate the eye-ball, they cross each other very distinctly. The reason of this is apparent on laying open the eye-ball, for we then find that the retina is a double membrane, the interior being of a brown colour, (probably from a very thin membrane expanded over the inner surface,) and the exterior of a white, opaque, medullary structure. The retina thus formed covers a great portion of the inner surface of the sclerotic. Anteriorly, *i. e.* a few lines behind the fixed or equatorial margin of the lens, it seems to terminate in a very fine radiated circle, composed of innumerable straight and parallel fibres, which have been compared not inaptly to the ciliary processes of vertebral animals, and are inserted into the fissure, dividing the lens into two hemispheres. The view, however, I have adopted of these fibres, is somewhat different; they have appeared to me constantly to arise from the sclerotic, but to be intimately connected with one of the layers or membranes of which the retina is composed. At a short distance, behind the margin of the lens alluded to, I have found, in the larger specimen examined, viz. the Sepia loligo, that the white, opaque, medullary portion of the retina seems to cease, and, at this point, the whole membrane is firmly attached all round the eye-ball to the sclerotic. The brownish coloured membrane is continued forward to unite very firmly with the ciliary fibres; to form, as it were, a part of them, and to accompany them as far as the crystalline humour.

It was now an object of considerable interest to ascertain the precise nature of the terminating edge of the white, opaque, and external layer of the retina. The specimen I examined did not permit of the investigation to the extent I could have wished, but it seemed to me, that, again assuming the form of excessively delicate fibres, and laying aside that of a membrane, it penetrated the ciliary processes just described, and thus disappeared. This, however, I consider as merely a conjecture, for, notwithstanding the use of the strongest glasses, I could not satisfy myself as to its correctness. In order to have a perfect view of the exact formation of the ciliary body or fibres, the inner membrane, which it receives from the retina, and which accompanies it quite to the crystalline humour, must be removed as much as possible.* We then see a range of parallel and straight fibres arising from the sclerotic, and proceeding forward towards the crystalline; they are remarkably strong, and do not require any glass to distinguish them. When they have proceeded for several lines, they unite with another set of fibres which arise also from the sclerotic, but nearer the pupil. These fibres join the ones first described obliquely. Both sets unite to form a firm homogeneous mass, in which no fibres can be discerned, and from this arises the central layer of fibres which complete the circle. and proceed to the crystalline itself, to which they are firmly united. From the inner margin of these fibres an excessively delicate membrane seems to be transmitted quite across, and to be thus interposed between the anterior and posterior hemispheres of the lens; but the fibres run into, and are, as it were, continuous with the outer layers of the lens, whose structure seems to differ somewhat from the more internal or central portion. From the point where the two sets of fibres meet but externally, arises another circular iris-shaped body, which, in like manner with the posterior one, passes in between the hemispheres of the lens, contributing to fix this humour the more firmly; and it even seemed to me, in one of the specimens examined, that this anterior layer of fibres was very intimately united by fibrous matter sent to it from the surface of the anterior hemisphere of the lens. However this may be, it is evident that these two layers of fibres are distinct, and that the anterior, as we should expect, is most intimately connected with the anterior hemisphere of the lens. When we remove this portion of the lens, we find

* This I have found to be quite impracticable in the smaller species of Sepiæ.

the anterior iris shaped body just described, to be composed chiefly of fibres, and to terminate in a semi-cartilaginous plate of no great breadth; but I have not yet been able to determine the nature of these fibres. Lastly, It is invested by a reduplication of the conjunctiva, which is reflected upon it from the inner surface of the sclerotic, and from it over the anterior surface of the crystalline humour.

Finally, it is to be carefully noted, that the two sets of fibres which fix the lens in its position, and pass in a short way betwixt its hemispheres, do not pervade its whole thickness, but suddenly terminate, uniting themselves intimately to the external layers of the crystalline humour, and leaving its central portion clear for the passage of the rays of light. But there is a peculiarity in the structure of this part of the crystalline humour which does not seem to have been remarked. The two distinct sets of fibres which I have described as fixing the lens in its situation, are chiefly connected each with the more external layers of its corresponding hemisphere; there is consequently left between them a small space filled with a darkish pigment, which space communicates with a wedge-like cavity, extending all round from the outer to the central portion or nucleus of the lens. Even here we distinctly perceive a darkish line passing over the nucleus of the lens; but I could not positively make out whether this wedge-like cavity was filled simply with a fluid, or whether, as is most probable, a very delicate membrane also traversed the whole thickness of the lens. External to the membranes described, is the sclerotic, seemingly of a cartilaginous nature, having a circular opening anteriorly, into which the lens projects, there existing neither cornea nor aqueous humour. It is perforated posteriorly by numerous foramina for the transmission of the nerves proceeding to form the retina.

The external aspect of the sclerotic is invested by a membrane, which I consider as analogous to the conjunctiva, excepting that, in the cuttle-fish, its internal layers are evidently muscular. It projects considerably beyond the anterior termination of the sclerotic, to form a true and highly moveable iris; a thin layer is reflected upon the inner surface of the anterior portion of the sclerotic, and is thence transmitted over the anterior surface of the lens. Contrary to what has been asserted, I found the iris just described to be perfectly moveable in the living Sepia, and the pupil it formed contracted and dilated precisely as in other animals. The pupil is linear and horizontal, and nearly equal in breadth throughout; but it expanded somewhat in the living animal on being removed from a strong to a weaker light, and on the death of the animal, which happened unexpectedly by merely pouring over it a quantity of spring-water, the pupil suddenly dilated so as to become circular, and continued so as long as preserved.

This seems to me the true anatomy of the eye of the cuttle-fish, as deduced from preparations which had been for some time immersed in spirits. The number examined was eight, viz. two of the calmar, and six of the smaller species of Sepia, frequently met with in the Frith of Forth; but as the latter were brought to me alive, it may be worth while to mention the precise appearances of the eye-ball when laid open in a perfectly fresh state. This may be done very briefly. I found the vitreous humour, hyaloid membrane, and lens, colourless, and eminently transparent; nothing indicated the presence of that darkish coloured stripe which we have shown to traverse the lens from side to side, or of those wedge-like cavities which we know to exist betwixt its hemispheres. The pigmentum covers every portion of the great central chamber of the eye-ball occupied by the vitreous humour, and is of a dark purplish colour; the antero-posterior diameter of the eye is short.

Having thus described what I consider as the true anatomy of the retina and ciliary processes in these animals, and corrected the highly erroneous notions hitherto entertained relative to the pupil, it will now be expected that I should offer some opinion as to the mode in which I suppose vision to be performed in the cuttle-fish; but this is a subject the consideration of which is attended with great difficulty. A part of the difficulty may be got over by supposing that the eye of the cuttle-fish is adapted not for the distinct perception of objects, but for the more general sensation of light, whereby it may regulate its course, and be guided to those depths in which it expects to discover its prey. I am inclined to adopt this opinion from the following considerations: 1*st*, The living specimen on which I had an opportunity of experimenting did not show any signs of fear when the hand or a sharp instrument was made to approach the eye, but if touched, the pupil closed entirely, the skin forming the eye-lids did the same, the animal became extremely agitated, and made strong efforts to escape. Now, it is difficult, if not impossible, to explain these facts otherwise than by supposing a want of distinct perception in the eye of the cuttle-fish. There is one objection, however, to this experiment, which candour obliges me to state. It is this; that, as the animal was placed in a very small quantity of water, it was in consequence exposed, perhaps, to a dazzling strength of light, which nearly closed the pupil, and might have rendered the eye generally unfit for distinct perception. It is, however, to be remembered, that the Buccinum and Snail, animals belonging to the same class as the Sepia, exhibit nearly the same phenomena as to vision, and the objection does not apply to them.

2*d*, We must consider the Sepia as being merely the most perfect of the mollusca. Now there is no proof whatever that any of these animals have distinct vision, and we know that the eye of the buccinum and snail may, in some measure, be considered as a miniature and less perfect representation of the eye of the Sepia. Now, it is undoubtedly a general truth, though it admit not of minute or particular application, that animals have been formed agreeable to certain general laws, and that they have been grouped into classes, the individuals constituting which possess functions having a general resemblance, however much their organs may differ in appearance. Thus it is with the eye of the cuttle-fish, which, notwithstanding its dimensions, the beauty and complexity of its form, expanded retina, and singularly constructed lens, I must still consider as merely the eye of a cephalopodous molluscous animal in its most perfect state.

3*d*, There is interposed betwixt the vitreous humour and retina an excessively dark pigment of considerable consistence, assuming the form of a membrane, and apparently presenting an insurmountable barrier to the passage of the rays of light in their progress to the retina. I have examined this membrane with the microscope, and find it exceedingly opaque; still it may be insufficient to prevent the rays of light from reaching the retina, or rather, (as we know not yet the nature of light sufficiently well,) we may say, that the membrane receives an impression which is thus communicated to the contiguous retina. The absolute opacity of the pigmentum, in the eye of the cuttle-fish, may even be doubted, and we know, by a very simple experiment,* that its immediate vicinity, or rather contiguity, with the retina, may possibly permit luminous rays to penetrate to the retina itself.

The observations on the mode in which vision is performed in these animals are altogether distinct from the anatomical details which I have been particularly careful in submitting to the Society, precisely as they appeared to me at the time of the dissections. The considerations which arose out of the facts I have stated, and out of those already known relative to the singular construction of the lens in this class of animals, in so far as they modify the received theories of vision, will shortly be submitted to the Society, by a gentleman whose extensive knowledge of optics eminently qualify him for so difficult and obscure an inquiry.

It seems proper to add, that most of the dissections, whose results are detailed in the preceding memoir, were performed in the presence of several friends, and that I had the honour of demonstrating the principal anatomical facts to the present distinguished Secretary of the Society. I shall farther endeavour, in order as much as possible to perfect the view I have taken of the anatomy of the eye of the cuttle-fish, to submit to the Society, at a future meeting, accurate drawings of the whole of the anatomical appearances in the order of dissection.

* The experiment alluded to consists merely in holding a dark coloured handkerchief or piece of black crape at a short distance before the eyes, so as completely to intercept the rays of light, and, comparing the total darkness so produced, with the tolerably distinct vision which follows, when the crape, instead of being placed at a distance from the eye, is brought in almost immediate contact with the cornea.

Art. II.—*An Account of the Frontier between the Southern part of Bengal and the Kingdom of Ava.* By Francis Hamilton, M.D.F.R.S. & F.A.S. Lond. & Edin. Communicated by the Author.

In two former papers I have given an account of this Frontier, so far as connected with the territories of the tribes called Tripura and Saksah, which occupy chiefly the banks of the Gomuti and Karnaphuli. I shall now proceed south from the latter, and give an account of the frontier so far as connected with the tribe, which the Bengalese call Joomea Mugg. In the first place, I shall give some account of this people, and of the tribes dependent, and then I shall give some account of the territory they possess.

The invasion of the province of Chatigang by the troops of Ava in 1794, and the giving up of the several refugees that had fled from Arakan (Rakhain) for protection, had occasioned a very general alarm among the Joomea Muggs; for there can be no doubt that these people came from Rakhain, the language and customs of which they retain unchanged. This terror made them in general unwilling to acknowledge any connection with Arakan, although the more intelligent among them acknowledged the name Marama, which the people of Rakhain assume. In common conversation, however, they called themselves men of the hills (Taumgsah,) or of the rivers (Khiaungsah ;) the former from their cultivating hills, and the latter from their using the torrents for a conveyance. It is true, indeed, that they would appear to have retired from their original country about the middle of the last century, that is, between thirty and forty years before the conquest of Rakhain by the King of Ava, while the refugees that were delivered up were insurgents, who had risen against the government of Ava ten years after the conquest. They were not in general aware that this would make any difference in the disposition of the English to protect them ; and no doubt they had received many new colonists, not only at the conquest, but on every occasion of discontent that afterwards arose. The opinion, indeed, which prevailed both in Chatigang and Ava, was, that the refugees were given up from fear; and this opinion has no doubt continued to operate on the ill-informed court of Ava, and has occasioned a frequent repetition of violence and insolence, ending in an open war. The consequence of this will no doubt be fatal to the King of Ava; but may produce subsequent difficulties to the Government of Bengal. These evils might probably have been avoided by a vigorous repulse of the invasion in 1794, and a positive refusal to hearken to any proposal for giving up the insurgents, after the court of Ava had adopted hostile measures in place of negociation, to which alone it was entitled.

The Joomea Muggs in their own country no doubt used the plough, and cultivated the level fields, both of which practices, on settling in Chatigang, they have entirely relinquished; but this seems to have been in order to conciliate the Bengalese, among whom they settled. The hills, of which they took possession, were entirely neglected by the Bengalese, as not admitting of being ploughed after the Indian fashion, so that they gave no umbrage in taking possession of this land; besides, these colonists were probably unable to purchase the stock necessary for ploughing; while that required for the joom cultivation is next to nothing. But farther, these colonists, from their hideous impurity, would not have been admitted among the Bengalese; for although most of these in the district of Chatigang are Muhammedans, they have adopted in full vigour the doctrine of cast and Hindu purity. The natives of Rakhain, on the contrary, eat, drink, and sleep, with no more regard to purity than Christians, and eat almost every thing, except milk and its preparations, which they abominate.

The written character of the Joomea Muggs is entirely the same with that of Ava, and almost all the names of persons and places mentioned in this account were given to me in writing. I have expressed this in English characters, not according to the form of the Alphabetum Burmanum, but in a manner more suited to express the provincial dialect of Arakan.

The Joomea Muggs are considerably more civilized than either the Tripuras or Saksahs, and are subject to three chiefs, of which the one in the centre is by far the most considerable.

The one who lives farthest north I had no opportunity of seeing, as his house was too far removed from a road accessible to a palanquin, the manner in which I travelled when in his vicinity; but I had some communication with him by messengers. His name or title is Agunnea, and his territory lies along the rivulets which fall into the north side of the Sunkar river, which is called Sunka by the Bengalese, and Reekri, (sweet water) by the Joomea Muggs. His house is on a small stream, called the Barwany, that falls into this river at a market-place, called Gulea cherra, and is three hours' journey from that place, above which, in 1798, the judge of the district had placed a guard to prevent the incursions of the Bonjugies. Agunnea is said not only to have among his dependants many of the Kunkies or Lingtas, but to have formed a very close connection with the chief of the Bonzhu or Bonjugies. This last circumstance, however, his messengers were not willing to acknowledge; and they alleged, that the Bonzhu chief resided fifteen days' journey from their master's house, which does not differ much from the account given on the Karnaphuli. His territory certainly includes all the country about the sources of the Karnaphuli and Sunkar, and, no doubt, extends some way down several considerable branches of the Arakan river, occupying the highest part of the frontier between Bengal and Ava, around what in our surveys are called the Blue Mountain and Pyramid Hill. The people of this tribe seem to trade chiefly with Arakan, and the greater part of their territory is probably considered by the King of Ava as his property.

The territory of the central and principal chief of the Joomea Muggs, extends from the south bank of the Sunkar over all the vallies watered by the branches of the Mamuri and Edgong rivers. In 1798 I staid two days at Sualuk, where this chief resides; and, during this time, I visited in his house, and in that of his chief priest, in return for the visits of these persons, and of their principal dependents; while in other parts of his territory, I had a similar friendly intercourse with the principal officers of the place, especially with Aunghiose, who managed the country on the Edgong river.

The people of this central tribe are often called Reekrisah, or sons of the sweet water, as they name the Sunkar river. The chief whom I visited was called Pomang Kaungla Pru. Po-mang, is his title, and signifies Captain; Kaungla was his proper name, and Pru (white) was his family name. By three women he had six sons and six daughters, of whom, all of the daughters and three of the sons were married. He had about twenty Hindu servants, and still more Muhammedans, his Dewan or minister being of that religion. The domestic who had charge of his table, or steward, was a person of the family of the Chaksah chief. The whole of his sons, married and single, lived in his house. Besides this numerous family, he had a great number of Marama slaves; that is, persons of his own tribe, who incur debt, go to him, and say, if you will discharge our debt we will become your slaves. On the master advancing the money, the slave must perform his work from six in the morning till ten in the forenoon, and from four in the afternoon till sun-set. The monthly allowance made to the slave by the master is one piece of coarse cotton-cloth, and one basket of unhusked rice, which is said to weigh 82 pounds avoirdupois; but one, which I measured, contained very nearly two Winchester bushels ($\frac{107}{130}$), being a cylinder of three feet long, and one in diameter. He seldom allows salt, or any other seasoning. The master cannot sell the slave, but must give him his liberty, if ever he is able to repay the money originally advanced; and, of course, the slave may change masters, if he can find any person who will advance the price of his head. This manner of treating debtors would perhaps be more rational, than that prescribed by the law of England, where the debtor may be condemned to perpetual imprisonment, without the possibility of being of advantage to his creditors, to himself, or to the public; but, among these eastern nations, this practice is attended by an abominable circumstance—the wife is often reduced to slavery for the debts of her husband; and, what is still worse, children are made slaves for the debt of their parent. The numerous slaves of this kind, belonging to Kaungla Pru, are chiefly employed in agriculture.

The house of this chief is supported on posts, and thatched, its floor and walls being constructed of bamboos split, and woven into mats; but it had several large apartments, and was furnished with chairs, carpets, beds, and mats. The yard is surrounded by a fence made of posts and mats, and is dignified with the name of Fort. In the adjoining village there are forty or fifty houses, and a convent (Kiaung) of priests (Poungris). For such a climate the houses seemed to be comfortable; but, as the women avoided my company, I could not be minute in examination without distressing the inhabitants. Kaungla Pru was a stout little man, with strongly marked Chinese features, and was about fifty years of age. He came to visit me in a palanquin, with many attendants, who appeared to be in easy circumstances, and both he and his family and suit were very obliging. Every thing about him had the appearance of considerable wealth, and he was said to lend much money to the neighbouring Bengalese proprietors, at the rate of $\frac{1}{32}$ part monthly, or $37\frac{1}{2}$ *per cent. per annum.*

The villages belonging to Kaungla Pru are managed by officers named Ruasah ; and I observed that, in one instance at least, several of these were under the authority of an officer styled Tamang. At any rate, this was the title of Aunghiose, who seemed to manage all the affairs of Kaungla Pru on the Mamuri river. I heard of another person named Pamang, and of a similar officer named Poummakri ; but I did not learn whether this was his proper name or a title. I went to visit Aunghiose at his village, which consisted of a few houses disposed in a street parallel to the river Mamuri, and having at its east end a rivulet named Yaungsa, and at its western extremity a small hill, on which is a convent or Kiaung. I found this officer's house of considerable size, and raised high on posts. The stair was very bad, being nothing more than a notched stick. From the stair we landed on a bamboo platform. To our right was a tolerably large hall, into which we were conducted, and on our left were the apartments of the women, who kept out of sight. In the hall there was no furniture, except a stool, which was given to me, and a small carpet, which was reserved for Aunghiose, with some mats for the attendants. I was received with much civility, although the poor man was a good deal puzzled about the ceremonials, wishing my servants to be seated with his kinsmen and his spiritual guide. This officer was reported to be rich, and to have made a great profit by lending his money to the people called Mroo, who give him their young daughters as pledges for the repayment ; and these are liable to be sold in case of failure. On the whole, the subordinate chiefs among the Joomeas seem to have more respectability than those of the Saksahs.

About the middle of April, the Joomea Muggs of this central tribe leave their villages, and go to the joom for six months. One day's labour enables a man to build such a hut as he requires during his residence, and he is supposed to raise a hundred baskets of rice, with cotton, dioscoreas, arums, tobacco, &c. in proportion, the cotton being sufficient, at any rate, to pay his rent. The free people have in their ornaments a good deal of silver, and are cleaner, and appear to be more comfortable than the common Bengalese. They also seem to have the good things of the world in greater abundance than the cultivators of the plains, or at least they are more willing to part with them. Kaungla Pru made me a present of eatables, in which were cloves, nutmegs, black-pepper, and asafœtida, things which, even at Ramoo, I could procure neither for money nor solicitation; and which, both Hindus and Muhammedans assured me, never entered into the fare of the Bengalese in the country parts of the district. Brandy and gin I was told were for sale at Sualuk.

The priests of this tribe are called Poungri (great virtue,) a title not unknown to those of Ava, although the latter are more commonly called Rahan. Their Kiaungs, or convents, have plain roofs, and are not ornamented like those of Ava ; but they bespeak the inmates to be in easy circumstances. That at Sualuk contained three apartments. In one of these I found a Poungri instructing some boys to read and write. Among the youths was a son of the chief. In a corner of this apartment were a few small images clothed in yellow, but in a posture different from that of Gautama or Godama, as represented in the temples of Ava. By the priest, however, they were said to be representations of that personage. They were placed on a stage adorned with silver, and with paper ornaments; and before the stage was a high iron lamp.

In one of the apartments of the convent the priest had slaves, both male and female. These were said to be numerous, and to be procured by advancing money for people who had fallen into distressed circumstances. These slaves were employed both as domestics and in the cultivation of the land; for the priests here never go out to beg like those of Ava, and although they receive contributions from the pious, do not choose to trust entirely to such for their subsistence. Among the slaves of the priest were three girls very desirous to change masters, nor was he unwilling to part with them, had I been inclined to pay the sum for which they stood indebted. Their levity and want of industry, and the priest's gravity and desire of gain, made both parties desirous of separating, nor did a separation from their relations, religion, and customs, seem any bar.

The chief priest was an intelligent man. He said that in the convent there was another Poungri, and a boy six years old, who was instructing in the duties of the priesthood, for which he was intended. Although not yet admitted into orders, he wore a yellow dress, which is contrary to the rules observed at Ava, and to the precepts of the Kammua or book of ordination; but perhaps the Rakhain edition of this book differs from that used in Ava; as I found that there existed many differences in the religious doctrines of the two people.

Among other doctrines which the Rahans of Ava would consider heretical, this priest acknowledged Brahma, or a supreme being, and that this author of nature had given a different religion to each of the one hundred and one nations of the earth. He believed in the same Munis or lawgivers, that the priests of Ava allege to have appeared on earth, namely, Chaucasum, Gonagom, Gaspa, (Kasiyapa,) and Godama, (Gautama;) but to these he added a fifth, named Maha Muni. These priests are possessed of books said to contain the doctrine of the two last Munis only, and to them alone they address their prayers, as they have no formula by which they could supplicate the others. They have books containing an account of Rama, of his spouse Sita, and of many other Hindu deities; but, like the natives of Ava, they consider these as beings still liable to the infirmities of mortality, and not yet arrived at Nriban, or the state of perfect bliss, free from change and misfortune. The priest compared Gautama to himself, and Maha Muni to his young disciple.

The principal circumstance, however, which distinguishes the religion of the Joomea Muggs from that of Ava, is, that the former are much addicted to the offering of bloody sacrifices to the spirits (Nat) of the air, mountains, woods, and rivers, a superstition held in abhorrence by the priests of Ava; nor in the whole empire did I see one instance of such a ceremony, but, during my stay at Sualuk, the drum, by which it is accompanied, never ceased. When a Joomea Mugg has made a vow, or when he wishes to render a Nat propitious, he hires a drummer, goes to the supposed residence of the spirit, dances for some time with all his might, and then kills the animal, pouring forth its blood to the hungry deities. The flesh is then dressed to the sound of the drum, and carried home to a feast, which also is accompanied by that noisy instrument. The Nat of the Sualuk residing near the place where my tent was pitched, I did not enjoy a moment's silence. This superstition, I believe, was not in use in Arakan, and has probably been adopted by the Joomeas from the rude tribes among whom they have settled, and among whom it universally prevails.

Soon after returning to my tent from the convent, I received a message from the priest, who wished to know if I would take him to Europe. I answered that I could not, but that I would be glad to carry him with me to my house at Lukhipur, in order to receive instruction from him in the language of Rakhain and Ava; and I requested to know if he would sell me a copy of the book Kammua. He said that he could not sell the book, but, if I resided near, he would make for me whatever books I wanted. Our views thus being unsuitable to each other's convenience, the negociation terminated.

The southern tribe of the Joomea Muggs in 1798 was subject to a chief called Umpry Palong; but whether this was his name or his title, I did not learn. The tribe then occupied six villages or townships, one under the immediate authority of the chief, and five under an equal number of officers called Ruasahs. All these are situated in the upper part of the river passing Ramoo, which the Bengalese call Bak-kally, and the Joomeas name Pangwa-khiaun. The chief whom I saw was a poor man with a few trifling golden ornaments, and had two ill-looking Bengalese attendants, who took every opportunity of restraining their master's inclination to satisfy my curiosity; but, so far as I could learn, the manners of this tribe do not differ from those of the other Joomeas, only they are poorer, although Umpry Palong sold a considerable quantity of cotton to the Bengalese. He pays some tribute to the Company, but I do not know the amount.

There can, as I have said, be little doubt that the Joomeas came at no remote period from Arakan; but they have subject to them the villages of some more rude tribes, who, although tributary, retain their own chiefs, customs, and languages; and, although they submit in some instances to have their disputes settled by the authority of the Joomea chiefs, still in ordinary causes they abide by the decisions of their own chieftains, and live in distinct villages, although these are intermixed with the villages occupied by Joomeas. The Joomeas, I know, hold several of these tribes in a state of slavery, and these slaves dwell in the villages of their masters; but I saw no instance of a Joomea being in slavery to any person of these rude tribes, although the Joomeas are often reduced to slavery with each other. The usual manner, indeed, in which slaves are procured, is by advancing money in loan, and when the debtor is unable to repay, he becomes a slave to the creditor. The Joomeas, being farther advanced in society, have more cunning than the rude tribes, and are therefore generally the creditors. I did see a few slaves who were said to be captives in war, but such, I believe, are very rare among the Joomeas. It is alleged that the Bonzhu have carried off many captives, both Joomeas and Bengalese, and either retain them as slaves, or have sold them to Ava, where, indeed, I saw several such.

The only rude people settled among the southern tribe of the Joomeas are a few of the Saksahs, called by the Joomeas Sak, and by the natives of Ava, Sæk. In this southern part of the district the Saksahs are, by the Bengalese, called Rajbangsi, which literally means descendants of princes, but all over India is a term denoting a person of low birth. The neighbouring part of the dominions of Ava is occupied by a portion of this tribe.

The rude people, most numerous among the subjects of Kaungla Pru, by the Bengalese are called Moroong; but under this name are included two distinct tribes; the first by the natives of Arakan called Mroo, and the second Mroung, and, in the dialect of Ava, Mroun. By the Joomeas the Mroo are also frequently called Lay Mroo, while the Mroung are called Wase Mroo, a nomenclature arising from some difference in the nature of the revenue which they pay; and a similar circumstance occasions some of the Mroo to be distinguished by the name Paungsah. The Bengalese sometimes distinguish the Mroung from the Mroo by calling the former Deinee Moroong. The Mroo call themselves Moroosa. So far as I could learn, all the Moroosa consider themselves as subject or connected with a chief named Layklang, who lives at a great distance, probably within the dominions of Ava; but each head of a village (Ruasah) seems to arrogate to himself very independent powers, and, according to the report of the Joomeas, battles between them are not uncommon, the power of the supreme chief being diminished by his residing at a distance, and in a different kingdom. Neither Joomeas nor Bengalese seem to think it worth their while to interfere in the disputes of these impure creatures; but I found that the Joomea chiefs subordinate to Kaungla Pru did not conduct themselves with haughtiness towards the Moroosa. On the contrary, they kept up a friendly correspondence by visits and presents. I had interviews with several people of this tribe on the banks of the Edgong river, and more intercourse with those on the Mamuri, having both received and returned visits to Kingdai, chief of one of their villages. The dialect spoken at Edgong differs a little from that in use on the Mamuri, but their language seems to have a considerable resemblance to the dialect of the Burma language spoken by the Joomea Muggs, as will appear from the following words.

English.	Joomea.	Moroosa of Edgong.	Moroosa of the Mamuri.
Sun	Nee	Ta-nee	Sat
Moon	Law	Pu-law	Law-ma
Stars	Kree	Kray	Kray
Earth	Mo-ree	Kraung	Kraung
Water		Tooee	
Fire	Mee	Mai	Mai
Stone	Kiouk	Tow-hoa	Mai-hua
Wind	Lee	Rlee	Lee
Rain	Mo		Mo-whang
Man	Loo	Mo-roo	Mo-roo
Woman	Meem-ma	Mee-sar	Mo-shee-wa
Child	Looshee	Na-sa	Mo-roo-sha
Head	Gaung	Loo	Lo
Mouth	Ko-naung	Nor	Nor
Arm	Lay-maung	Boung	Boung
Leg	Kree-ei	Sæ-pom	Klaung
Foot	Po-wa	Ko-koum	Ko-paw
Hand	Lay-wa	Roo-koom	Roo-pa
Beast		Ko-paw	
Bird	Hgnak	To-waw	Wa-ouk
Fish	Nga	Dam	Dam
Good	Kaung	Yoong	Yaung
Bad	Makaung	Yoongduay	Yaungda
Great	Kree	A-yoo-ko	Yoogma
Little	Shay	A-tsoi-tsa	Sum-tsha
Long	Akree	Akrang	Klangma
Short	Ato	A-toung	Atong-sha
One	Tay	Lou	Lak
Two	Hnay	Pray	Pray
Three	Soum	Soum	Soom
Four	Lay	Ta-lee	Ta-lee
Five	Nga	Ta-nga	Ta-nga
Six	Kro	Ta-rouk	Ta-ro
Seven	Koney	Raneet	Raneet
Eight	Shay	Reeat	Ryat
Nine	Ko	Ta-koo	Ta-ko
Ten	Tsay	Haw-moot	Haw
Eat	Tsaw	Tsaw	Tsaw
Drink	Souk	Kam	Kam
Sleep	Eit	Eep	Eim-moi
Walk	Hlay	Ma-nay-bo	Tsam-psa
Sit	Tein	Tsom	Tsam

English.	Joomea.	Moroosa of Edgong.	Moroosa of the Mamuri.
Stand	Ta	Roo	Roo
Kill	Koymay	Tap	Too-tay-moi
Yes	Hooi-ou	Na-za	Na
No	Ma-hou-poo	Na-doi	Po-da-po
Here	Heca	Wang	Oay
There	A-wee-ma	Pai-koi	O-ro
Above	Gaung-ko-ma	O-roo-koi	Mo-kaung
Below	A-nee	Krongkoi	Yooa

The Moroosas have no written language, but their form of writing the syllables of their words is evidently similar to that used by the natives of Ava and Arakan in their written languages ; thus, the word *eit*, signifying sleep in the Arakan dialect, is the same with *eim*, the first syllable in the compound word *eim-moi* used by the Moroosas, for *t* final before *m* is pronounced *m* both at Ava and Arakan.

(To be concluded in next Number.)

Art. III.—*On the Quartz District in the neighbourhood of Loch Ness.** By George Anderson, Esq. F.R.S.E., &c. Inverness.

1. The rock I am now to describe, is more abundantly found in the counties of Inverness and Ross than is generally imagined ; but its character and geological relations are no where better exemplified than along each side of the banks of Loch Ness.

2. In the lower, or eastern portion of the *Great Glen*, of which the basin of this lake forms a considerable part, the quartz-rock is associated with sandstone, while in the central and higher districts it is connected with granite and with gneiss.

The mountains along the north side of the lake are immediately connected with a chain of similar ones,—no large valley intervening, while those on the south side are separated from the succeeding ranges, in the interior of the country,

* Read before the Royal Society of Edinburgh on the 5th April 1824.

by a wide and dreary alpine plain, or valley, called Strath Errick. This valley is almost entirely composed of granite, which is of a red or grey colour, large-grained, and most commonly contains hornblende. The granite is also distinguished by the frequent occurrence of small rounded, or concretionary imbedded portions of mica-slate and clay-slate.

On the north side of Loch Ness granite occurs, constituting one of the mountains (called the *Red Rock*) next the lowest or eastern extremity, but is here remarkably small-grained, and, as I shall afterwards more particularly notice, differs but little from the ordinary compact quartz-rock. Such is the distribution of the granite. That of the quartz-rock I shall describe, after explaining its characters. It appears to be a rock which is daily assuming a more important place than it formerly possessed in the classification of mountain masses.

3. The predominating colour of the quartz-rock of Loch Ness is light red or brown, but it is to be found of a blue or grey tint. The substances which compose this rock, are felspar, quartz, and mica, but of these three ingredients the quartz is the most abundant. Its texture is granular, or nearly compact, and the form of the particles crystalline. The three ingredients are so intimately combined as to exhibit a perfectly homogeneous structure. But it is by the hardness, and the shape of the fragments produced by the hammer, that this rock is chiefly distinguished from the older sandstone. The hardness is indeed so great, that, in breaking off specimens, they frequently fly into the air and *ring* like clinkstone. The cross fracture is uneven, very small and granular, and the form of the fragments is rhomboidal, and rarely rectangular.

The texture of the rock, though in general small-grained or compact, is, however, occasionally diversified by the occurrence of large imbedded masses of conglomerate, into which those portions of the quartz-rock contiguous to it gradually pass.

The conglomerated variety occurs in the neighbourhood of Foyers, and on the margin of Loch Ness, between Inverness and the General's Hut. But it is most abundantly found in the mountains below Foyers, as we proceed eastward from the margin of the lake. On the north side of Loch Ness, the conglomerate is less abundant, but it is found on the summit of the well known mountain named *Mealfourvoney*, which is more than 3000 feet high. This is, therefore, one of the greatest altitudes in Britain in which rocks of a conglomerate character have been traced. The fragments which compose this rock, may be described as different varieties of granite, gneiss, mica-slate, quartz, and felspar; chlorite may be also occasionally detected. The fragments are angular and rounded, those of the latter form betraying undoubted marks of attrition. They also vary in magnitude, from the size of large boulders to that of small grains.

I shall now state the only distinctions which I have been able to discover between the conglomerate rock which occurs in the quartz district, and that which is associated with the red sandstone. The former is much harder than the latter, yielding to the blows of the hammer with far greater difficulty. Again, in the conglomerate peculiar to the quartz-rock, the fragments have often the appearance of imperfect crystals, which have been separated and re-united. This character, however, is not found in the variety of conglomerate which is associated with the red sandstone.

I may next observe, that the conglomerate which is found on the summit of Mealfourvoney, contains a much smaller variety of substances than is observed elsewhere, as they chiefly consist either of quartz-rock itself, or of a variety of the same which approaches to the character of gneiss.

With regard to the structure of the quartz-rock, it is sometimes schistose, but in its general character can scarcely be considered as stratified; at least, it displays but imperfectly any regular lamellar arrangement. The natural seams and lines of fissility which its surface exhibits, are unlike those of regular strata, having no uniform or parallel direction. There is also no regular dip or inclination to any particular point of the compass.

This rock varies much in its liability to decomposition, but in general it very strongly resists the action of the weather. In decomposing, however, it is to be remarked, that the compacter kind never assumes the rounded concretionary disposition incidental to most varieties of granite.

The forms presented by the hills of quartz-rock, are conoidal, and in one or two instances serrated: the acclivities are smoother than those which are found in mountains composed of mica-slate or clay-slate, but they are bleak, and strewed over with fragments. The conglomerated hills present more undulating outlines, and their slopes are heaved up into rude irregular precipices.

The high mountain of Mealfourvoney, so often referred to, exhibits on its summit a large dome or cupola of conglomorate, springing from a basis of the more compact quartz-rock. This summit likewise sends off two very long waved ridges, to the east and west, while its northern and southern sides are formed into rugged mural precipices.

4. Having thus described the detached characters of the quartz-rock, its importance and geological position will now be understood, by attending to its junctions with the other rocks of the district; and I shall next describe the quartz-rock as it is found in junction with granite.

This takes place on the south side of Loch Ness, especially at the vitrified station of Dun-Jardil.

There is no change produced on the quartz-rock in regard to its chemical composition; but some of the ingredients of which it consists, increase in size, become visible to the naked eye, and in many cases pass into a hard conglomerate, the portions of which are sharp or angular, and partake more of a form that is irregularly crystalline, than one which can be considered as induced by abrasion. This appearance is occasionally accompanied by the presence of large rhomboidal crystals of felspar. The conglomerate here alluded to likewise partakes of a mixture of the predominating colours of the quartz-rock and granite. In other cases, however, the junction is marked by the quartz-rock and granite alternating with, or succeeding each other, in the form of irregular layers,—the passage of one substance into the other being gradual, and almost imperceptible.

I have only further to remark, with regard to the relations of these two rocks, that in certain places, especially on the north side of the lake, veins of granite are seen traversing the quartz. In the conglomerate, also, large fragments of granite occur, though these are but rarely seen in the compact homogeneous quartz-rock.

The granitic mountain on the north side of Loch Ness, to which I have alluded, is a variety approaching very near to the character of quartz-rock, being, like it, naturally resolved into short angular and rhomboidal fragments, of a tabular appearance, while its structure is finer than we generally meet with in granitic rocks. In the neighbourhood of the same mountain, we also find the more common variety of the quartz-rock, while its alliance to this variety of small-grained granite, which it so nearly resembles, is confirmed by the passage through each of *veins* of an undoubted *large-grained* granite.

This red quartz-rock likewise contains cavities encrusted with small rock-crystals; and, associated with these, I discovered particles of galena, copper-glance, and antimony.

5. The other primitive rock to be noticed is gneiss, with which, as I have stated, the quartz-rock of this district is connected. Gneiss occurs chiefly on the north side of the lake, extending from thence as far as Ross-shire.

The changes induced on the quartz-rock by its contact with gneiss, are shortly these:—There is, first, an increase of mica, which adds to its schistose tendency, and gives it a grey or blue colour. Secondly, the gneiss is disturbed in the regularity of its stratification, for I observed it to deviate from an inclined or vertical position into a horizontal one. Lastly, both the gneiss and the quartz-rock are mutually intersected by granite veins, and imbedded masses of various sizes, consisting of hornblende, often beautifully crystallized, in which garnets are sometimes found.

6. This concludes my account of the important relations of quartz-rock to gneiss and granite. I shall now describe briefly its connections with sandstone.

On the north side of Loch Ness, granite is succeeded towards the east by quartz-rock, intermixed with gneiss; and to these are joined a lower sandstone ridge, on the last of which, or that nearest the sea, is the celebrated vitrified fortification of Craig-Phadric.

On the south side of Loch Ness, is the coarse conglomerate chain of hills named Balcharnoch. From the softer and more iron-shot texture of these conglomerate rocks, and from their gradually passing into sandstone, I am inclined to regard them as not belonging to the quartz-rock.

To complete my account of the sandstone, I have only to add, that its predominating varieties are the common old red sandstone, and a grey micaceous sandstone, very soft and fissile. It is also associated with a bituminous rock, hitherto but little noticed by geologists. This rock deserves a separate consideration.

7. The exact line of junction between the quartz-rock of a compact texture, and the sandstone, cannot always be accurately determined; but a change is indicated on the quartz-rock, by its very inferior degree of hardness, and by a corresponding alteration in its texture; the component particles losing somewhat of their crystalline aspect, and acquiring more of an arenaceous structure.

At a little distance from the point of junction, the rock assumes a more determinate form; that is, it gradually acquires a stratified arrangement, and the strata are varied in their line of bearing, while they are generally inclined at a very low angle. The circumstance, therefore, of stratification, is a very characteristic difference between the sandstone and quartz-rock. But, besides this distinguishing mark, the sandstone strata appear to be superimposed on the quartz-rock, while the latter, in its relations to granite and gneiss, observes no such determinate mode of position.

Such are the relations of the quartz-rock. Its connection, on the one hand, with granite and with gneiss, and, on the other hand, with sandstone, have been severally explained. The quartz-rock, therefore, maintains a very important place in geological systems, as, from the nature of its ingredients, from its structure and transitions, it is the probable commencement of the great series of sandstone rocks.

The peculiar quartz-rock now described as so abundant in the vicinity of Loch Ness, has been elsewhere observed; and

Dr MacCulloch notices it as a curious variety, while Dr Hibbert has identified it with the quartz-rock of Shetland.

*** *Mr Anderson's Account of the Geographical Distribution of the Quartz-rock, and of the bituminous strata associated with the Sandstone, will be given in our next Number.*

Art. IV.—*On the Genus Calymperes of Swartz and Syrrhopodon of Schwaegrichen, of the Order Musci.* By W. J. Hooker, LL.D. F.R.S. &c. &c. Regius Professor of Botany in the University of Glasgow, and R. K. Greville, L L. D. F. R. S. E. &c. &c. Communicated by the Authors.

In noticing under the same head the two genera above mentioned, we are influenced by their great similarity in habit, and by the circumstance of both having been previously considered as belonging to one genus, that of Calymperes.

The genus *Calymperes* was instituted by Dr Swartz; and, as it appears, published for the first time at Kiel, in the year 1813, in the *Tabula Muscorum Frondosorum* of Weber; but, as we do not possess that table, we are not aware what character was there ascribed to it, or what species, if any particular one, was there described. In the year 1816, our friend Dr Schwaegrichen published the genus in his *Mantissa Generum aliquot Novorum*, attached to the second part of the first supplement to the "*Species Muscorum*," simply with the character, "Peristomium nullum, thecæ orificio membrana spongiosa tecto. Flores terminales dioici;" and describes under it two new species, C. *lonchophyllum*, and C. *Palisoti*.

In the year 1818, there appeared in Sprengel and Schrader's "Jahrbücher der Gewächskunde," Dr Swartz's paper, with an excellent account of this genus, under which the C. *Afzelii* is described; and there we find the following generic character. "Peristomium nudum. Calyptra carinata, persistens, infra sporangium constricta, apice circa operculum (maturitate solutum) rimis longitudinalibus hians."

About the same time, but without being aware of the memoir last mentioned, Dr Hooker published in his *Musci Exotici*, what he then considered, from the remarkable habit of the plant, and from the nature of the peristome, a species belonging to the same genus, under the name of Calymperes *Gardneri.* Here, however, Dr Hooker discovered the presence of actual teeth to the peristome, united at the base into a membrane, whereas in the figures of Calymperes given by Schwaegrichen, there is an horizontal membrane radiated with lines, as it were the rudiments of teeth, very similar to the appearance which the peristome of C. *Gardneri* presents in a young and moist state.

Schwaegrichen then, in his last supplement, considering *Calymperes* to be destitute of actual teeth, and C. *Gardneri* to be furnished with them, and finding some further characters to exist in the calyptra, constituted of the latter the genus *Syrrhopodon*, adding to it the Weissia *ciliata* of Hooker, and four other species.

The two genera, as we have already observed, are very closely allied in habit. They grow mostly on the trunks of trees in a tufted manner, somewhat like the genus *Orthotrichum.* Their leaves, generally narrow and much elongated, have for the most part a close and compact texture, except at the broad sheathing base, where a considerable portion is occupied by extremely large, very pellucid, and even transparent, colourless, quadrangular cellules. The extremity is often lengthened out, again becoming broader at the very apex, so as to be somewhat spathulate, and there producing minute jointed bodies, which have so much the appearance of a species of conferva, that we cannot help considering them as quite analagous to the Conferva *Orthotrichi*, and by no means to the male flowers of mosses, although Schwaegrichen considers them as such, and makes them form a part of his generic characters. Swartz spoke of them doubtfully as the male flowers, and we have ourselves seen the real gemmiform male flowers of Hedwig, in more than one instance. The margins of the leaves are more or less incrassated, serrated, or entire; when serrated, the serratures are often extended to the summit of the back of the nerve, and, in one instance, are in that situation so much and so irregularly scattered, as to give that part a spiculated appearance. The nerve is percurrent, (except in the doubtful species Syrrhopodon *Taylori*, which is the only species also which wants the reticulated pellucid base.) The seta is terminal, more or less elongated. The capsule oblong or subcylindrical, smooth, sometimes very shining. Operculum more or less acuminated and straight. Calyptra large, enveloping the capsule, and, in most instances, closely embracing the fruit-stalk with its base.

The points in which the two genera appear to differ are these. In the first genus, *Calymperes*, the fruit-stalk is rarely exserted beyond the points of the leaves. The calyptra is constantly very large, deeply striated or sulcated, closely enveloping the capsule, like a mantle with many longitudinal folds, somewhat spirally twisted, firmly embracing the upper part of the seta, never, that we can find, deciduous, but opening by fissures where it surrounds the mouth of the capsule, and containing at its extremity the loosened operculum. This operculum is, we believe, in every instance conico-acuminate, and never equal to half the length of the capsule. The capsule has no true peristome; but in lieu of it, Schwaegrichen finds in the species *lonchophyllum* and *Palisoti*, a yellow horizontal membrane, with a circular line at a short distance from the margin, and radiated in one from the centre to the circumference; in the other only to the intra-marginal circle, with sixteen lines, representing, as it were, so many teeth. We, on the contrary, can only see in very perfect specimens of C. *Palisoti*, a uniform, whitish, spongy, horizontal membrane. Schwaegrichen, again, in his C. *Moluccense*, both figures and describes this membrane as conical, green, and filling the interior of the operculum. Sprengel describes that of C. *Berterii* simply as covering the mouth of the capsule.

In the genus *Syrrhopodon*, the seta is more elongated, mostly exceeding the length of the leaves. The calyptra is smooth, not twisted, opening longitudinally on one side, and deciduous. This part, however, we must confess, is variable in length, and, in some instances, approaches too near to the true dimidiate calyptra. The operculum has a subulate point, as long as the capsule, (except in the doubtful S. *Taylori*.) The peristome is variable: in S. *Gardneri*, which must be considered as the type of the genus, the peristome is unquestionably horizontal, formed of sixteen transversely striated red teeth, united at the base into a thickish spongy yellow membrane inserted just below the mouth of the capsule. This materially differs from the figure of the same plant given by Schwaegrichen, who has further represented a longitudinal line down the centre of each tooth, which we have not been able to discover. In Syrrhopodon *ciliatus*, the teeth are similar to those of the genus Weissia, separated to the base, erect, or only slightly inclined inwards, and marked with a distinct longitudinal line, which Schwaegrichen has entirely omitted. S. *fasciculatus* also has teeth similar to these, but so opaque we have not been able to discover a longitudinal line, if it exists. In imperfect specimens of S. *Hobsoni*, we find a horizontal membranous annulus, as if when in perfection it might have had the teeth of S. *Gardneri*, or it may have had a horizontal membrane, as in *Calymperes.*

It will now be seen how very nearly allied are some species of Syrrhopodon to the genus Weissia. And, in truth, we should never consent to the separation of especially S. *ciliatus* and *rufescens*, were it not that they differ so widely in habit from the acknowledged species of Weissia, and are so closely allied to S. *Gardneri*. Here, therefore, we have adopted the golden rule of Linnæus, which is equally applicable to the mosses, as to the higher orders of plants: Genus dabit characterem, non character genus. Others may be perhaps more fortunate than ourselves in discovering good generic marks of distinction.

Calymperes. *

Gen. Char.—*Seta* terminalis. *Peristomium* nullum, os membrana spongiosa horizontali tectum. Calyptra sulcata, persistens, infra capsulam constricta, apice circa operculum (maturitate solutum) rimis longitudinalibus hians.

1. C. *Palisoti*, foliis lineari-lingulatis, obtusis, submarginatis, siccitate crispatulis; seta vix exserta.

Calymperes Palisoti, Schwaegr. Suppl. I. 2. p. 334. t. 98, (in tab. sub. nom. *C. lonchophylli.*)

* "Etymologia a Græca voce *velamen* et *transadigo* quoniam calyptra qua fructus tegitur rimis apice aperitur."—Sw.

HAB. St Thomas, in the West Indies, and French Guiana, *Richard.* Abundantly upon the bark of trees in the island of St Vincent, and also in the island of Grenada, upon the trunk of *Bignonia leucoxylon, Rev. L. Guilding.* Barbadoes and Dutch Guiana, *C. Parker, Esq.* Oware on the coast of Africa, *Pal. de Beauvois.* Sincapore, *Dr Wallich,* but without fruit.

This species is remarkable for the obtuseness of the leaves, and for their being quite entire at the margin. They are likewise shorter and broader than in any species with which we are acquainted, but not so much so as those of *C. Berterii* are represented to be.

Many of the upper leaves are lengthened out, and spathulated at their extremity, bearing on their upper surface a cluster of conferva-like bodies. The species varies in length, many of our fructified specimens from St Vincent's being only half an inch long, while those we have from Barbadoes and from Sincapore are from an inch to an inch and a half in length.

Upon the capsules of our most perfect specimens, we have found a membrane stretching across the mouth, but have never been able to detect the radiated appearance represented by Schwaegrichen.

2. C. *Moluccense,* " caule subsimplici, compacto; ramulis vix conspicuis, foliis densissimis, capsula brevioribus, lanceolatis, obtusis." *Schwaegr.*

Calymperes Moluccense, Schwaegr. Suppl. II. 2. p. 99. t. 127.

HAB. In Rauwack, one of the Molucca islands, *Gaudichaud.*

This species, which we do not possess, and of which not a very excellent figure is given by Schwaegrichen, in his last supplement, resembles *C. Palisoti,* of which Schwaegrichen thinks it might be made a variety.

3. C. *Berterii,* " foliis ovato-oblongis, apice dentatis, seta elongata." *Spreng.*

C. Berterii, Spreng. in Neue Entdeck, v. 3, p. 1.

HAB. upon the ground in Hispaniola, *Bertero.*

This appears, from the form of the leaves, to be most nearly allied to *C. Palisoti,* except that here they are described as ovate-oblong, and toothed at the extremity.

4. C. *Afzelii,* caule elongato, foliis linearibus marginatis, apicem versus serrulatis, siccitate tortilibus marginibusque involutis; seta foliis subduplo longioribus.

Calymperes Afzelii, Spreng. in Jahrb. der Gewaechsk. p. 3. t. 1. 1818.

HAB. Sierra Leone, *Swartz.* We have received specimens from *Mr Dickson* gathered on the west coast of Africa.

Although Steudel in the second volume of his Nomenclator Botanicus, seems to consider this as the same plant as *C. Palisoti* of Schwaegrichen, (in the text, but not in the plate,) it appears to us to be sufficiently distinct, judging as we do, both from the figure in Sprengel's work, above quoted, and from a specimen which we received from Mr Dickson; which specimen perfectly accords with that figure.

C. Afzelii too, is the individual upon which the genus was established by the late excellent Dr Swartz. The stems are almost twice or thrice the length of *C. Palisoti;* the leaves are longer and narrower, and towards the extremity constantly serrulate. In those leaves which have the conferva-like processes, they are produced in globular heads at the tips of the excurrent nerve; whereas in *C. Palisoti* the leaf itself is lengthened out into a spathulate extremity upon the upper surface of which these bodies are produced.

5. C. *Guildingii*, caule elongato, foliis lineari-setaceis, subrigidis, siccitate subtortis, marginatis, omnino integerrimis; seta vix exserta.

Hab. frequent upon the bark of trees in shady places, on Mount St Andrew, Island of St Vincent, *Rev. L. Guilding.*

The stems are from an inch and a half to two inches and a half in length; the leaves very slender, somewhat rigid, not much crisped when dry, gradually acuminated upwards. Seta scarcely longer than the leaves. Calyptra of a browner colour than usual. Neither in this species, nor in *C. lonchophyllum* have we observed the conferva-like bodies.

6. C. *lonchophyllum*, foliis longissime angustissimeque linearibus, marginatis, apicem versus serratis, siccitate tortuosis.

Calymperes lonchophyllum, Schwaegr. Suppl. I. 2. p. 333. t. 98. (In tab. sub. nom. *C. Palisoti.*)

Hab. Upon trees in Guiana, *Richard.* Island of St Vincent, *Rev. L. Guilding*, and *C. Parker, Esq.* This has by far the longest leaves of any in the genus. They are tender and pellucid, having a singularly thickened margin, serrated only towards the upper extremity. The seta scarcely rises above the summits of the leaves.

Syrrhopodon.

Gen. Char.—Seta terminalis. Peristomium e dentibus sedecim horizontalibus, basi membrana unitis, vel sedecim liberis, erectis, inclusisve. Calyptra lævis, magna, capsulam involvens, demum lateraliter fissa, decidua. *

1. S. *Gardneri*, foliis linearibus, obtusis, submarginatis,

* Imperfect as this character must appear, we fear it would scarcely be improved by altering it to that of Schwaegrichen. "Peristomium simplex, breve: dentibus sedecim intus adnatis, conniventibus.

Flores masculi foliigeni, raro axillares. Calyptra lævis, subcampanulata, latere fissa, quibusdam longa." *Schwaegr.*

serratis, siccitate crispatis; seta breviuscula; calyptra lævissima.

Syrrhopodon Gardneri, Schwaegr. Suppl. II. 2. p. 110. t. 121.
Calymperes Gardneri, Hook. Musc. Exot. t. 146.
HAB. Upon trees in Nepal. *Honourable D. Gardner,* communicated by *Dr Wallich.*

We have little to observe with regard to this highly beautiful species, more than what has been said in the Musci Exotici above quoted; except, that we find the teeth in some instances seem less distinctly united by a membrane, and that, in the dry state, they become nearly erect, especially in old capsules.

Schwaegrichen's figure by no means does justice to this plant, nor do we understand his meaning when he says, "Calymperis *Gardneri* Hookeriana icon et descriptio difficultatem mihi exhibet. Folia enim sistit serrata, marginata et peristomium breve, ut in Syrrhopodonte Gardneri, caulem vero et calyptram Syrrhopodontis *Taylori.* Forte ambas habuit species commixtas." We have again verified the correctness of that figure. The stems vary from half an inch to an inch, and the leaves are more or less involute, and more or less distinctly serrated. The leaf at Fig. 3, of Schwaegrichen's representation, and the calyptra at Fig. 11, do not seem at all to belong to the true Syrrhopodon *Gardneri.* Among numerous specimens, we have never been able to find the conferva-like bodies which Schwaegrichen has drawn at Figs. 6 and 7 of his plate.

2. S. *albovaginatus,* "caule subramoso, foliis lingulatis secundis, rigidulis; basi alba vaginantibus; calyptra breviuscula." *Schwaegr.*

Syrrhopodon albovaginatus, Schwaegr. Suppl. II. 2. p. 112. t. 131.
HAB. In Rauwack, one of the Molucca islands, *Gaudichaud.*

The calyptra of this being described as shorter than the capsule, and cleft and spreading at the base, it does not consequently correspond with our generic character, as taken from the calyptra. Should this be the case, we scarcely know upon what characters, as taken from the fructification, the genus can rest. Here is a dimidiate calyptra like that of a *Weissia,* and we have shown that, in one instance at least, the peristome is erect, like that of a Weissia: yet we can truly say, that all the species we have included in the present genus, are so closely allied in habit, that they cannot be separated without doing violence to nature.

3. S. *Hobsoni,* foliis linearibus acutiusculis, marginatis, serratis, planiusculis, erecto-patentibus, siccitate crispatulis; seta foliis duplo longior, calyptra lævis.

Calymperes Hobsoni, Grev. in Annals of Lyc. New York, v. 1.
HAB. Guiana; from whence it was received and communicated to us by Mr Hobson of Manchester.

This differs from *S. rigidus* in having the leaves shorter, broader, and crisped, when dry: in this species also, the reticulated portion at the base is of a white instead of a reddish colour. The seta is shorter than in *S. rigidus*. The capsule ovate-oblong and shining. We have not seen the peristome, but have observed the remains of a membranaceous circle similar to the membrane which occurs at the base of the teeth in *S. Gardneri*, but which may be the remains of that kind of membrane which is characteristic of the genus Calymperes. The lid is subulate, and equal in length to the capsule.

4. S. *involutus*, "caule subramoso, fastigiato, foliis erectis, linearibus, margine involutis pellucidis, serrulatis, tortilibus, capsula ovata, calyptra mediocri." *Schwaegr.*

Syrrhopodon involutus, Schwaegr. Suppl. II. 2. p. 117. t. 132.

HAB. In Rauwack, one of the Molucca islands, *Gaudichaud.*

5. S. *Taylori*, "caule subsimplici, foliis linearibus, subdentatis, subsecundis, tortilibus, capsula cylindrica, calyptra magna, basi contracta." *Schwaegr.*

Syrrhopodon Taylori, Schwaegr. Suppl. II. 2. p. 115. t. 132.

HAB. In Nepal, on the trunks of decaying trees.

We are quite unable to understand what the author intends by this plant, which was communicated to him by our valued friend Dr Taylor, and of which he says, that the stem and calyptra resemble the figures of these parts as represented in the plate of Dr Hooker's Calymperes *Gardneri*, in Musci Exotici. There may indeed be but a slight difference in the appearance of the stems, but his calyptra, Fig. 13. we must assert, is totally unlike any thing figured by Dr Hooker in his Calymperes *Gardneri.* Our own collection of Nepal mosses is so similar to that of Dr Taylor, that there cannot be a question that we must also possess this plant, and, most assuredly, as far as regards the figures of the entire plants in Schwaegrichen's plate (Figs. 1 and 2,) of the leaves, (Figs. 3, 3,) and the base * and extremity of the leaves (Figs. 4 and 5,) of Syrrhopodon *Taylori*, they correspond in every particular with a Nepalese Dicranum which we possess. But then again, the figures of the teeth and entire peristome, (Figs. 11 and 12,) if correctly drawn, can never belong to our plant. We hope to be able to speak of this subject with more certainty on another occasion.

6. S *fasciculatus*, caule elongato, fastigiato-ramoso, foliis lato-lanceolatis, undulatis, lato-marginatis, serrulatis, siccitate crispis; seta longa.

HAB. Island of Ternate, *Mr Dickson.* Sincapore, *Dr Wallich.*

By far the longest and most robust species we know of the genus, the stems measuring full three inches in length. The leaves are remarkable

* We may here observe, that, both according to Schwaegrichen's figure and description of this base, it altogether wants that peculiar reticulated and pellucid appearance which forms so striking a character in the other species of the genus.

for their broad semi-pellucid and waved margin. The capsule is cylindrical, the calyptra long, obscurely striated, enveloping the whole of the capsule, and even the upper part of its seta with its base. The teeth are long linear-subulate, erect, red, distinctly jointed like those of many species of *Weissia.*

7. S. *incompletus,* "caule ramoso-fastigiato, foliis lineari-lanceolatis, serratis, marginatis, peristomio membrana brevissima indivisa." *Schwaegr.*

Syrrhopodon incompletus, Schwaegr. Suppl II. 2. p. 119.
Hab. In the Island of Cuba, Dr Poeppig.

8. S. *rigidus,* foliis lineari-setaceis, marginatis, serratis, rigidis, siccitate strictis, margine involutis; seta elongata; calyptra lævissima.

Hab. Upon trees on Mount St Andrew, at an elevation of 1012 feet above the level of the sea, in the Island of St Vincent. *Rev. L. Guilding.*

Of this fine moss we have seen no perfect peristome, but, on account of the smooth calyptra, we have ranked it with the present genus. The stems are from one to two inches long, branched. The leaves long, slender, peculiarly rigid and straight when dry; many of them attenuated upwards, but spreading again somewhat at the extreme point, and these producing conferva-like bodies. The base of the leaves, which is white in most species, is here of a red colour. We have received it from no country but St Vincents.

9. S. *ciliatus,* foliis lingulatis planis, longissime ciliatis.

Syrrhopodon ciliatus, Schwaegr. Suppl. II. 2. p. 114. t. 132.
Weissia ciliata, Hook. Musc. Exot. t. 171.
Hab. In the Island of Ternate, whence it was received by *Mr Dickson.*

We have followed Professor Schwaegrichen, in including this plant in the genus Syrrhopodon. It possesses we think, sufficiently of the habit and most evidently the pellucid base of the leaves belonging to the genus. The teeth have, however, a line down the middle, which we cannot find to exist in any other species; and we must add, that an old fallen calyptra, represented in Musci Exotici, (Fig. 7,) had the appearance of being truly dimidiate, although before the falling of the calyptra it entirely envelopes the capsule, and embraces the upper part of the fruit-stalk with its base.

10. S. *spiculosus,* foliis anguste linearibus, dorso marginibusque incrassatis spiculoso-denticulatis, siccitate vix crispatulis.

Hab. Sincapore, *Dr Wallich.*

We only possess this without fructification, but, in habit and in the texture of its leaves, it quite accords with the other species of the genus, from all of which it differs in the numerous pellucid denticulated or spiculated unequal processes, which are found not only upon the margin of the leaf, but also on the nerve, especially on the back. These leaves approach in size and somewhat in general appearance to *S. rufescens.*

11. S. *rufescens,* sericeis; foliis lineari-subulatis, marginatis, integerrimis, laxissime reticulatis, pellucidis, ad apicem solummodo opacis, siccitate vix crispatis; seta gracillima.

Hab. Sincapore, *Dr Wallich.*

A very singular species of a most soft and silky texture, growing in dense tufts, apparently upon the trunks of decaying trees. The colour is a very pale reddish green. The stems are from one to two inches long, thickly clothed with leaves, which are remarkable in being formed almost entirely of those large pellucid and even transparent cellules which exist only at the base of the leaves in other species. The opaque portion of the leaf is almost wholly confined to the very extremity, or running down for at most one third of the leaf, gradually quitting the nerve and disappearing at the margin. The seta is about half an inch long, extremely slender, yellowish. The capsule shortly oblong, at first yellowish, afterwards red-brown. The lid has a subulate point equal in length to, or longer than the capsule. Calyptra almost white, enveloping the capsule, but we have not seen it in a mature state.

Art. VI.—*Some Account of the Climate, &c. of the North of France, collected partly from Observation, partly from a free Communication with the Inhabitants of various ranks.* Written during a Residence in that Country, for the use of a Friend in Britain. By H. H. Blackadder, Esq. Surgeon.

The northern part of France, distinguished more exclusively by the name of French Flanders, comprehends about 60 square leagues, or 180 square miles,—extending N. E. to W., from Dunkirk to Calais, about nine leagues, and N. to S. E., from Gravelines to Cassel, about eight leagues. This tract of country forms one extensive level plain, which was, beyond all doubt, at some remote period occupied by the sea. The insulated hill on which Cassel stands, and which rises from five to six hundred feet above the level of the plain, was, at one time, bathed by the sea, from which it is now distant about six leagues,—and there are monuments which seem to indicate that vessels could, in former times, reach even to St Omer, which is eight leagues from the present shore of the English Channel.

The period at which the land began thus to encroach upon the sea, is lost in the lapse of ages,—all that we can discover from history is, that this encroachment had made considerable progress anterior to the age of Julius Cæsar. No fossil shells are found in the soil, but trees, similar to those found in Holland, have been dug out sixteen feet below the surface. The cause of this formation of land, and consequent repulsion of the sea, seems to be the successive accumulation of alluvial matter brought down by the rivers,—including, perhaps, the Rhine, the Meuse, and the Scheld, along with the action of the North Sea on the coast of Holland. Gravelines, built at the mouth of a river, was, at the beginning of the last century, bathed by the sea, and is now distant from it about three miles.

The surface of the country is but very little elevated above the level of the sea at low water; and when the sea is full, the land is so much below it, that were it not for the artificial embankments along the shore, and if the sluices were not regularly shut at Calais, Gravelines, Dunkirk and Fort Nieulay, the whole country would be inundated. Hence it is that the rivers and canals do not flow during high water, a phenomenon which always attracts the attention of strangers, more especially when unacquainted with the cause.

Strictly speaking, there is but one river that passes through this country, which is named the Aa, and which has its origin near Reuti in Artois, about six leagues to the S. W. of St Omer. Passing through the last mentioned town, its direction is towards Gravelines, and about a league beyond that place, it reaches the sea,—its whole course not being less than sixty or seventy miles. At different parts, as in the vicinity of St Omer, the bed of the river has been raised many feet above the surrounding fields, so that it is impossible to divine what its original distribution may have been. At Waten it gives off a branch called the Colme, which runs N., passes Bergue, and enters the sea at Dunkirk. A second branch goes toward Bourbourg, which it surrounds and crosses, and, with the Colme, reaches the sea at Dunkirk. About two centuries ago these branches were enlarged, (being then only small streams,) so as to form two canals for the purpose of navigation,—and serving also more effectually to carry off the water from the innummerable small canals, (termed *water-gangs* in the language of the country,) and from the ditches which communicate with them.

To a stranger, nothing is more novel and characteristic, than the manner in which this tract of country is divided and intersected by the small canals and ditches; the meadows, corn-fields, plantations, and gardens of each proprietor, being divided by these watergangs into small and more or less regular squares, each of which is completely insulated, so as to admit of boats readily passing between them. The whole may be compared to the streets and alleys of a large city, where water and boats come in the place of pavement and carriages. The execution of these works has been of incalculable advantage to the country,—immense tracts of rich soil, otherwise worse than useless, has been rendered highly productive; land-carriage is almost unknown; and last, but not least, the endemic diseases, which were formerly the scourge of the inhabitants, have now nearly disappeared.

The river Aa runs slowly on a slimy channel, and which is fit for forming peat.* Hence the water has a peculiar brackish taste, which is very disagreeable. Over the whole of this

* In many places peats are dug out of the watergangs, &c. several feet under the surface of the water. For this purpose, the person goes into a large half-decked boat, and is provided with a very long-handled spade, the rest for the foot being four or five feet from the cutting extremity. With this instrument he digs up the peat, which is easily raised to the surface of the water, but then requires a considerable exertion to place it on the deck. Afterwards the peats are transferred to the land, to be thoroughly dried, and where, for a considerable time, they emit a most offensive odour. When dry they are very different from the peat to be met with in Scotland. They are very hard, black, and ponderous,—not easily kindled, and in burning, give out a most disagreeable and almost unsupportable odour. This odour is well known to strangers who may have walked round the old ramparts of Calais, though they may have remained ignorant of its true origin. The cause is doubtless to be traced to the great quantity of decayed animal matter that enters into the composition of this species of peat. As the canals afford a ready and cheap mode of conveyance, and as both wood and pit-coal are high priced, these peats are much used by the lower ranks, both in the towns and villages, as well as in the country.

country, indeed, the water is sufficiently bad; but that of the Colme and the canals is even worse than that of the Aa. In general it has a muddy brown colour, and deposits a greenish yellow slime in great abundance. Many of the inhabitants are nevertheless under the necessity of using water from the watergangs and ditches however unwholesome. It is very dangerous to make use of these waters as drink, but their offensive taste commonly prevents their use in that form, the drink of the inhabitants being always a kind of tea or beer. Much use is made of water from draw-wells, though the quality of this is also very bad, being strongly impregnated with saline and other substances. It is more discoloured, and of greater specific gravity, than the water of the rivers and canals, and is unfit for culinary purposes, animal and vegetable substances when concocted in it, acquiring a horny consistence. The principal use to which the water of draw-wells is applied is the washing of the houses, a practice to which the inhabitants are, to appearance, excessively addicted. But, perhaps, if their houses were not thus kept proportionably damp, the inmates would be less able to resist the excessive dampness of the external air, to which they are liable to be exposed in all variety of circumstances.

It is much to be regretted that cisterns, from which so much advantage has long been derived in Holland, are here almost unknown.

The soil seems to be of the same description over the whole of this tract of country. It is very moist, and is composed of a mixture of clay, siliceous earth, peat-moss, and a considerable proportion of animal and vegetable substances in a state of decomposition. So much do the latter substances abound, that, when it is examined in the hand, it has that over-rich, or rather greasy appearance of the soil that is to be found in the vicinity of old dunghills. Hence it is, that ashes are in such great repute as a manure, and are sold at a high price. The cultivated fields are highly productive, and the pastures and meadows, especially those on the banks of the canals, around the villages and large farm-houses, are rich even to luxuriance. There are also considerable plantations, the vegetation of which is strikingly rapid, many trees acquiring large dimensions in the course of a few years. The progress made after engrafting is also remarkable; in some instances, indeed, that I had an opportunity of observing, it exceeded any thing I could have imagined in so northerly a climate. It may be observed, that the trees incline to the east, and that on their sides next to the sea there are comparatively few branches. The agricultural productions are, in general, of the best quality; wheat and rye in great abundance, a great quantity of these being sent to the interior. The diseases which affect the corn, are said to be le charbon, la nielle, la rouille, le blé moucheté; the ergot of the rye is of very rare occurrence. It is not uncommon, excepting in the summer months, to see the meadows, pastures, and, in some places, even the corn-fields, covered with water. Hence it happens, that when the autumn is particularly rainy, the sown fields are ruined, and it becomes necessary to re-sow them in the month of March.

Potatoes are in general cultivation, though not so much used as in Britain, excepting on occasions of scarcity. There are some varieties to be met with in the markets. The first is characterized by paleness of the skin and whiteness of the flesh, resembling, in these respects, the variety named *white blooms* in some parts of Scotland, but in other respects it is much superior. It is, upon the whole, rather tasteless, and is most apt to be injured by frost. The skin of the second has a fine claret colour, and the flesh, sufficiently dry, is more compact than that of most other varieties. It seldom exceeds the size of an egg, has an agreeable flavour, and is much used in soup along with other vegetables. The third is an excellent and beautiful variety of the kidney species. The skin is of a bright claret colour, which extends into the flesh. It grows from two to five or six inches in length, and of uniform thickness, which is seldom so much as an inch. This potatoe is very dry, has a very agreeable flavour, and though, with other varieties of the kidney species, it is not very productive, it is surprising that it is not met with in our gardens. It is usually the first that appears in the market, and must be considered an early variety. The fourth is that named the black potatoe, though its flesh be the whitest of all. This, as elsewhere, is cultivated for spring use, being universally recognized as withstanding the frost, and as being later in vegetating than any other variety. I never observed any appearance of disease in the potatoes raised in this country.

The horticultural productions are very abundant, and, upon the whole, rather luxuriant, approaching to that which is termed *rank*—the quantity and size being much more characteristic than the richness of the flavour. Still, however, the cherries, currants, apples, pears, peaches, plums, and other fruits, form a great part of the wealth of the inhabitants. Gooseberries are not much cultivated, and are chiefly used in an unripe state. Much use is made of roasted apples and pears, more especially in the time of Lent. The coarsest apples and pears, which are otherwise only fit for making cider and perry, become pulpy, and of a fine subacid taste, by simple roasting in the oven. In this state they are preserved close packed in jars for almost any length of time, and without the addition of sugar. Spinage and sorrel are also preserved in jars, so as to furnish a constant supply at a trifling expence during winter and spring,—a little salt and half boiling of the leaves being all that is necessary. For the purpose of promoting and protecting early vegetation, I find much advantage is derived from the use of easily moveable hurdles, made by placing a thin layer of straw or reeds longitudinally between thin wicker-work, and which can be constructed at almost no expence. These are placed in various directions around the beds, and shifted according to circumstances. There is one method of having early salad, which is very simple. They sow the lettuce seed very thick, and when the young plants are about an inch in height, they are thinned out. These young plants make a most delicate salad, and the taste can be rendered more piquant by the addition of a few plants of the *Lactuca virosa*, or by a little endive, or blanched dandelion.

On the sea-shore is found the *Critim. marit. maj.*, which, when confected in vinegar, is an article of commerce.

The prevailing quality of the air is humidity, the face of the sky being commonly concealed by a sombre greyness of the atmosphere, at no great height above the earth. The barometer is variable, seldom remaining of the same height for two days in succession. The extremes are said to be 26, 3[1]—29. It has been remarked, that the changes are more frequent and rapid than in the interior, and that the variations are most remarkable about the equinoxes. The mean temperature is about 5° above that of Paris. The cold season is of long duration, but is commonly not severe. Judging from the animal sensations, however, this climate is colder than that of Paris, which must arise from the great dampness of the air, caused by the vicinity of the sea, the number of canals and ditches, the lowness and consequent moistness of the soil, and the great luxuriance of vegetation.

When the south or west winds continue for some time in any season, abundant rain is the consequence. The animal system then feels relaxed and oppressed; the circulation is slow, and the secretions interrupted. Persons feel themselves heavy, and incapacitated for either mental or corporeal exertion, and many, but particularly strangers, acquire a dingy yellow colour of the skin, obviously connected with some irritation of the biliary organs. This state of the atmosphere is quickly changed by a north or north-east wind coming from the sea. These winds are dry and invigorating, but not unfrequently accompanied by a dense fog. The winds are very variable, often changing in the course of the same day. The most frequent are the south-west and the north, the most rare the east. The south-west and north winds are always the strongest, and the south wind is very moist. The south-west wind is common in autumn, the north wind in spring.

The number of serene days is about 40, and occur only during a very hot or very cold state of the air. Most commonly the sky is covered with a universal greyness, through which the sun only occasionally makes his appearance.

They count, on an average, about twelve thunder storms in the course of the year; and not unusually a tremendous one all at once ushers in the winter. In a storm of this kind which I witnessed, a wind-mill, at a short distance, was struck by the electric fluid, and immediately after the flash, there suddenly fell a shower of angular pieces of ice, by which some individuals had their faces slightly lacerated.

Heavy fogs are very frequent, often appearing at mid-day, and, extending from the sea, envelope all Flanders, but seldom advance interiorly beyond the province of Artois. These fogs occur occasionally at all seasons, but are most common in spring and autumn.

The quantity of rain is only somewhat greater than at Paris. There, the mean is 24 inches 2 lines, and there are 119 days with rain; here, the mean is 24.4, and the number of days with rain 159. May, July, August, and November are the months in which most rain is observed to fall.

In spring, the north wind is almost constant, especially from the beginning of March to the middle of April. This wind is strong, dry, cold, and sharp. It freezes in the night, and the barometer always keeps high, but the sky is uniformly obscured. Hoar-frosts are apt to occur until May; and it is not till the middle of that month that the air begins to feel sensibly and steadily warmer.

In summer, the weather is very variable, there being continual changes from heat to cold, and *vice versa*, not only from day to day, but in the course of the same day. A fog coming in a direction from the sea, extends all over the country, and then the thermometer sinks. In July and August the heat is considerable, sometimes so high as 92°. On such occasions there is always a perfect calm, but this state of the air never lasts long; clouds soon begin to make their appearance, and the thermometer falls to about 65°. The usual summer heat is from 65° to 80°. At this season, there is always a heavy dew during the night, accompanied by a very cold and dense fog, the thermometer falling from 8° to 14° lower than during the day. Hence the origin of various diseases to which persons are liable when exposed to the open air during the night. No where is the sudden sensation of cold at sunset more remarkable.

In autumn, the weather is most steady; after the equinox, the thermometer sinks to 50°, and vacillates but little for a considerable length of time. Frosts do not usually commence till December; but during the night and part of the morning, there is always a dense cold fog, which moistens all the surface of the ground, and of solid bodies resting on it.

In winter, the temperature rarely falls so low as 20°, but it has once or twice been observed nearly at 0°. In the winter of 1819, I observed it so low as 10° a considerable time after sunrise. There had previously been a great fall of snow without wind, and there was now a gentle but steady northerly breeze. The whole sky was free of clouds, had a deep blue colour, and a peculiar glistening appearance, produced by minute icy spiculæ with which it was heavily charged, and which, impinging on the face, in walking against the wind, were sufficient to blister it. These spiculæ had no effect on the appearance of the sun, if it was not to render the light more intensely white and glistening.

A humid atmosphere, habitual heavy fogs, a moderate temperature, a low and moist soil, the free use of watery drinks, such as beer, the daily use of a great quantity of milk and butter, an abundant nourishment of wheat-bread, butcher's meat, tea, and fresh water fish, and garden vegetables of all kinds, the ease of all ranks of society, and labour to occupy all hands, all these things united must greatly influence the physical and intellectual constitution of the inhabitants. In general, men, animals, and vegetables, are large. A moist climate, and a fertile soil, are favourable to the developement of all the parts of animate beings. Hence we remark large bones, large muscles, with a profusion of cellular substance. When King Henry the Eight described a certain princess as "a great Flanders mare," the comparison was rude, but sufficiently intelligible. In general, the complexion of the inhabitants is fair, the eyes blue, and the hair chesnut. They support labour well, and often arrive to an advanced age. In character they are a mixture of the Frenchman and Hollander, and which, when closely analyzed, is found to be rather an odd compound.

Beer of various qualities is much used, and spirituous liquors (particularly gin, which sells at the rate of about sixpence the bottle) are consumed in great quantity. Drunkenness, however, even in the towns, is rare, very rare, compared with what may be observed in Britain, and habitual drinkers still more so. But it is an almost universal practice to take a glass of raw spirits on first rising in the morning, a practice common, and said to have been found beneficial, in most damp countries on the continent of Europe. The use of spirits mixed with water, in the form of grog or punch, is all but unknown, such a mixture being considered highly pernicious to the stomach, and it would be well, perhaps, if all their opinions were equally well-founded. Tea, with or without milk, but always without sugar, a weak beer, and "bouillie," are the common drinks. As formerly mentioned, the water cannot be used in its crude state with impunity. The bouillie is made from a decoction of bran, to which old leaven has been added; fermentation ensues, and the product is a refreshing subacid liquor, which removes thirst very well.

Milk, butter, cheese, and bread, constitute the principal nourishment of the country people. Even the common people never eat bread without butter, (excepting in Lent) and he who is reduced to do so, is considered at the depth of misery. Hence the proverbial expression, "*Manger le pain sec.*"

There is a mess called sour-milk much used by the country people, and which is made as follows: A considerable quantity of milk is put into a deep wooden vessel, and a certain quantity of salt is added to it. It is then left until the whey separate from the curd, when the former is poured off and given to the pigs, and the latter is stirred round, and more milk added to it. This operation is repeated until the desired quantity of curd is obtained, and which is found to have acquired a very acid taste. In this state it is kept for winter use, and is used in mixing a quantity of it with water and flour, which is boiled, and then bread is added to it. This mess is used for breakfast and supper, which always conclude with bread and butter.

There is another mess of curd often used in the summer months, and much relished for supper. For making it, two vessels are provided, the one of which goes within the other, the innermost being perforated with numerous holes for the escape of the whey. The milk is coagulated by means of runnet made by infusing a small piece of the dried stomach of a young hare in white wine. To the curd, well freed of the whey, is added salt and pepper, but many consider eschalots an indispensable ingredient.

In the country, the houses are built of mud or brick, and roofed with thatch. In the towns, they are built of brick, and roofed with flat tiles, which at least have a better appearance than those used in Scotland, but they require the roof to be covered with deal, the same as in the case of slates. Nothing is more agreeable than the internal appearance of these houses; every where there is exhibited, as in Holland, an exact attention to cleanliness; but the means employed for attaining this is far from being agreeable to strangers. Several large tubs of cold water are emptied in each apartment, and when every part has been well scrubbed with a birchen broom, the remaining water is swept out by the door, and in this state it is left to dry, which, in this climate, is a very slow process. This deluging operation is of perpetual recurrence, and hence those who are not completely accustomed to this moist manner of life, are continually exposed to attacks of rheumatism, toothache, &c.

Occasional inundations from heavy falls of rain are liable to take place, and when the water is nearly evaporated, there are elicited vapours of a very noxious quality. Notwithstanding the numerous canals, &c. there still exist some marshes, and in hot weather their effluvia are very pernicious. Some of these marshes are formed by digging peat, and clay to make bricks; others have existed from time immemorial. At each farm-house there is a pond of no small extent, to receive the fluid part of the dunghills, &c. These are of a greenish or reddish brown colour, and in autumn give out a most abominable odour. Strange as it may appear, however, almost every farmer sends his cattle to drink out of these ponds, and even the animals themselves seem to prefer this fluid (for water it cannot be called) to the water of the canals and ditches. It must be admitted, that there are no direct proofs of the use of this fluid as drink being prejudicial, and one thing is certain, that these ponds must be almost, if not altogether free of insects and animalcula, which literally swarm everywhere else, whether air, earth, or water.

The immense quantity of small animals of one kind and another, that are to be seen in and about the canals, ditches, and fields, enables us to account for no small portion of the decayed animal matter that is so abundantly mixed with the soil. Frogs are very abundant, but though they are regularly brought to the market in Brussels, I never saw or could hear of their being used as food in this country. At some places leeches are bred in the marshes, and, during the war, a great deal of money was made by the sale of them. A common mode of collecting these animals deserves to be noticed, as it explains a fact which has often caused suspicion and blame to attach to upright leech-dealers in the interior, and in Scotland not less than elsewhere. A number of persons, commonly young women, are employed to wade in the water with their feet and legs uncovered, and when they come out after a short stay, these parts of their body are found covered with leeches, which are then removed and secured in vessels provided for their reception. This operation they repeat as often as may be requisite for obtaining the desired quantity, and, far from suffering any injury from the loss of blood, these Flemish water nymphs informed me that their health was always improved by it at the time; that their complexions became clearer, and that afterwards they got more into a state of *en bon point.* It must be obvious, that leeches, caught in this manner, must acquire a small quantity of blood, but, when afterwards they are sold for use, and when some of this blood, still remaining, happens to be ejected on the application of the animal, it is forthwith taken for granted that the dealer has acted dishonestly in selling used leeches for fresh ones.

Hares, partridges, and snipes, are in great plenty. Quails were once common, but are now become exceedingly rare. In the river are trout, which I have seen from two to three pounds weight, but their flesh is not delicate, approaching somewhat to that of the pike, which is, no doubt, owing to the gross slimy quality of the water. Artificial flies for the purpose of fishing are here unknown;—an excellent proof this that necessity is the mother of invention, for here artificial flies are unnecessary. At almost every step along the river is to be found the fly most proper for ensnaring the trout, and as it is neither small nor delicate, and as the river moves slowly, it is not soon torn from the hook. The fly is often seen to rest on and float down the stream when seized by the fish, and the fisher has only to imitate this dull operation. In the canals and ditches are pike, and an abundance of perch and other small fish. I have been informed that, about twenty years ago, a pike was killed of the enormous weight of 32 pounds; no one seemed to doubt the fact, but I have met with no one who had himself seen such a fish.

The canals and ditches, from time to time, become more or less choked, from the continual deposition of alluvial matter, and, when cleared out by the workmen, the matter ejected yields a most unsupportable odour. As the riches of the country depend on the keeping of these canals in repair, they are cleaned out at least once every two years, besides other occasional repairs; and there is a class of workmen who nearly confine themselves to this particular occupation, which is none of the most healthy. It is in autumn, winter, and spring, that these operations are carried forward, and the matter ejected is spread over the fields as manure. Nothing of the kind can be more offensive to the smell, and few more pernicious to health, than the vapour which continues for a long time to exhale from it. Still, if we suppose a foreign army to take possession of this country, it would be of the first importance to protect the inhabitants, and give every possible encouragement to the regular execution of these works, otherwise they would soon and dearly pay for their imprudent conduct.

On the sea-shore the inhabitants are, in general, more healthy than in the interior; but when the sea happens to break over the dikes, and the water afterwards comes to be evaporated, exhalations of an extremely pernicious quality are elicited, and which cause fevers of the very worst kind.

Intermittent fevers are not so frequent here as on the coast of France, in the vicinity of Rochfort. In this country the ditches are less frequently dry, the temperature being considerably lower, and the air in common much damper, the evaporation is much less active. The adult inhabitants are but little subject to the attacks of the endemic fevers, but children and strangers rarely escape. They are commonly attacked in autumn; at first it appears under the form of a tertian, afterwards it changes to a quartan, and, about January, some change to triple quartans, and in other instances to quotidians. From the middle of April to the middle of May, these fevers, when not interfered with by medical treatment, cease of themselves. The patients, however, are liable to a recurrence of the disorder in the course of the ensuing summer; and nothing is more common than to see children who have had the fever hanging about them for two or three years in succession, during which time they preserve their appetite, and even eat more than when in perfect health. It is not customary to treat this disease medically in the case of children, and accidents are rare. When a child has once had and got quit of the fever, he is thereby *acclimaté*, or rendered less liable to suffer from the climate in the after period of his life, if he be not much exposed to the exciting cause, such as digging the ditches. Of all others, the men who mow the hay suffer most; the ditchers are all natives, but the hay-makers come from a different and higher part of the country, being allured by the love of gain. As they always work at what is termed piece-work, their exertions are great, and as the hay falls, the dank surface of the soil, consisting of the half decomposed ejectment from the ditches, is exposed to the direct rays of the sun: Hence it happens that the noxious vapour arises most abundantly at a time when the men are exhausted with labour, and consequently when the system is least able to resist its influence. These labourers contract complicated tertians, and, in the language of the country, are said to have "*swallowed the frog in Flanders*." The patient experiences a feeling of great debility; the secretions seem almost suspended; the respiration is slow and oppressed; and the surface of the body assumes a leaden colour. The first care of those unfortunate persons is to quit the marshy country, and when they get home, and are properly attended to, they often recover, though some occasionally sink under various supervening complications.

Upon the whole, this is a very rich and populous country, and, in several respects, very highly interesting; but it is neither very agreeable nor very healthy, especially to strangers, as a place of residence. Catarrh and rheumatism are frequent in autumn and spring. In summer diarrhœa, verging to dysentery, is not unfrequent. In the towns, chronic ophthalmia is pretty common, and there appears to be an unusual proportion of halt and lame, and that apparently from their youth.

ART. VI.—*Account of the Specific Gravity of several Minerals.* By WILLIAM HAIDINGER, Esq. F. R. S. E. Communicated by the Author.—*(Continued from Vol. II. p. 74.)*

ORDER VI. SPAR.

1. *Diatomous Schiller-spar,* from the Baite in the Hartz, a species generally confounded with the hemi-prismatic Schiller-spar or Bronzite,	2.691
2. *Serpentine,* the rock in which the former is imbedded; it acts a little upon the magnetic needle,	2.684
3. *Hemi-prismatic Schiller-spar,* the grey variety of Diallage, from Monteferrato,	3.149
4. *Serpentine,* accompanying it, along with Labradorite; does not act upon the magnetic needle,	2.717
5. *Bronzite,* of a greenish-grey colour, from Pruck, in the district of Pinzgau in Salzburg,	3.201
6. *Bronzite,* grey, locality unknown,	3.216
7. *Bronzite,* a liver-brown variety, with a particularly distinct cleavage,	3.234
8. *Bronzite,* clove-brown, from Bayreuth,	3.252
9. *Hypersthene,* from the coast of Labrador,	3.390
10. *Rhaetizite,* a yellowish-grey variety, in long columnar compositions, little coherent,	3.545
11. *Rhaetizite,* milk-white,	3.560
12. *Kyanite,* deep ash-grey pebbles, from Ohlapian in Transylvania, where it is brought along with the nigrine,	3.630
13. *Kyanite,* smalt-blue crystalline masses, engaged in quartz, from the Saualpe in Carinthia,	3.635
14. *Kyanite,* of a deep-blue, transparent, cut and polished; a variety to which sometimes the name of sapphire is given,	3.676
19. *Prehnite,* a variety in irregularly formed crystals preserved in the collection at Gratz, and said to be from Elba,	2.925
20. *Spodumene,* from Sweden,	3.169
21. *Datolite,* a compound variety from Arendal; the individuals easily separated,	2.989
22. *Leucite,* a yellowish-grey transparent crystal, from Greenland,	2.483
23. *Sodalite,* crystals,	2.295
24. *Sodalite,* massive, cleavable,	2.293
25. *Mesotype,* from Auvergne,	2.249
26. *Natrolite,* the red variety from the Tyrol, the crystals,	2.168

27. *Natrolite,* the fibrous mass near the centres of the globular masses of this same variety, 2.152
28. *Chabasie,* the rhombohedron R, from Giants Causeway, 2.041
29. *Chabasie,* from the same locality, in crystals, presenting all the rhombohedrons known in the species, and several pyramids, 2.043
30. *Chabasie,* also from Giant's Causeway, in compound groups, apparently traversed by a great number of fissures, 2.005

The specific gravity of the crystals from Bohemia has been found = 2.100 by Professor Mohs. Chabasie forms a curious instance of the dangers of authority in science. The numbers 2.1176, given by La Metherie* and Fourcroy,† differ but little from those obtained by Mr Mohs and myself. But we find in the first edition of Haüy's Mineralogy,‡ the numbers 2.7176 evidently agreeing with those of La Metherie and Fourcroy, with the difference only that the second decimal is changed. In the works subsequent to this period, the authority of Haüy has been preferred to the former correct determination, and 2.7, sometimes along with the rest of the decimals, are given by Lucas,[a] Brongniart,[b] Thomson,[c] Karsten,[d] Steffens,[e] Hoffmann[f] Hausmann,[g] Oken,[h] Cleaveland,[i] Jameson,[j] Leonhard,[k] Ure,[l] Phillips,[m] Beudant,[n] and probably by many others, the works of which I have not had an opportunity of consulting. As the characteristic of Mohs, which appeared in 1820, contained a new and correct indication of this property, Professor Jameson has quoted it along with the erroneous specific gravity of Haüy, in the third edition of his system, and the limits 2.0—2.71, given by Leonhard likewise, include the true specific gravity.

31. *Stilbite,* thick prisims, from Iceland, 2.161
32. *Heulandite,* a large single crystal, from Iceland, 2.192
33. *Heulandite,* smaller crystals, from Iceland, 2.213

* *Theorie de la Terre.* t. iii. p. 313. 1797. † *Système des Connoissances Chimiques.* t. ii. p. 312. 1800. ‡ *Traité* t. iii. p. 176. 1801.

[a] *Tableau Méthodique.* 1806. t. i. p. 70. [b] *Traité élém. de Min.* 1807. t. l. p. 382. [c] *System of Chem.* 3d ed. 1807. vol. iv. p. 318. [d] *Mineral. Tabel.* 1808. s. 31. [e] *Voblst. Handb. der Oryctogn.* 1811. th. i. s. 400. [f] *Handb. der Min.* 1812. th. ii. s. 259. [g] *Handb. der. Min.* 1813. th. ii. s. 585. [h] *Lehrb. der Min.* 1813. th. i. s. 349. [i] *Elem. Treatise on Min.* 1816. p. 315. [j] *System of Min.* 3d ed. 1820. vol. i. p. 360. [k] *Handb. der Oryctogn.* 1821. p. 450. [l] *Dict. of Chemistry.* 1821. [m] *Elem. Introd. to Min.* 1823. p. 139. [n] *Traité élém. de Min.* 1824. p. 351.

34. *Apophyllite*, from Iceland, crystallized and easily cleavable, 2.335

*35. *Mesole*, from Faroe, 2.370

36. *Petalite*, large cleavable individuals in a granular composition, 2.440

37. *Hemi-prismatic Felspar Adularia*, white and perfectly transparent, from St Gothard, 2.559

38. *Hemi-prismatic Felspar*, semi-transparent, of a fine clove-brown, perfectly cleavable, particularly parallel to $-\frac{Pr}{2}$ (P of Haüy,) from Norway, 2.583

39. *Hemi-prismatic Felspar, the Labradorite*, from Norway, 2.591

*40. *Albite*, white, faintly translucent, from Chesterfield in Massachusetts, the siliceous spar of Hausmann and Stromeyer, 2.612

This variety does not show the re-entering angles formed by the faces of the most distinct cleavage, (P of Haüy,) like the crystals of albite from St Gothard and other places, because it is composed parallel to this face in the manner dedescribed by Professor Mohs.* The individuals are very thin between the two opposite faces of P; when broken across in the direction of $\bar{P}r + \infty$, (*M* of Haüy,) they exhibit the slight salient and re-entering angles produced by the meeting of the less distinct faces of cleavage, parallel to *M*. The same frequently takes place in other varieties of albite, for instance, the reddish-white one, from the syenite of Dresden.

*41. *Albite*, small, perfectly transparent crystals, from Oisans, where they occur along with anatase, 2.614

*42. *Albite*, larger crystals than the preceding variety, white, translucent, from St Gothard, 2.633

*43. *Labradorite*, from America, with a bright play of colour, 2.751

*44. *Labradorite*, bluish-grey without bright colours, and having rather an imperfect cleavage, from Siebenlehn in Saxony, 2.714

*45. *Labradorite*, in every respect similar to the preceding, associated with the serpentine, No. 4, and hemi-prismatic Schiller-spar, No. 3, from Monteferrato, 2.714

*46. A similar variety, associated with hornblende, from Rosswein in Saxony, 2.714

*47. A green nearly compact variety, very much of the same description, and probable belonging to the species of labradorite, associated with the grey hemi-prismatic Schiller-spar, No. 6. 2.697

*48. *A Tetarto-prismatic kind of felspar*, faintly translucent, yellowish-white, in twin-crystals, joined parallel to the face of perfect cleavage, from St Gothard, 2.553

*49. Another specimen of the same, 2.548

* Treatise, vol. ii. p. 257, Fig. 88.

These two varieties are very remarkable for their specific gravity, which is equal to that of the hemi-prismatic felspar, while their form is tetarto-prismatic. The difference in their specific gravity from albite, and some differences in the forms, render it very probable, that they will be found to belong to a distinct species of the genus felspar. They occur not unfrequently in simple crystals.

*50. *Common Felspar* of Werner, from Baveno, the red nearly opaque variety, cleavable with the greatest facility, but only in one direction, - 2.392

*51. A variety in very thin lamellar compositions, pale reddish-white, locality unknown, 2.423

*52. *Thicker Lamellae,* of another kind, much resembling the former, 2.425

*53. Fragments of Crystals, yellowish-white, nearly opaque, said to be from Elba, associated with the prehnite, No. 19. 2.445

The low degrees of specific gravity, and the highly perfect cleavage observable, almost exclusively of the rest, parallel to $\frac{\overset{o}{Pr}}{2}$ (*P* of Haüy,) render it extremely probable that these varieties will also form a distinct species. We are yet, however, much in want of decisive observations, particularly in respect to the regular forms. The degrees of transparency are very low, the varieties being scarcely translucent on the edges.

54. *Scapolite,* a single crystal, white, translucent, from Pargas in Finland, 2.724

55. *Paratomous Augite-spar,* a variety resembling Sahlite, of a grass-green colour, and easily cleavable, from the Bacher mountain in Lower Stiria, 3.234

56. *Mussite,* from Piedmont, in large laminae, of a yellowish-grey, compound in the direction of $\overset{o}{Pr}+\infty$, 3.254

57. *Pale-grey Augite,* (a variety frequently mistaken for bronzite,) showing faces of composition. It is engaged in Saussurite, 3.256

58. *Augite,* a wax-yellow, granular variety, associated with liver-brown garnet, from Schwarzenberg, Saxony, 3.278

59. *Fassaite,* deep leek-green, an isolated twin-crystal from Fassa, 3.328

60. *Omphacite,* leek-green, translucent, showing bright but interrupted faces of cleavage, from the the Saualpe, Carinthia, 3.329

61. *Mussite,* very pale ash-grey, in large individuals, from the Tyrol, 3.350

62. *Common Actinolite,* of Werner, from Breitenbrunn in Saxony, 3.537

The angles of the cleavage of this variety agree with those of paratamous augite-spar. It is also composed in the same way parallel to $\mathring{P}r + \infty$, and possesses the same hardness. Its colour is a dark leek-green; the specific gravity lies beyond the limits usually assigned for the species. The jeffersonite having been recognized by Troost and Keating to be a variety of the paratomous Augite-spar, the common actinolite, from Breitenbrunn, forms the second instance of a specific gravity greater than 3.5; and we have thus reason to expect, that many other varieties, like the one immediately preceding, will be discovered, intermediate between these and the rest of the augites, salites, mussites, &c. also in regard to this property.

63. *Augite,* blackish-green, perfectly cleavable, crystals compressed between $\mathring{P}r + \infty$, the faces marked *r* by Haüy, and imbedded in sodalite, from Greenland, 3.491

This variety is associated with the arfvedsonite of Mr Brooke, and intermixed with it in such a manner, that the axes of the individuals of the two species are parallel, a case frequently occurring in diallage, but produced there by a similar composition of green varieties of paratomous and hemi-prismatic augite-spar.

64. *Tremolite,* white, crystalized, 2.931

65. *Actinolite,* of a very pale-green colour, nearly alike to some of the varieties of hemi-prismatic augite-spar, called tremolite, from Presnitz in Bohemia, 2.937

66. *Smaragdite,* from Corsica, 3.000

67. *Hornblende,* blackish-green, perfectly cleavable, 3.006

68. *Actinolite.* thick leek-green crystals, from the Zillerthal, Salsburg, 3.026

69. *Common Hornblende,* perfectly cleavable, but showing faces of composition, parallel to the long diagonal of the rhombic prism, and in consequence, called diallage, from Gulfield, Norway. 3.043

70. *Smaragdite,* from the valley of Saass, 3.056

71. *Hornblende,* black, perfectly cleavable, with smooth and shining planes of composition, parallel to the long diagonal of the prism, from Kongsberg, Norway, 3.114

72. *Carinthine,* from the Saualpe, in Carinthia, 3.127

73. *Smaragdite,* grass-green, occurring in the same specimen as No. 67, but containing thin films of paratomous augite-spar, 3.129
74. *Basaltic Hornblende,* fragments of imbedded crystals, from Lower Stiria, 3.167
75. *Zoisite,* grey, cleavable, from the Saualpe, 3.269
76. *Zoisite,* rose-red, compact from the Radlgraben, Carinthia, 3.334
77. *Epidote,* brown, thin columnar composition, 3.336
78. *Zoisite,* ash-grey, cleavable, from Bayreuth, 3.355
79. *Pistazite,* dark pistachio-green crystals from Arendal, 3.425
80. *Wollastonite,* a brownish-white variety from the Bannat, 2.805
*81. *Arfvedsonite,* large, perfectly cleavable individuals, 3.431

This mineral must be included in the genus augite-spar of Mohs, to the species of which it is allied by a very high degree of resemblance, particularly to the hemi-prismatic augite-spar. Mr Brooke has found the angles of its prism of cleavage to be 123° 55′, different from the angle of hornblende, which he quotes at 124°30′; but even if the two substances did agree in this respect, their specific gravity would render it unavoidable to consider them as distinct species.

82. *Prismatic Azure-spar,* the dark blue variety from Vorau, in Stiria, 3.039
83. *Prismatoidal Azure-spar,* pale-blue, crystalline fragments, Stiria, 3.024
*84. *Elaolite,* of a pale-brown colour, 2.589
*85. *Eudialyte,* imbedded crystals, 2.898
*86. *Gehlenite,* dark greenish-grey, four-sided prisms, 3.029
*87. *Saussurite,* compact, from Corsica, including the variety of smaragdite, No. 66. 3.026
*88. *Saussurite,* granular, Bayreuth, 3.253
*89. *Saussurite,* granular, Piedmont, 3.256
*90. *Saussurite,* compact, from the shores of the Lake of Geneva, 3.343
*91. *Spinellane,* crystallized from the Lake of Laach, 2.282

(To be continued.)

Art. VII.—*Botanical Letters from* J. J. Rousseau *to* M. Gouan, *Professor of Botany at Montpellier.* Communicated by Dr Hooker.

Amongst the original correspondence of the late M. Gouan, Professor of Botany at Montpellier, which has come into our hands, are the two following letters from Jean Jacques Rousseau.

Whatever may have been the faults and the foibles of this otherwise eminent man, thus much is certain, that, in the character of a botanist, he has always shown himself to be thoroughly acquainted with the principles of the science, and that in these letters, penned confidentially, and never intended for the public eye, he has written with a degree of modesty, and a diffidence in his own knowledge, which is seldom found in persons of much inferior acquirements. They are dated from Dauphiné in Savoy, in the year 1769, eight years before his death, during the period when he concealed his real name under that of Renon, when returning from England, disgusted with the world, he sought for amusement and health in investigating and studying the vegetable creation in the beautiful alpine district just alluded to; and we think that they will be found to strengthen the remark made by Sir J. E. Smith, under his article *Rousseau*, in Rees' *Cyclopædia*, that " botany had spread a charm over the latter years of this distinguished man, and soothed their real and imaginary evils," and that " whenever he touches on this favourite subject in his writings, he communicates the same charm to his readers."

The effect which was produced by the letters on botany of J. J. Rousseau, in giving popularity to the Linnæan system of botany in France, is well known; and even in this country, we could scarcely mention any truly elementary work which has been more generally read and admired, or which appears more calculated to encourage a taste for the science, especially among young students.

W. J. H.

A Bourgoin en Dauphiné, 28th May 1769.

C'est trop longtems, Monsieur, profitter en silence de vos bontés et de vos dons. Je n'y suis pas moins sensible, je vous proteste, que si je vous en avois remercié bien fréquemment; mais le retard de la première lettre dont vous m'avez honoré, et qui ne me parvint que plusieurs mois après sa date, a fait un premier tort involontaire que la honte et l'embarras ont multiplié. Mieux vaut tard que jamais, et il n'y a plus moyen de resister aux nouvelles marques d'attention que vous avez bien voulu me donner par M. de la Fosse, et donc j'enricherai l'herbier que je tiens de M. Dombey. Je suis bien fâché de n'avoir pu profiter des tresors qu'il avoit acquis l'an dernier aux Pyrénées à votre suite. Mais il vint sans m'avoir prévenu dans un moment d'embarras et de decouragement, la veille de mon depart pour Grenoble, où, surchargé de soins désagréables et indispensables, j'avois autre chose à penser qu' aux plantes. Celà m'empêcha de le voir, mais la chose est faite, j'en suis fâché; s'il m'eut prevenu de son voyage, je me serois arrangé pour en profiter, et s'il a mal choisi son tems, toute la perte en est à moi seul. Continuez moi vos bontés, Monsieur, je vous supplie. Je suis un vieux radotteur de disciple qui n'a que du zêle et de l'opiniâtreté sans fruit pour la botanique; mais dont le cœur est plein de reconnaisance pour les attentions dont vous avez bien voulu l'honorer. Si mon ignorance ne me permet de les payer d'aucun retour utile, elle ne m'empêchera pas du moins d'en sentir le prix, et j'étudierai vos livres avec le regret de ne pouvoir écouter vos leçons, et vous témoigner en personne les sentimens avec lesquels je vous serai toute ma vie attaché.

Renon.

A Montquin, le 6. 8bre. 1769.

Je vois, Monsieur, que vous avez la bonté de vous occuper de moi, bien moins encore que je n'en aurois besoin mais bien plus que mon ignorance ne le mérite. Je suis bien reconnoissant des recherches que vous avez eu la bonté de faire sur l'Ecphrasis de Columna, mais je n'abuserai pas de la découverte que vous avez faite de ce livre pour l'acquérir à vôtre prejudice, n'ayant assurement ni le pouvoir ni la volonté d'en donner le prix que De Bure en demande. Ainsi, Monsieur, qu'à moi ne tienne que vous n'en fassiez l'acquisition, si celà vous convienne. Une des choses qui me dégoûteroient de la Botanique seroit le prix énorme de la pluspart des livres qui en traitent, et la necessité toutefois d'avoir tous ces livres ou la plupart, surtout lorsque n'ayant point suivi de cours ni etudié sous aucun maitre, on est réduit à étudier seul. J'ai été forçé par la même raison de renoncer à l'Hortus Cliffortianus, aux Amœnitates Academicæ, et a beaucoup d'autres livres qui me seroient egalement necessaires pour suppléer, par leurs descriptions, à la secheresse du species, et, ne vous en déplaise, à celle de l'Hortus Monsp. et de Flora Monspel. Vous avez, Messieurs, ecrit seulement pour les doctes, c'est fort bien fait. Mais j'aurais grand besoin de livres qui apprissent aux ignorans à le devenir. Il faudroit pour celà force figures et force descriptions, et tout celà je trouve épars dans une bibliotheque de Botanique si volumineuse, et si ruineuse, que ce que j'ai ne me pouvant suffire, je ne vois d'autre parti que de le vendre pour acquérir le reste, ou de tous abandonner.

Je suis bien sensible, Monsieur, au cadeau de votre Ichtyologie que vous voulez bien me faire, et dont je sens assurement bien le prix; mais je dois vous prévenir, que vous ne sauriez vous choisir un lecteur plus inepte, et moins en état de vous entendre. Je me garde de vouloir faire aucune excursion dans les autres parties de l'histoire naturelle, ma vieille cervelle ayant déjà bien de la peine à contenir la très mince provision de foin dont je tâche de la repaître. Vous vous moquez, assurément, Monsieur, de votre radotteur de disciple très indigne, quand vous le consultez sur les Ombellifères dont vous doutez. Avant votre lettre, je ne doutois pas du *Selinum palustre*, j'en doute à present parceque vous en doutez, et ce n'est que de vous que j'attends la décision de ce doute. Je vois que dans la figure de Crantz il y a plusieurs feuilles caulinaires, il n'y en a qu'une dans le specimen; dans Crantz les feuilles radicales sont plus petites que les caulinaires, dans le specimen elles sont plus grandes. M. Guettard dit que le bord des feuilles est légèrement crenelé, dans le specimen il ne l'est point du tout, il ajoute que le bout des feuilles est mousse, dans le specimen il est non seulement pointu mais affilé; voilà tout ce que je puis dire très grossiement (grossièrement?) sur cet article, il me semble que la question pouvoit se decider aisément par la plante fraiche, en voyant si elle faisoit du lait. A l'égard du *Seseli pyrenæum*, n'ayant point l'honneur de le connoitre, je n'en saurois parler que comme un aveugle des couleurs. Cependant l'objection que vous vous faites vous même de la figure des graines me paroit bien forte.

M. Linnæus parle, à la vérité, d'une feuille unique, comme elle est dans le specimen, mais le rameau ne sort pas de l'aisselle, comme il le dit. Il dit encore, et même il le repète, que l'involucelle est plus long que l'ombellule, et c'est ce qui n'est point du tout dans le specimen. Je vois partout le pour et le contre, et ne sais que penser, jusqu' à ce que vous m'ayez decidé. A l'égard de l'*Athamanta libanotis*, je n'ai rien du tout à en dire, parceque je ne l'ai pas trouvé dans l'herbier, et je suis sur qu'il n'y etoit pas quand je l'ai reçu, car j'en fis sur le champ le catalogue, dans lequel il n'est pas; non plus que le *Selinum caruifolium* de Crantz, dont j'ai la figure aussi dans ses ombellifères, à laquelle je ne trouve rien de semblable dans celles de l'herbier. Je suis certain que cet herbier ne m'a pas été donné tel qu'il a pu être arrangé sous vos yeux; car independant des ombellifères, famille sur laquelle je n'ose prononcer, tant elle me paroit difficile, il y a un grand désordre et beaucoup de faux noms dans toutes les autres, principalement dans les Veroniques, et dans les Graminées. J'ai remarqué que M. Dombey déterminoit fort legerement, et se trompoit de même, celà ne pouvoit guère être autrement à son age. Je suis persuadé qu'il est dejà plus circonspect aujourdhui. Son procedé genereux et honnete mérite bien ma reconnoissance, et mon affection. Quand vous aurez, Monsieur, de ses nouvelles, vous m'obligerez de vouloir bien m'en donner.

Vous me faites bien vivement sentir mon ignorance et ma misère par la note des Ombellifères que vous m'envoyez et dont je n'ai, ni ne connois pas, une, hors le seul *Selinum caruifolium*, (non celui de Crantz mais celui de Linnæus,) que j'ai trouvé à Trie il y à deux ans, et dont j'ai apporté un seul exemplaire que je destinais à mon herbier, mais que je vous céderois bien volontiers si vous n'en aviez point et qu'il vous fit plaisir. Ce pays-ci, très pauvre en Ombellifères, n'en fournit aucune que je sache qui se rapporte a votre note, excepté peut-être un petit *Seseli* dont j'ai rencontré, il y à quelques jours, un pied unique et qui ressembleroit beaucoup à l'*Hippomarathon* si ce n'etoit que l'involucelle est polyphylle. Cette plante me paroit être celle que M. Haller décrit dans sa dernière édition, No. 762, et qu'il rapporte, mal à propos, se me semble au *Seseli bienne* de Crantz. J'ai très peu de vue, Monsieur, je suis très paresseux, je n'ai jamais eu la presomption de croire pouvoir rien recueillir qui fut digne d'être offert à des botanistes de votre ordre, et j'ai même rarement le courage de rien ramasser pour moi-même. Ma manière d'herboriser est d'errer au hazard par la campagne, et d'observer à droite et à gauche les plantes qui frappent mes yeux, souvent même sans les arracher pour les desséquer ; vous concevez que cette manière nonchalante d'étudier ne doit pas rendre un commençant de soixante ans fort habile. Le desir de me rendre bon à quelque chose auprès de vous est bien capable de me rendre vigilant et laborieux, quoique ce ne soit pas je vous jure un miracle facile à faire. Je n'avois pas même imaginé de recueillir des graines jusqu' à un voyage de Pila que je viens de faire, et où je n'ai trouvé que les plantes alpines les plus communes, excepté le *Sonchus alpinus*, le *Prœnanthes viminea*, et le *Lichen islandicus* que je crois moins communs que le reste. Ce pays-ci est humide et les *Carex* n'y manquent pas ; ainsi je pourrai sur cet article vous servir l'année prochaine. Donnez moi vos ordres, Monsieur, peut être le désir d'en être digne me fera-t-il assez eventuer pour me mettré en état de les suivre. Je n'ai point eu l'honneur, que je sache, de voir M. le Vicomte de St Priest. Permettez qu'avec la simplicité et la cordialité d'un pauvre herboriste, je vous salue et vous embrasse.

Monsieur, de tout mon cœur,

RENON.

ART. VIII.—*On the Construction of Meteorological Instruments, so as to register their Indications during the Absence of the Observer at any given Instant, or at successive intervals of Time.*

THIS paper, of which we propose at present to give a brief abstract, was read before the Royal Society of Edinburgh, on the 2d May 1825, when Mr Blackadder exhibited to the society some of the apparatus described in this paper.

The principle of Mr Blackadder's contrivance applies either to the spirit or mercurial *Thermometer*, and consists in keeping a small index suspended at, or in contact with, the extremity of the fluid in the stem of the instrument; so that the former shall accompany the latter in all its movements, until the instant arrive when we wish to determine the existing temperature. At this instant the index is so acted upon as to remain fixed to its place, while the fluid either passes beyond, or retires below it.

When a spirit-thermometer is used, the bore of the tube, and the weight and form of the index, require attention;* but the adjustment is not difficult. As to the spirit, there is a certain strength which seems to answer best, and it must be colourless, of some age, and carefully and repeatedly filtered. The colouring matter usually added to spirit-thermometers, is in this instance of no use, and would be injurious. For, after a time, the colouring matter is partially deposited, and particles of this getting into the stem of the instrument, would interrupt the movements of the index. It is for the same reason that old spirit and frequent filtration are requisite; for if the spirit is new, and if not frequently and carefully filtered, small whitish flocculi, or minute fibres may be seen suspended in the fluid, from which interruption to the index is liable to take place. Mr Blackadder had, on one occasion, much trouble in adjusting an index, and, at length, discovered, that the whole had arisen from a very minute particle of colourless glass, which had by some accident got into the stem. With proper care and attention, however, nothing is more simple than the construction of a good and perfectly accurate spirit-thermometer, for meteorological purposes. Nothing, at the same time, is more rarely to be met with; for such instruments, as usually made, are exceedingly inaccurate, and altogether unfit for scientific purposes.

When a thermometer has been constructed in the way now described, all that is necessary to keep the index constantly and exactly at the summit of the fluid, whatever change of temperature may take place, is to invert the instrument, and retain it either in a perpendicular or somewhat inclined position; the attraction of the fluid to the index being quite sufficient

* The bore of the tube admits of being so very minute, that the difficulty of readily distinguishing the index is the chief obstacle, and hence the bulb does not require to exceed three or four tenths of an inch in diameter.

for the suspension of the latter, and for overcoming its friction on the sides of the tube. When, however, the instrument is placed in a horizontal position, the index no longer accompanies the fluid in all its motions; for if the temperature rises, the fluid passes the index as if no such body were present; and if the temperature is diminished, the index is dragged along by the fluid. Upon this latter property, the *Psychrometer*, or instrument for registering the lowest temperature, was constructed. If, then, we take such a thermometer, and suspend it vertically, and in an inverted position, *on a moveable axis*, it is obvious, that, by connecting with it a time-piece, we can have it placed in a horizontal position at any given instant. And if we also make provision, that the instant the instrument comes to its horizontal position, its bulb is exposed to a higher temperature than that of the air, it is evident that the index will point out the exact temperature of the air at the time the instrument was changed from its vertical position, and that it will continue to do so as long as the instrument retains its new position, and has its bulb kept at a higher temperature than that of the air.

The means by which the bulb of the instrument is kept at a higher temperature than that of the air, is the aqueous vapour originating from the flame of a small lamp; and, in the coldest stormy weather, the flame does not require to be larger than that produced by at most two small cotton threads immersed in oil. When gas is at command, it is doubtless the most convenient combustible, as a minute flame can be kept up almost interminably, and without requiring any attention.

When a mercurial thermometer is used, the difference is, that, in this case, the instrument is not placed in an inverted position; and, when it is brought into a horizontal position, the bulb, instead of being kept at a higher, must be kept at a lower temperature than that of the air. This can readily be effected, by providing the means for supporting a continual evaporation from the surface of the bulb. When the instrument receives its horizontal position, the bulb is made to come into contact with a soft hair-pencil, of a hollow circular form, through which distils *guttatim*, and slowly, from a reservoir, some evaporating fluid. On some occasions, as in a very humid state of the atmosphere, ether may be requisite; but, on most occasions, rain-water is sufficient; the use, however, of common ardent spirits for such a purpose, is attended with but a trifling expence, and may be found convenient.

Having thus shown how the temperature of the air and other bodies may be determined, during absence, and at any given instant, it may readily be conceived, how it may, in like manner, be determined at successive intervals of time, by multiplication, and a proper arrangement of the same means. Thus, seven thermometers of the before mentioned construction, connected by a very simple piece of mechanism, will enable us to determine the exact temperature every hour during the whole course of the day and night, and that with very little trouble. For, to obtain this, it is necessary to inspect the instrument only three times in the course of the day, or during that period not usually appropriated to sleep; for example, at 7 A. M., 4 P. M., and 11 P. M.

Having described Mr Blackadder's method of registering the indications of the thermometer at any given instant, and at successive intervals of time, the application of the same principle to the registering of the *Hygrometer* will not require much illustration: For, if it be admitted that the atmizomic hygrometer (that is, a hygrometer constructed on the Huttonian principle,) may be depended upon, all that is requisite to procure an accurate register is, to attach two thermometers to one slip of metal, on which is engraved a scale for each, and to keep one of the bulbs moist with water. When at any instant the instrument thus constructed is brought into the horizontal position, the index in the one tube will indicate the temperature of the air, and that in the other the temperature produced by evaporation. Nothing is more simple than this modification of the registering apparatus, for nothing can be more easily effected than keeping one of the bulbs moist with water, and in this only does it differ from that fitted to register the atmospheric temperature alone.

Hitherto there has been no method devised for registering even the extremes of the barometric changes, which does not infer a very considerable increase of mechanical friction; and which, consequently, does not include a degree of inaccuracy no way consistent with the present advanced state of meteorological science. For it is admitted, that, at the present day, a variation in the elevation of the mercurial column to the five hundredth part of an inch, must be attended to by those who aim at scientific accuracy.

The principle of the method for registering the indications of the barometer which Mr Blackadder was led to adopt, consists in cutting off, at a given instant, all communication between the atmosphere and the mercury of the barometer, than which, certainly, nothing can be more simple. If, at a given instant, the communication between the air and the mercury be cut off, the height of the mercurial column must remain unaltered by any change in the pressure of the atmosphere, until the communication is restored.

A section of the barometer cistern, which is made of iron, is represented in Plate VI. Fig. 1, where *a* is an orifice for the introduction of the mercury, afterwards shut up by means of a screw; *e*, the air-duct, having a screw formed on its outer surface; *f*, an air-tight stop-cock, having a female screw, by which it is attached to the air-duct; *g*, a small orifice in the side of the stop-cock, to serve as a passage for the air, and so as to exclude dust; *h*, a lever connected with a time-piece, by means of which the stop-cock was shut, and the communication of the air with the mercury cut off at any given instant. The cistern is about two inches in diameter—the depth of mercury in the cistern, and the distance between the surface of the mercury and the top of the cistern, must be as small as the correct operation of the instrument will admit of.

By combining several such instruments in one piece of mechanism, we can have the exact height of the barometer every hour in the course of the day and night. Thus seven barometers, arranged at equal distances around a hollow column of wood, four inches in diameter, and about three feet in height, having a projection at the base, in the form of a pedestal, would form not only an elegant but a very complete and highly useful barometrical apparatus. The column being hollow, not only lessens the weight, but permits the timepiece and connecting mechanism to be entirely concealed within it.

The barometers, however, may also be arranged on a flat surface, without producing any thing of an unwieldy appearance, and the adaptation of the mechanism for shutting one of the stop-cocks each hour in succession, is not thereby rendered more difficult.

Art. IX.—*Observations on the Gulf-Stream, in crossing it from Halifax to Bermuda, and from Bermuda to Halifax, in his Majesty's Ship Jaseur, in* 1821. Communicated by J. D. Boswall, Esq. R. N., F. R. S. E.

The Gulf-stream is generally supposed to proceed through the Gulf of Florida, along the coast of America, until it gets a few degrees to the North of Bermuda, and then turns off to the N.N.E., N. E., and E.N.E., between the latitudes of 38° and 41° north. When it gets so far to the east as 61° of west longitude, it spreads itself more, and its situation becomes more southerly. Its breadth is commonly supposed to be about two degrees, but it sometimes expands and contracts, in consequence of the strength of the current varying from a number of causes not yet ascertained. In making a passage from Halifax to Bermuda, I have known the ship to be upwards of two degrees to the eastward of the longitude by account, and I have seen (but very seldom) the vessel not as many miles. It is very difficult to ascertain the rate and direction of the gulf-stream by a boat, as calms are seldom experienced in that quarter, and gales and squally unsettled weather is very common, excepting with north-easterly winds which bring fine weather along with them.

The occurrence of the weed, called the gulf-weed, has been considered by several navigators as a proof of their being in the current, but this opinion is by no means correct. The same weed is found all over the westerly part of the Atlantic, and I have generally observed the greatest quantity on the edges of the stream, and least in the middle. The weed I believe comes originally from the gulf, but it is driven about by the different winds as much as by the stream, and is to be seen floating about in strings in whatever way the wind blows, and not always lying in the direction of the current.

The thermometer seldom errs in indicating the gulf-stream, if we pay attention to the direction of the wind. If we cross the gulf-stream from Halifax to Bermuda, or any place to the southward, and keep a strong northerly wind across it, the air will be considerably colder than with a southerly wind, and, consequently, there must be a greater difference between the temperature of the air and the water. On the contrary, in crossing the stream going to Halifax, or any way to the northward, if we keep a southerly wind across, the air will be much warmer than with a northerly wind, and, consequently, the difference between the temperature of the sea and the air will be less.

Date	Hours.	Ship's Place at Noon.	Thermometer. Air.	Water.	Winds.	Remarks, &c. from Halifax to Bermuda.
Sept. 22, 1821	4	At anchor in Halifax Harbour.	62°	57°		P. M Moderate and fine weather.
						2, Weighed and made sail for Bermuda.
	8		63	58	NW. by W.	8, Fresh breezes and clear.
	12		59	58		Midnight, moderate and fine.
23.	4	Course S. 17° W.	59	56	NW. by W.	A. M. Fresh breezes and clear.
	8	139 miles Lat.	57	57		
	12	42° 13′ N Long.	58	58		Noon, fine weather.
	4	64° 20′ W. Chron.	60	60		P. M. Do. weather.
	8	64° 15′ W.	59	61		6, Fresh breezes and cloudy.
	12		58	64	WNW.	Midnight, hazy weather.
24.	4	Course S. 23° W.	66	69	NW. by W.	A. M. Fresh breezes and hazy weather.
	8	176 miles Lat.	65	75		
	10	Obs. 39° 30′ N.	66	75	NW.	On the north edge of the stream.
	12	D. R. 39° 27′ N.	66	74½		8, Moderate and fine.
	2	Long. 65° 48′ W.	68	78		Noon, light breezes and fine.
	4	Chronometer 65°	68	79		P. M. Do. weather.
	6	12′ W.	68	78		
	8		68	78	Variable.	8, Calm and cloudy.
	10		69	78		9, Light breeze.
	12		68	78	S. by E.	Midnight, fresh breezes & cloudy
25.	2	Course S. 67° W.	72	78		A. M. Strong breezes and squally.
	4	48 miles. Lat.	76	78	South.	4, Fresh gales, air getting warm, owing to south wind.
	6	Obs. 39° 16′ N.	74	73		
	8	D. R. 39° 11′ S.	74	73	SW.	8, Strong gales, with a heavy cross sea.
	10	Long. 66° 46′ W.	74	73		
	12	Chron. 66° 10′	73	74		Noon, fresh gales and squally, with rain.
	2	W.	75	79		
	4		77	78		P. M. Strong gales, and squally.
	6		76	77		Longitude not at all affected by the stream these last 24 hours.
	8		78	77		
	10		75	76		8, Fresh gales and thick weather.
	12		74	76		Midnight, fresh gales and squally, with rain, thunder, and lightning.

Date	Hours.	Ship's Place at Noon.	Thermometer. Air.	Thermometer. Water.	Winds.	Remarks, &c. from Halifax to Bermuda.
Sept.	4	Course S. 26° E.	75°	73°	SW.	A. M. Fresh breezes, with rain and lightning.
26,	8	114 miles Lat.	74	76	WSW.	
1821	12	Obs. 38° 09′ N.	72	75	E. by N.	4, Moderate, 8, light airs, with heavy rain, and a cross breaking sea.
	4	D. R. 37° 34′ N.	72	77	N. by E.	
	8	Long. D. R. 65°	71	75		
	12	42′ W. Chron. 64° 34′ W.	72	77	North.	Noon, strong breezes and cloudy. P. M. Do. weather. 4, Moderate and fine. Midnight, light airs, with heavy rain.
27.	4	Course S. 9° E.	72	77	Variable.	A. M. Moderate and cloudy.
	8	55 miles. Lat.	76	78		8, Squally, with rain.
	12	Obs. 36° 52′ N.	76	82	Calm.	Noon, calm and fine.
	4	D. R. 37° 14′ N.	79	81	North.	P. M. Moderate and cloudy.
	8	Long. D. R. 65°	74	78	WNW.	8, Fresh breezes.
	12	32′ W. Chron. 64° 23′ W.	74	78		Midnight, do. weather.
28.	4	Course S. 15° W.	74	77	NNW.	A. M. Fresh breezes, with small rain.
	8	152 miles. Lat.	74	76	NNE.	
	12	Obs. 34° 31′ N.	74	79		8, moderate and fine.
	4	D. R. 34° 26′ N.	76	79	NE.	Noon, do. rain.
	8	Long. D. R. 68°	76	79	East.	P. M. Light breezes and fine.
	12	20′ W. Chron. 64° 46′ W.	76	79		8, Cloudy. Midnight, moderate and cloudy.
29.	4	Wreckhill the	76	80	ENE.	A. M. Do. weather.
	8	SW. end of Ber-	77	80		
	12	muda, NNE. 3	75	78	E. by N.	Noon, fresh breezes and hazy, with rain.
	4	miles.	76	79		
	8		76	78	ENE.	P. M. Squally weather.
	12		74	77		Midnight, fresh breezes, with rain.
30.	4	Off the east end	74	77	SE. by E.	A. M. Do. fresh light breezes, with thick fog.
	8	of Bermuda 6 or	75	78		
	12	7 miles.	73	78	ENE.	8, squally.
	4		74	77	NE. by E.	Noon, strong breezes and squally, with rain.
	8		74	78		
	12		74	76	E. by S.	P. M. Do. weather. Midnight, strong breezes, and squally.
Oct.	4	At anchor in Ber-	74	78		A. M. Fresh breezes and cloudy.
1.	8	muda.	75	77		
	12		77	77	ENE.	Noon, fresh breezes and fine.
						REMARKS, &c. FROM BERMUDA TO HALIFAX.
Nov.	4	3 Miles off the	71	73	ESE.	A. M. Moderate, with rain.
1,	8	north end of	72	74		
1821	12	Bermuda.	77	76	South.	Noon, fresh breezes and fine.
	4		77	76		P. M. Moderate and fine.
	8		77	76	W. by S.	6, Light breezes and cloudy.
	12		76	75		Midnight, squally weather.

Date	Hours.	Ship's Place at Noon.	Thermometer. Air.	Thermometer. Water.	Winds.	Remarks, &c. from Bermuda to Halifax.
Nov.	4	Course N. 20° E.	75°	76°	West.	A. M. Fresh breezes and squally.
2.	8	91 miles. Lat.	75	74		
1821	12	D. R. 33° 54′ N.	76	74	NNE.	Noon, do. weather.
	4	Long. D. R. 63°	76	74		P. M. Hazy weather.
	8	34′ W.	71	73		8, Strong breezes and cloudy.
	12		74	73	NE. by N.	Midnight, do. weather.
3.	4	Course S. 6° W.	69	67		A. M. Fresh breezes and squally.
	8	52 miles. Lat.	69	74		
	8	Obs. 34° 54′ N.	70	74	NE.	
	12	D. R. 34° 46′ N.	70	74		Noon, cloudy.
	2	Long. D. R. 63°	71	74		P. M. do. weather.
	4	41′ W. Chron.	69	73	E. by N.	
	6	63° 34′ W.	69	74		
	8		69	73		8, Moderate and cloudy.
	10		70	73		
	12		71	73	ENE.	Midnight, do. weather.
4.	2	Course N. 36° W.	70	72		A. M. Moderate and fine.
	4	145 miles. Lat.	71	73		
	6	Obs. 37° 03′ N.	71	73		
	8	D. R. 37° 00′ N.	71	74		8, Light breezes and fine.
	10	Long. D. R. 65°	73	73		
	12	15′ W. Chron.	74	73	ENE.	Noon, do. weather.
	2	65° 38′ W.	74	74		P. M. Moderate and fine.
	4		73	74		
	6		72	74		
	8		73	76		8, Light breezes, getting into the
	10		73	77		stream by the thermometer.
	12		72	77½		Midnight, moderate and fine.
5.	2	Course N. 11° W.	73	76	ENE.	A. M. Moderate and fine.
	4	140 miles. Lat.	72	73		4, Cloudy weather, with lightning.
	6	D. R. 39° 20′ N.	72	70		
	8	Long. D. R. 65°	69	69		
	10	50′ W.	69	69		
	12		69	70		Noon, moderate, with heavy rain.
	2		68	70	E. by N.	P. M. Moderate, with thick rainy
	4		66	68		weather.
	6		61	56		6, Out of the stream by thermo-
	8		62	58		meter.
	10		63	57		8, Fresh breezes and hazy.
	12		58	58		Midnight, fresh gales and squally.
6.	4	Course N. 16° W.	51	53	E. by N.	A. M. Fresh breezes and hazy.
	8	144 miles. Lat.	49	52		4, Squally with rain.
	12	D. R. 42° 41′ N.	49	52		Noon, fresh gales with rain.
	4	Long. D. R. 66°	52	49	East.	P. M. Do. weather, sounded in 33
	8	39′ W.	52	51		fathoms.
	12		52	50		Midnight, strong breezes & squally.
7.	4	Course N. 23° W.	49	48	East.	A. M. Do. weather.
	8	73 miles. Lat.	49	46		8, Fresh gales and thick hazy weather.

Date	Hours.	Ship's Place at Noon.	Thermometer. Air.	Thermometer. Water.	Winds.	Remarks, &c. from Bermuda to Halifax.
Nov.	12	D. R. 42° 47′ N.	49°	49°	At 10	P. M. Fresh gales and squally, with
7,	4	Long. D. R. 67°	50	47	sounded	rain.
1821	8	19′ W.	50	46	in 36 fa-	4, Moderate and fine, sounded in
	12		49	52	thoms.	38 fathoms.
						8, Cape Sable, NNW.
						Midnight, fresh breezes and fine.
						N. B.—On making the land ship about 1° 50′ east of the longitude by account.
Mar.	4	NE. end of Ber-	64	67	SW.	A. M. Fresh breezes and fine wea-
29,	8	muda, SW. 9	62	89		ther.
1822	12	miles.	65	68		Noon, do. weather.
	4		61	68		P. M. do. weather.
	8		59	67		
	12		59	64		Midnight, fresh breezes and cloudy.
30.	4	Course N. 39° E.	60	64	NNW.	A. M. Strong breezes and squally.
	8	146 miles. Lat.	57	66		8, Fresh breezes.
	12	Obs. 34° 30′ N.	55	66		Noon, moderate and cloudy.
	4	D. R. 34° 21′ N.	51	65		P. M. do. weather.
	8	Long. D. R. 62°	55	66		
	12	50′ W. Chron. 62° 12′ W.	55	64	N. by W.	Midnight, light breezes.
31.	4	Course N. 31° E.	57	60		A. M. light breezes and cloudy.
	8	74 miles. Lat.	61	65	North.	6, Squally, with heavy rain.
	12	D. R. 35° 23′ N.	62	62		Noon, fresh breezes.
	4	Long. D. R. 62°	60	63	Variable.	P. M. do. weather.
	8	03′ W. Chron.	71	72		8, Moderate on the edge of Stream
	12	61° 50′ W.	68	72	W. by N.	by thermometer.
						Midnight, fine weather.
Apr.	2	Course N. 39° W.	64	70	WSW.	A. M. Moderate and fine.
1.	5	75 miles Lat.	59	70		
	6	D. R. 36° 32′ N.	56	70		
	8	Obs. 36° 50′ N.	54	70		3, Heavy sea.
	10	Long. D. R. 63°	52	70		
	12	03′ W. Chron.	50	71	SW.	Noon, fresh breezes and fine.
	2	61° 58′ W.	50	71		P. M. do. weather.
	4		49	71		
	6		49	70		
	8		48	69		8, Squally.
	10		49	69		
	12		48	69	W. by S.	Midnight, fresh gales and squally.
2.	2	Course N. 20° W.	50	70	W. by N.	A. M. Fresh gales, with heavy
	4	138 miles. Lat.	54	70		squalls.
	6	D. R. 39° 01′ N.	54	70		
	8	Lat. Obs. 89° 27′	50	71		8, Moderate.
	10	N. Long D. R.	50	71		
	12	64° 04′ N. Chron.	49	71	NW.	Noon, moderate and cloudy.
	2	62° 46′ W.	49	69		P. M. do. weather.
	4		49	69	NNW.	
	6		48	69		
	8		48	70		8, Light airs and cloudy.
	10		49	69		
	12		49	69	North.	Midnight, fine weather.

Date	Hours.	Ship's place at Noon	Thermometer.		Winds.	Remarks, &c. from Bermuda to Halifax.
			Air.	Water		
Apr. 3.	2	Course N. 29° W.	50°	69°		A. M. Calm and cloudy.
1822	4	36 miles. Lat.	51	69		
P. M. Going at the rate of 8 miles an hour.	6	D. R. 39° 34′ N.	52	69		
	8	Lat. Obs. 39° 48′	53	70	West.	8, Light airs and fine.
	10	W. Long. D. R.	56	70		Noon, fresh breezes.
	12	64° 49′ W. Chron.	58	69		P. M. Do. weather, at 4 out of the stream, as plainly to be seen by thermometer.
	2	63° 46′ W.	58	60		
	4		58	47		
	8		55	51		8, Moderate and fine.
	12		52	47	W. by N.	Midnight, fresh breezes and squally.
4.	4	Course N. 6° W.	48	40		A. M. Fresh breezes and squally.
	8	157 miles. Lat	33	35		4, Moderate.
	12	D. R. 42° 10′ N.	36	35	NW.	Noon, squally.
	4	Lat. Obs. 42° 24′	34	34		P. M. Do. weather.
	8	N. Long. D. R.	34	33		8, Strong breezes and clear.
	12	65° 11′ W. Chron. 63° 38′ W.	33	34	West.	Midnight, do. weather.
5.	4	Moored in Halifax Harbour.	34	35		A. M. Moderate—2, sounded in 70 fathoms.
	8		34	34		
	12		34	23	SW.	8, Light airs, Sambro lighthouse.
	4		35	34		Noon, 3 miles.
	8		34	34	SSW.	P. M. Moderate, with snow, at anchor in Halifax.
	12		35	34	Calm.	
						8, Calm, with rain—12, do. weath.

Found the chronometer nearly right on making the land.

ART. X.—*On Lithion-Mica.* By EDWARD TURNER, M. D. F. R. S. E. Lecturer on Chemistry, and Fellow of the Royal College of Physicians, Edinburgh. Communicated by the Author.

IN the last Number of this Journal, I gave the analysis of a mica from Cornwall, which was supposed, from its action before the blow-pipe, to contain lithia; and it was there stated, that several similar micas had fallen under my notice, with the investigation of which I was at that time engaged. Having possessed an active assistant in my friend and pupil Mr William Gregory, I have been able to complete the analysis of three lithion-micas, besides repeating the former one, which I subsequently found reason to suspect of slight inaccuracy. Of these different analyses I shall now give a description; but before speaking of each individually, it will be advisable to describe the method of separating lithia from potash which was adopted in all of them.

To separate lithia from potash.—The mica, after being reduced to fine powder by friction in an agate mortar, was intimately mixed with six times its weight of carbonate of baryta, and then exposed for an hour and a half or two hours to the full white heat of a Black's furnace. The ignited mass was dissolved in dilute muriatic acid, and evaporated to perfect dryness. The soluble parts were taken up by a considerable quantity of hot water, pure ammonia was then added to separate alumina, iron and manganese, and these precipitates together with the silica were at once collected on a filtre. To the filtered solution, while still hot, an excess of carbonate of ammonia was added, so as to separate all the baryta in the form of carbonate. The clear solution, thus freed from baryta, was evaporated to perfect dryness, and the dry salt ignited to expel muriate of ammonia. A fused mass was always left, which deliquesced rapidly on cooling. It was dissolved by water, mixed with a little solution of muriate of platinum, and evaporated to perfect dryness. The dry mass was now treated with alcohol of moderate strength, which readily took up the muriate of lithia, and the excess of platinum salt, leaving the muriate of platinum and potash undissolved. A perfect separation of the two alkalies was thus effected, and they could each be determined in the usual way. It is necessary to convert the muriate of lithia into sulphate, because the former is so deliquescent, that it attracts moisture during the operation of weighing; and, moreover, its composition is not so well known as that of the sulphate. The conversion was of course easily effected, by adding a neutral sulphate of ammonia to the alcoholic solution of the muriate of lithia, evaporating to dryness, and igniting. It was found most convenient also to determine the potash by means of the sulphate, since the addition of sulphate of ammonia to the double salt of platinum and potash, facilitated the separation of the platinum.

I might here mention, that before adding the salt of platinum, the absence of lime was proved by oxalate of ammonia; and by way of precaution, a little hydrosulphuret of ammonia was added, to remove any manganese or iron which might be present. This was in general unnecessary; for the manganese is separated completely in the former parts of the process; and though a little iron always escaped, it was rendered insoluble by the ignition alone.

In the former analysis of the brown Cornwall-mica already alluded to, I did not succeed in separating the lithia from the potash completely. I there followed Professor Gmelin's method of removing the baryta by sulphuric acid, adding muriate of platinum to the mixed sulphates of potash and lithia, and dissolving away the sulphate of lithia from the double salt of platinum and potash by the aid of water. With whatever care this process was performed, the water always took up more or less of the double salt in addition to the sulphate of lithia, and on this account I adopted the process which has just been described.

Analysis of the Zinnwald Mica.—This mica is of a silver-white colour, mixed with grey, as described by Klaproth. It occurs in crystalline groups, the laminæ of which are flexible, elastic, and of considerable size. The specific gravity of some crystals, which had been boiled in distilled water to expel air, was 2.985.

Heated to redness, it suffers no appreciable loss of weight, and undergoes little change of aspect. Before the blow-pipe flame it fuses readily, and at the same time tinges the flame distinctly of a red colour. An appearance of boiling accompanies the fusion, and a black scorious mass is left.

To determine the alkalies, 51.235 grains of the powder were acted on by carbonate of baryta. The mass contracted greatly from the ignition, and became of a dark greenish black colour. By the process already described, I obtained 7.35 grains of sulphate of lithia, equivalent to 2.281 grains, or 4.09 per cent., of pure lithia; and 9.68 sulphate of potash, equivalent to 5.28 grains, or 9.467 per cent., of pure potash.

In making these calculations, it is presumed, that sulphate of potash is composed of 40 sulphuric acid, and 48 potash; and sulphate of lithia, of 40 acid, and 18 lithia. (Dr Thomson.)

The determination of the other constituents is somewhat complicated, owing to the presence of fluoric acid, which occurs in all the micas I have hitherto examined. The method employed by Berzelius in his analysis of the topaz was therefore resorted to; but as it is one of some delicacy, I shall describe the various parts of the process carefully.

A

29.38 grains of the mica, in powder, were mixed with three times their weight of carbonate of soda, and ignited during the space of half an hour in a moderate red heat. The mass had contracted greatly, and was of a dirty-yellow colour, stained green in parts by manganese. It was treated by successive portions of hot water, till all the soluble alkaline matter was completely removed.

B

Carbonate of ammonia was now added to the alkaline solution, and it was then exposed to a temperature of about 100° F., till the ammoniacal odour had completely ceased, by which means the portion of alumina and silica, at first dissolved by the soda, was deposited. The liquid, after filtration, was exactly neutralized by muriatic acid, and the fluoric acid precipitated by muriate of lime. The fluate of lime, after being ignited, weighed 5.41 grains, equivalent (on the supposition that 100 fluate of lime contain 27.86 of fluoric acid) to 1.509 grains, or 5.138 per cent., of fluoric acid.

C

The matter that was undissolved by water in A, together with what separated from the alkaline solution in B, was dissolved by muriatic acid. The solution was evaporated to dryness; the soluble parts were taken up by water acidulated with muriatic acid, and the silica collected on a filtre. After ignition, it weighed 15.07 grains, which is 44.277 per cent.

D

To the acid liquid, while cold and moderately diluted, a solution of carbonate of soda was gradually added, till the alumina and iron were precipitated. They were separated from one another, after filtration, by pure potash. The alumina, after exposure to a white heat, weighed 8.349 grains, which is 24.532 per cent. The ignited peroxide of iron amounted to 3.709 grains, equivalent to 3.329 grains, or

11.33 per cent., of protoxide. It was proved by examination to be pure.

E

The solution from which the iron and alumina had been separated, was boiled briskly to expel carbonic acid, and rendered decidedly alkaline by carbonate of soda. A dirty-white precipitate subsided, which, when heated to redness, amounted to 0.543 grains of the brown oxide of manganese, equivalent to 1.489 grains, or 1.664 per cent., of the protoxide. It proved, on examination, to contain neither lime nor magnesia.

This Mica is hence composed of—

Silica, - - - -	44.28
Alumina, - - -	24.53
Protoxide of iron, - - -	11.33
Protoxide of manganese, - -	1.66
Fluoric acid, - - -	5.14
Potash, - - - -	9.47
Lithia, - - - -	4.09
	100.50

According to the analysis of Klaproth, (*Beyträge*, vol. v. p. 69,) it is composed of—

Silica, - - - -	47
Alumina, - - -	20
Oxide of iron, - - -	15.50
Oxide of manganese, - - -	1.75
Potash, - - - -	14.50
	98.75

Analysis of a Mica from Altenberg, near Zinnwald.—This mica accompanies the peculiar kind of topaz called pycnite. Its colour is of a dull-green; its laminæ are smaller than those of the Zinnwald-mica, and possess flexibility and elasticity in a lower degree. Its specific gravity, when first put into water, was 3.0195; but after being boiled for a short time to expel air from between its laminæ, it was 3.0426.

Its loss, when ignited, is hardly appreciable, not exceeding one quarter per cent. The fire rendered it more brittle, and increased its lustre. When heated before the blow-pipe, it gives rise to the same phenomena as the Zinnwald-mica, but the redness is less distinct.

The analysis itself is so precisely similar to the preceding, that it would be mere repetition to describe it. The result is given below.

Analysis of a Greyish White Mica from Cornwall.—The laminæ of this mica are small and brittle, and it is hence easily pulverized. Its density is 2.814 when first put into water, and 2.897 after being boiled.

Its loss from ignition did not exceed a quarter per cent. It melts readily before the blow-pipe, and bears a close analogy, with respect to the phenomena it then exhibits, with the Zinnwald mica, as well in its fusibility and power of reddening the flame, as in forming a black scoria indicative of iron.

The following Table contains the result of the analysis of the three preceding micas. The result of a new analysis of the brown Cornwall-mica is likewise added.

	Zinnwald.	Grey Cornw.	Altenb.	Brown Cornw.
Silica,	44.28	50.82	40.19	40.06
Alumina,	24.53	21.33	22.72	22.90
Protoxide of iron,	11.33	9.08 black oxide.	19.78 peroxide.	27.06
Protox. of manganese,	1.66	a trace.	2.02	1.79
Fluoric acid,	5.14	4.81	3.99	2.71
Potash,	9.47	9.86	7.49	4.30
Lithia,	4.09	4.05	3.06	2.00
	100.50	99.95	99.25	100.82

The state of oxidation of the iron in these micas is estimated by their colour.

I have been unable, in any of these varieties, to detect the presence of titanium ; nor do lime and magnesia enter into their composition. The essential ingredients, if we may judge from the constancy with which they occur, are silica, alumina, oxide of iron, fluoric acid, and the two alkalies. It is exceedingly curious, as was remarked on a former occasion, that all these micas are found in tin districts; and, if justified by future observation, the occurrence of lithion-mica may even, perhaps, assist the judgment of the practical miner in his search after veins of tin.

I may here notice one circumstance which should not be lost sight of in performing the process for fluoric acid. If manganese existed originally in the mica, a portion of it is sometimes retained by the alkaline solution, and remains in it even after the fluate of lime has subsided, without communicating any colour by which its presence might be suspected. It is a good precaution, therefore, to drop a little hydrosulphuret of ammonia into the liquid, which will separate the manganese if present. It is also advisable to evaporate the solution to dryness, after separating the fluate of lime, to ascertain if all the silica had been separated in the former part of the process.

The substance which was supposed in all these cases to be lithia, has of course been proved to be such. Its characters are quite distinct. It forms a salt with muriatic acid, which is easy of fusion, deliquesces with surprising rapidity, and dissolves in alcohol. It forms, with sulphuric acid, a neutral sulphate, which fuses readily, and afterwards dissolves completely in water. Acetic acid combines with it, and the acetate is deliquescent. When its solution is evaporated, it becomes tenacious like mucilage while drying; and when quite dry is very brittle. When the acetate is ignited, a carbonate is left, which has decided alkaline properties, dissolves with difficulty in water, fuses with great readiness, and shoots into a crystalline mass on cooling. It stains the surface of platinum when fused upon it. These properties leave no doubt whatever of its being lithia.

Professor Gmelin was the first, so far as I know, to show that the alcoholic solution of the muriate of lithia had the property of burning with a red flame; and he even observed that both the sulphate and supersulphate of lithia could cause alcohol to burn in the same manner. This property may, I find, be made apparent in various ways. Perhaps the neatest mode of producing the effect with the muriate of lithia is to dip a little bibulous paper into the alcoholic solution, and set fire to it. If a fragment of the solid muriate or acetate of lithia, slightly moistened, be taken upon the point of a knife, and be made to touch the flame of a candle, a redness will be instantly communicated to it. The carbonate can be made to produce the same effect, though much less distinctly. The sulphate is exceedingly well adapted for the purpose, and this is a very useful fact, as it enables us at once to distinguish lithia from every other salifiable base with which it can be confounded. The muriates of strontia and lime both occasion a red light when they are moistened and brought into contact with the flame of a candle. The acetate of lime has not that property, but the acetate of strontia has. But no sulphate except that of lithia possesses it. The sulphates of lime and strontia, whether moist or dry, give no trace of red; and even if they did, their insolubility at once distinguishes them. * Magnesia is the substance which is most likely to be mistaken for lithia, and the sulphate of that base does not in any way affect the flame of a candle. The sulphate of lithia, on the contrary, has a distinct effect even when minute quantities are used. Thus, to give an extreme case, I have made the redness visible to several persons at a time, with less than $\frac{1}{1000}$th of a grain of the crystallized sulphate of lithia. In operating with such minute quantities, a proportional degree of care is of course requisite. The best mode of performing the experiment is as follows: A particle of the crystallized sulphate is taken upon the point of a pen-knife, and held for an instant in the flame of a candle to make it adhere to the steel; it is next moistened in water, and brought into contact with the extreme border of the flame at its lower part where it burns blue. A red light then appears, forming a sort of fringe to the proper flame of the candle, but it disappears as soon as the salt becomes dry. By moistening it again, the effect is renewed, and the experiment may be repeated a great many times with the same particle of salt. If the sulphate is held in the body of the flame, a mixture of colours is produced, which lessens the distinctness of the effect, and for that reason I have expressly mentioned that it should barely touch the outer border of the flame. It is of course necessary to

* If the sulphate of strontia be finely pulverized, and then made very moist with water, it does communicate a red colour when placed upon the wick of a candle. I have not observed the same effect from sulphate of lime.

make such observations at night, or in a dark room; and a wax candle, from the pure whiteness of its light, is best fitted for them.

While engaged in this inquiry, it became necessary to ascertain what effect the sulphates of potash and soda would exhibit under similar treatment, and I was thus led to an observation of some interest, and which to me is new. When a crystal of Glauber salt is put into the flame of a candle, and more particularly when made to touch the wick, the flame itself enlarges considerably, and becomes of a decidedly yellow colour. When the powdered sulphate of potash, well moistened, is treated in like manner, the candle burns with a pale violet-coloured light, without enlargement of flame. These salts do not produce their characteristic effect when used in very small quantities like the sulphate of lithia. The effects here ascribed to the sulphates of potash and soda, may also be procured with the carbonates and muriates of those alkalies.

There is no doubt, therefore, that the three alkalies, potash, lithia, and soda, may readily be distinguished from one another by their action on the flame of a candle.

From the result of the analyses contained in the present paper, together with the foregoing observations, it is certain that the lithion-micas owe their property of reddening the blow-pipe flame to the presence of lithia, and that this phenomenon is consequently a proof of the presence of that alkali in them.

It would appear from the facts just detailed, that a body must be fluid in order to produce an effect in colouring flame. The insoluble salts of lime and strontia are quite inert, as are the soluble salts of lime, strontia, and lithia, when quite dry. It is perhaps from their easy fusibility that the lithion-micas owe their power of reddening the blow-pipe flame, while other lithion-minerals, as spodumene and petalite, which are of difficult fusibility, do not possess that property. It would follow from this, that by mixing some flux with spodumene, so as to render it fusible, it should acquire the property of tinging the flame red; and if so, an easy and expeditious method might be discovered of ascertaining the presence or absence of lithia in any mineral whatever. My observation has not yet been sufficiently varied for forming an opinion concerning the justice of these remarks; but, in the meantime, I may state, whatever the rationale may be, that when spodumene is mixed up into a paste with fluate of lime, and the blow-pipe flame is thrown upon it, a brilliant red colour appears; whereas spodumene alone does not yield a trace of redness.

With respect to the lithion-micas, I may add, that the presence of potash is most likely one cause of the facility with which they fuse. For I have remarked, that though the compounds of lithia themselves are easily fusible, they become much more so when potash is likewise present. Thus, the mixed carbonates of potash and lithia fuse at a lower temperature than pure carbonate of lithia. In like manner, the mixed muriates are more easy of fusion than pure muriate of lithia; and the same observation is applicable to the sulphates.

(To be continued.)

ART. XI.—*Observations on the Presence of the Waters of the Gulf-Stream on the Coasts of Europe, in January* 1822.* By EDWARD SABINE, Esq. F.R.S. F.L.S. &c. &c.

THE Iphigenia sailed from Plymouth on the 4th January 1822, after an almost continuous succession of very heavy westerly and south-westerly gales, by which she had been re-

* This very interesting paper is abstracted from Captain Sabine's *Account of Experiments to determine the Figure of the Earth by means of the Pendulum vibrating seconds in different Latitudes, as well as on various other subjects of Philosophical Inquiry.* 4to, Lond. 1825. This valuable work, printed at the expence of the Board of Longitude, and dedicated to Davies Gilbert, Esq. M. P., exhibits, in a striking point of view, the varied talents of its author, and bears testimony to the zeal and ability with which he has fulfilled the scientific mission with which he was entrusted by the British Government. Besides the experiments with the pendulum, it contains various interesting geographical notices; experiments for determining the variation in the intensity of terrestrial magnetism, and several curious atmospherical notices.—ED.

peatedly driven back, and detained in the ports of the Channel. The following memorandum exhibits her position at noon on each day of her subsequent voyage from Plymouth to Madeira, and from thence to the Cape Verd Islands, the temperature of the air in the shade, and to windward, and that of the surface of the sea. It also exhibits, in comparison, the ordinary temperature of the ocean at that season, in the respective parallels which Major Rennell has been so kind as to permit me to insert on his authority, as an approximation founded on his extensive inquiries. The last column shows the excess or defect in the temperature observed in the Iphigenia's passages.

Date 1822.		North Lat.	West Long.	Temp. of Air.	Temperature of Surface Water-		Excess or Defect.
					Observed.	Usual.	
Plymouth to Madeira,	Jan. 5,	47° 30′	7° 30′	47° Fahr.	49°	50°	—1
	6,	44 20	9 30	52.5	55.7	52.5	+3.2
	7,	41 22	11 37	54	58.2	54	+4.2
	8,	38 54	13 20	54.2	61.7	55.7	+6
	9,	No Observation.		56	63	58	+5
	10,	33 40	15 30	60.7	64	60	+4
Madeira to the Cape Verd Islands.	19,	26 0	17 50	66	65.5	67	—1.5
	20,	24 30	18 50	68	67	68.4	—1.4
	21,	23 6	20 0	69	69	69.5	—0.5
	22,	21 2	21 27	69.5	69.5	71.2	—1.7
	23,	19 20	23 0	70.6	70.2	71.6	—1.4

It is seen, from the preceding memorandum, that, in the passage from Plymouth to Madeira, the Iphigenia found the temperature of the sea between the parallels of $44\frac{1}{3}$° and $33\frac{2}{3}$° several degrees warmer than its usual temperature in the same season, namely, 3°2 in $44\frac{1}{3}$° increasing to 6° in 39°, and again diminishing to 4° in $33\frac{2}{3}$°, whilst, at the same period, the general temperature of the ocean in the adjoining parallels, both to the northward and to the southward, even as far as the Cape Verd Islands in $19\frac{2}{3}$°, was colder by a degree and upwards than the usual average. The evidence of many careful observers, at different seasons, and in different years, whose observations have been collected and compared by Major Rennell, has satisfactorily shewn that the water of the Gulf-Stream, distinguished by the high temperature which it brings from its origin in the Gulf of Mexico, is not usually found to extend to the eastward of the Azores. Vessels navigating the ocean between the Azores and the continent of Europe, find, at all seasons, a temperature progressively increasing as they approach the sun; the absolute amount varies according to the season, the maximum in summer being about 14° warmer than the maximum in winter; but the progression in respect to latitude is regular, and is nearly the same in winter as in summer, being an increase of 3° of Fahrenheit for every 5° of latitude. It is farther observed, that the ordinary condition of the temperature in that part of the ocean under notice, is little subject to disturbance, and that in any particular parallel and season the limits of variation in different years are usually very small. After westerly winds of much strength or continuance, the sea, in all the parallels, is rather colder than the average temperature, on account of the increased velocity communicated to the general set of the waters of the North Eastern Atlantic towards the southward. To the heavy westerly gales which had prevailed almost without intermission in the last fortnight in November, and during the whole of December, may therefore be attributed the colder temperatures observed in the latitude of 47½°, and in those between 26° and 19⅓°

If doubt could exist in regard to the higher temperature between 44⅓° and 33⅔°, being a consequence of the extension in that year of the gulf-stream in the direction of its general course, it might be removed by a circumstance well deserving of notice, namely, that the greatest excess above the natural temperature of the ocean, was found in or about the latitude of 39°, being the parallel where the middle of the stream, indicated by the warmest water, would arrive by continuing to flow to the eastward of the Azores, in the prolongation of the great circle in which it is known to reach the mid-Atlantic.

One previous and similar instance is on record, in which the water of the gulf-stream was traced by its temperature quite across the Atlantic to the coasts of Europe; this was by Dr Franklin, in a passage from the United States to France, in November 1776.* The latter part of his voyage,

* Franklin's Works, 8vo, London, 1806, vol. ii, pages 200, 201.

i. e. from the meridian of 35° to the Bay of Biscay, was performed with little deviation in the latitude of 45°. In this run, exceeding 1200 miles, in a parallel of which, the usual temperature, towards the close of November, is about 55½°, he found 63° in the longitude of 35° W., diminishing to 60° in the Bay of Biscay; and 61° in 10° west longitude, near the same spot where the Iphigenia found 55° 7′ on the 6th of January, being about five weeks later in the season. At this spot, then, when the Iphigenia crossed Dr Franklin's tract, the temperature, in November 1776, was 5½°, and in January 1822, 3° 2 above the ordinary temperature of the season.

There can be little hesitation in attributing the universal extension of the stream, in particular years, to its greater initial velocity, occasioned by a more than ordinary difference in the levels of the gulf of Mexico, and of the Atlantic. It has been computed by Major Rennell, from the known velocity of the stream at various points of its course, that in the summer months, when its rapidity is greatest, the water requires about eleven weeks to run from the outlet of the Gulf of Mexico to the Azores, being about 3000 geographical miles; and he has farther supposed, in the case of the water of which the temperature was examined by Dr Franklin, that perhaps not less than three months were occupied in addition by its passage to the coasts of Europe, being altogether a course exceeding 4000 geographical miles. On this supposition, the water of the latter end of November 1776, may have quitted the gulf of Mexico, with a temperature of 83° in June; and that of January 1822, towards the end of July, with nearly the same temperature. The summer months, particularly July and August, are those of the greatest initial velocity of the stream, because it is the period when the level of the Caribbean Sea and Gulf of Mexico is most deranged.

It is not difficult to imagine, that the space between the Azores and the coasts of the old continent, being traversed by the stream, slowly as it must be, at a much colder season in the instance observed by the Iphigenia, than in that by Dr Franklin, its temperature may have been cooled thereby to a nearer approximation to the natural temperature of the ocean in the former than in the latter case, and that the difference between the excess of 5° 5′ in November, and of 3° 2′ in January, may be thus accounted for. If the explanation of the apparently very unusual facts observed by Dr Franklin in 1776, and by the Iphigenia in 1822, be correct, how highly curious is the connection thus traced between a more than ordinary strength of the winds within the tropics in the summer, occasioning the derangement of the level of the Mexican and Caribbean Seas, and the high temperature of the sea between the British Channel and Madeira, in the following winter.

Nor is the probable meteorological influence undeserving of attention, of so considerable an increase in the temperature of the surface water, over an extent of ocean exceeding 600 miles in latitude, and 1000 in longitude, situated so importantly in relation to the western parts of Europe.

It is at least a remarkable coincidence, that in November and December 1821, and in January 1822, the state of the weather was so unusual in the southern parts of Great Britain, and in France, as to have excited general observation.

In the meteorological journals of the period, it is characterized as "most extraordinarily hot, damp, stormy, and oppressive;" it is stated, "that an unusual quantity of rain fell both in November and December, but particularly in the latter; that "the gales from the W. and SW. were almost without intermission;" and that in December, the mercury in the barometer was lower than it had been known for thirty-five years before.

ART. XII.—*On the Depression of the Horizon of the Sea over the Gulf-Stream* *. By EDWARD SABINE, Esq. F. R. S. F. L. S. &c. &c.

IN estimating the depression of the horizon of the sea, corresponding to the different heights of an observer's eye, the

* Having already laid before our readers the results of various observations on the depression of the horizon, (see this *Journal*, vol. ii. p. 365,) we think it proper to call their attention to the following valuable obser-

horizon is supposed to be raised by terrestrial refraction, *one-fourteenth* part of the depression due to the spherical figure of the earth; and the corrections for different heights, rigourously computed from the dimensions of the earth, are reduced, accordingly, in that proportion, in the tables of the most approved authorities. Experience has shown, that in general, when the temperature of the air is colder than that of the surface of the sea, the tabular depressions so computed and reduced, are in error in defect,—and when the air is warmer than the sea, in excess—of the true depression: the proportion of the error to the difference of the temperature being, however, too irregular, and the differences themselves subject to exceptions of too decided a character, to allow any practical rule to be established for a corresponding allowance in correction. So long as the error of the table is confined to a few seconds in amount, its occurrence may be safely disregarded in all the ordinary purposes of navigation; but it was a question only to be solved by experience, whether, in cases of an extreme difference between the temperatures of the air and water, the amount of error might not be so considerable as to require attention, especially in deducing a ship's place by chronometrical observations within three hours of noon. It was the purpose of having this question tried in the *Gulf-Stream,* where the sea is frequently many degrees warmer than the air, that Dr Wollaston contrived the dip sector, which, from accidental circumstances, had not been applied in its original design until the present occasion.

The following Table presents an abstract of the observations, (which may be confided in to less than five seconds,) by which it will be seen, that, so far as their evidence can determine, a navigator may be right nine times in ten in apprehending a tabular error in defect when the sea is warmer than the air; but that, with differences in the temperature of the air and water, frequently amounting to between 10° and 20°, and once even so great as 29°, (the sea being always the warmer,) the error of the Tables was not found, even in a single instance, so great as two minutes.

vations of Captain Sabine, taken from the work quoted in the preceding article, and particularly from their connection with the subject of the Gulf Stream.—Ed.

Date.	Geographical Position.	Lat.	Long.	Height of the Eye.		Temperature.	
						Air.	Sea.
1822.				*Ft.*	*In.*		
Aug. 9	Atlantic,	13° 20′ S.	37° 45′ W.	19	2	76°.1	77°.1
Nov. 10.	Caribb. Sea,	18 33 N	79 36	15	3	82	83 .1
10.	Do.	18 33	80	15	3	83 .2	83 .8
11.	Do.	19 20	81 4	15	3	81 .8	83
13.	Do.	20 25	83 30	15	3	80 .	82 .5
14.	Do.	20 40	83 45	15	3.5	79 .	82 .2
14.	Do.	21 0	84 20	15	10	78	82
15.	Do.	21 30	84 55	15	3.5	78 .8	80
17.	G. of Mexico,	22 49	84 57	15	3.5	80 .3	82
17.	Do.	22 51	84 20	15	3.5	80 .2	82 .1
30.	Gulf Stream,	29 12	79 30	15	3.5	78 .8	81 .1
Dec. 4.	Do.	35 40	73 30	18	3	47	76
5.	Do.	36 24	72 40	15	3	60 .5	74
5.	Atlantic,	36 39	72 30	15	3	61 .5	62 .4
6.	Do.	36 58	73 40	15	3	43	60 .6
7.	Do.	37 35	74 33	15	8	49 .5	59 .5
7.	Do.	37 45	74 33	15	3	50 .8	54 .2
8.	Do.	38 30	74 26	15	1	43 .8	53 .5
9.	Do.	40 0	74 0	15	1	37 .8	49 .5
1823.							
Jan. 8.	Gulf Stream,	In the passage from New York to the British Channel.		15	10	52 .5	69 .2
8.	Do.			15	10	56	69
9.	Do.			16	1	64 .2	67
10.	Do.			15	9	61 .8	67 .8
16.	Do.			15	0	56 .5	60
17.	Do.			16	0.5	53 .5	59
17.	Do.			16	0.5	53	59

Art. XIII.—*On the Effects of Heat and Motion.* In a Letter to Dr Brewster from M. Seguin, *aîné.*

Sir,

I beg leave to thank you for having inserted in your interesting Journal the letters which I had the honour of addressing to Mr Herschel, respecting the new views, which I considered as affording a more simple explanation of several physical facts than that which is derived from received theories.

I originally presented these views in reference to their connection with astronomy, because I conceived that a solution of the difficulties might be obtained from a profound study of the laws of gravitation discovered by Newton, and by giving

Depression.		Tabular in Excess or Defect.	Temp. of Air in Excess or Defect.	REMARKS.
Observed.	Tabular.			
4′ 25″.4	4′ 19″	—0′ 6″.4	— 1°	Light airs.
4 3 .4	3 51	—0 12 .4	— 1.1	Wind ENE. pleasant breezes, with fine weather.
3 56 .2	3 51	—0 5 .2	— 0.6	Ditto, ditto, ditto.
3 53 .3	3 51	—0 2 .3	— 1.2	Wind ENE. sunshine, with occasional clouds.
4 17 .2	3 51	—0 26 .2	— 1.7	Wind NE. by E. ditto, ditto.
4 21 .2	3 51.3	—0 29 .9	— 2.7	Ditto, ditto, ditto.
4 18 .7	3 55.5	—0 23 .2	— 4	Wind NE. with light rains.
4 21 .2	3 51.3	—0 29 .9	— 1.2	Fresh NE. breeze, with occasional squalls.
3 51 .3	3 51.3		— 1.7	Ditto, ditto, ditto.
3 48 .7	3 51.3	+0 2 .6	— 1.9	Little wind, with sunshine.
4 14 .2	3 51.3	—0 22 .9	— 2.3	Sunshine.
4 50	4 13	—0 37	—29	Becoming calm after a northerly gale.
4 56 .6	3 51	—1 5 .6	—13.5	Wind light, southerly.
3 36 .6	3 51	+0 14 .4	— 0.9	Wind freshening.
4 57 .8	3 51	—1 6 .8	—17.6	Wind NW., fresh.
5 36 .2	3 55.2	—1 41	—10	Wind light, easterly.
4 37	3 51	—0 46	— 3.4	Soundings in 33 fathoms.
5 15	3 50	—1 25	— 9.7	Wind NW., fresh, soundings in 30 fathoms.
5 45.6	3 50	—1 55 .6	—11.7	Wind faint NW., clear weather, hazy, very distinct, but with the appearance of the inversion of a ripple.
5 16 .6	3 55.6	—1 21	—16.7	Steady breeze ENE.
5 0 .8	3 55.6	—1 5 .2	—13	Ditto,
4 19.2	3 57.6	—0 21 .6	— 2.8	Wind south, fresh.
4 4 .4	3 55	—0 9 .4	— 6	Wind SW. with light squalls.
3 32 .6	3 49	+0 16 .4	— 3.5	Wind E., fresh, with light rain.
4 0 .0	4 0	0 0 0	— 5.5	Ditto, ditto.
4 0 .0	4 0	0 0 .0	— 6	Ditto, ditto.

them all the generality of which they are susceptible. If, as our celebrated astronomer Laplace supposes, the different planetary systems owe their formation to a material mass minutely divided, which, in obeying the single law of being attracted in the inverse ratio of the square of the distance, the molecules, at the origin of their motion, obeying their gravity to reunite at the centre of the mass, and experiencing perturbations from the neighbouring molecules, ought to approach each other more and more, describing curves which satisfy the integral conservation of the motion which they have acquired during the passage they have made. Each particular system will, by this means, have made part of another system, with the power of being able, according to certain laws which are unknown, to give or receive from it a certain quantity of motion, but with the express condition that the t tal sum cannot be augmented or diminished, excepting in so far as there has been an approach or recession of the constituent parts with respect to the common centre of gravity. This law may be applied to a simple crystal, the matter of which is sufficiently dense, that the interval which separates the particles may be comparable to that which separates the celestial bodies in respect to the space which they occupy. This leads to questions of the most important kind, but upon which I do not feel myself capable even of hazarding conjectures.

We see by experience that light, which, from its effects, we regard as a compound body, may penetrate certain other bodies with great facility. Magnetism does not seem to be stopped by the densest bodies with which we are acquainted, neither is it impossible that a molecular mass may circulate round the earth, subject to the same laws as the planets; and since we see magnetism and electricity pass through the densest bodies, may we not conclude from this that currents of matter circulate across the mass of the globe? Astronomy affords us, in the ring of Saturn, the belts of Jupiter, and, perhaps, in the zodiacal light, an example of matter subject to revolve in circular masses. If we suppose on the earth a series of rings subject to move in ellipses, of which the centre of the earth is one of the foci, we might give a sufficient and very simple explanation of the changes in the pole of the magnetic meridian, and of other observed phenomena. Thus it would happen that, in certain points of the globe, the direction of this current would be a tangent to the horizon; that, in other places, it would have an inclination determined by conditions which it would be easy to verify; and, in approaching the pole, it would become almost nothing. The existence of similar satellites does not seem improbable.

Since the existence of the celestial bodies, in general, is independent of their mass, their velocity may be computed at from 5 to 6000 miles per second, which would be sufficient for explaining the great velocity of these fluids. If we apply to insulated bodies the suppositions made on the great scale to the celestial mass, we may conceive the possibility of establishing round two of them similar currents. Experience, indeed, demonstrates, that friction determines electrical currents, whose tenacity is greater, in proportion as the bodies approach a solid of revolution; and the loss of electricity by points comes to the support of the theory, since the molecules, which exist circularly around bodies, ought to separate from it whenever its mass is no longer able, by its attraction, to be in equilibrium with the velocity of its satellite. It would then happen that the parts escaping in a right line, in a tangential direction, might have a velocity sufficiently great to transmit a part of the motion to the organ of vision, and procure us the sensation of sight, and to the organ of smell, the particular sensation which it experiences.

This way of explaining the phenomena differs essentially from the received one, by the motion which I suppose to exist in solid bodies; and the most forcible objection which can be made to it is, that bodies ought to be continually augmenting in density, or to have a general centrifugal motion, which ought to be perceived; but might we not say as much of all the planetary system; and may not the same laws which cause the heavens to present for thousands of years the same aspect, preserve also, during a certain time, the same figure to terrestrial objects. Dense bodies are certainly more or less subject to an intestine motion. Crystallization in the middle of semifluid substances which appear to our eyes in absolute repose, evidently demonstrates this motion, and may explain a variety of geological facts, which are at present extremely embarrassing.

Such are the reasons which induced me to offer my views to the consideration of astronomers. Since that time, I have had the honour of conversing on the subject with Mr Herschel in London, and the satisfaction of having been listened to with a degree of interest, which has encouraged me to communicate to you at present another part of my reflections on this subject.

I would be ashamed to present myself to your notice, as one of the founders of systems, the result of which is almost always to load science with new difficulties; but it appears to me that my object at present consists rather in simplifying, and in seeking to arrange, under laws already known, a series of facts, which, in the present state of science, are, in my opinion, very imperfectly explained.

The striking relations which exist between the production of force and the use of caloric, are well worthy of the notice of philosophers, for the admitted theory actually leads to the creation of force, as to the doctrine of a mechanical perpetual motion, which it is impossible to admit. If we suppose, indeed, that at each stroke of the piston of a high-pressure steam-engine, the quantity of caloric employed is represented exactly by the elevation of temperature of the water of condensation, abstracting all loss, it follows, that we have lost nothing in obtaining a very great effect, and that, if it were possible (which is supposable) to condense the caloric contained in a mass M, into another represented by $\frac{M}{x}$, in such a manner that it may be reduced into vapour at the primitive pressure, we may, by means of a small quantity of caloric, produce an indefinite number of oscillations.

If, instead of considering the pressure exerted on a piston, or suppose the vapour condensing in a cylinder, the reasoning will be the same, and the two cases will present in the dilatation of the aeriform fluid, a loss of temperature, which we may consider as the true employment of the caloric. The consideration of the proper motion of bodies given, is simple, and, in my opinion, a satisfactory explanation of these phenomena. For, if we suppose that the molecules of water are subject to a circular motion, and that the velocity the caloric of bodies, or rather is caloric itself, then it is evident, that the mass will augment with the acceleration of the velocity, till it reaches an epoch, at which the motion will be so great, that the attraction which retains the molecules at a distance from one another, is insufficient to maintain the equilibrium. The molecules will then begin gradually escaping in all directions in a right line in the direction of the tangent, and will communicate it to other bodies which they meet, till they have lost as much as will prevent the two faces again to come into equilibrium. I have the honour to be, your humble and obedient servant,

SEGUIN *ainé.*

ANNONAY, *Dep. de L'Ardeche,*
March 28, 1825.

ART. XIV.—*Observations on the apparent Distances and Positions of* 389 *Double and Triple Stars.* By J. F. W. HERSCHEL, Esq. Sec. R.S. Lond. and F.R.S. Edin., and JAMES SOUTH, Esq. F.R.S. Lond. and Edin.

MORE than forty years ago, the late celebrated Sir W. Herschel directed the attention of astronomers to the importance of determining the distances and positions of double stars; and during the years 1779 and 1784, he published in the *Philosophical Transactions*, descriptions and names of 702 double and triple stars. The result which he obtained in this inquiry, may be considered as forming an entirely new department of physical astronomy, in which the agency of attractive forces has been found to exist in the remotest regions of the sidereal universe.

It was fortunate for astronomy, that a subject of such interest was taken up by his son, whose mathematical acquirements, and habits of nice observation, fitted him in a peculiar manner for the task, and that he was aided by such an excellent observer as Mr South. The object with which these gentlemen commenced this inquiry, was to determine the existence and amount of annual parallax, but this was soon lost sight of amid the more extensive views of the construction of the universe, which gradually unfolded themselves. They have clearly established the existence of binary systems, in which two stars perform to each other the offices of sun and planet. They have ascertained with considerable exactness the periods of rotation of more than one such pair. They have observed the immersions and emersions of stars behind each other; and they have detected among them real motions sufficiently rapid to become measurable quantities in very short intervals of time.

The instruments employed by Mr Herschel and Mr South, were two achromatic telescopes of *five* and *seven* feet focal length, mounted equatorially. The object-glass of the *five* feet telescope, has an aperture of 3¾ inches, and was made by the late P. and J. Dollond. The power usually employed was 133, but powers of 68, 116, 240, 303, and 381, were occasionally used, by double eye-pieces; and a single lens, with a power of 578, was sometimes applied for the purpose of minute scrutiny.

The object-glass of the *seven* feet telescope, which is considered the *chef-d'œuvre* of Mr Tully, has a clear aperture of *five* inches, and under high magnifying powers it is supposed to be surpassed in distinctness by no refractor in existence. Under favourable circumstances, and with a power of 600, the discs of the two stars of η Coronæ, and of σ Coronæ; of ζ Bootis, and of ζ Orionis, are shown perfectly round, and as sharply defined as possible. The power usually employed was 179, but a lower power of 105, and a higher power of 273 were occasionally resorted to.

In observing with these fine instruments, Mr Herschel and Mr South found that the proper degree of illumination was a matter of great consequence, and that it differed in almost each particular star. They found that *many very minute stars bore, without extinction, strong degrees of illumination, and were even the better for it, while others apparently brighter were found unable to bear even the slightest extraneous light.* This they considered as probably owing to an excess of blue light in the star, forming a contrast* with the ruddy tint of the lamp's illumination, for the most remarkable instances of the phenomena were those in which the small star was decidedly of a blue colour.

For example—

σ *Scorpii* is much improved by illumination.

* We are disposed to ascribe this curious phenomenon to the circumstance of the *blue* colour of the star being the harmonic colour of the *orange yellow* tint of the lamp-light. When the retina is impressed with any colour, it is more sensible to weak impressions of its harmonic colour than to any other.—Ed.

η *Lyræ.* A small blue star, was much improved by illumination.

ι *Trianguli.* A small blue star, bears illumination very well.

η *Persei.* A small and extremely faint blue star, bears illumination well.

59 *Serpentis.* A small blue star of the 9th mag. *bears all the illumination.*

22 *Monocerotis.* A small star, bears the illumination well, while a small white star near it bears it ill.

θ *Virginis.* The extremely faint small star bears a good illumination.

51 *Piscium.* This star, of a ruddy plum colour, bears a very bad illumination in proportion to its size.

When the stars under examination had the last degree of faintness, Mr Herschel and Mr South resorted to a singular method of obtaining a view of them, and even a rough measure of the angle of position. *They directed the eye to another part of the field.* In this way, a faint star in the neighbourhood of a large one will often become very conspicuous, so as to bear a certain illumination, which will yet *totally disappear,* as if suddenly blotted out, when the eye is turned full upon it, and so on, appearing and disappearing alternately, as often as we please. The small companion of 23 (h) Ursæ Majoris, is a remarkable instance of this, and also ζ Persei; 7 Tauri; 43 Persei; ι Leporis (R. Asc. $5^h. 4^m.$); 63 Geminorum. "The lateral portions of the retina," our author remarks, "less fatigued by strong lights, and less exhausted by perpetual attention, are probably more sensible to faint impressions than the central ones, which may serve to account for this phenomenon."

The explanation here given of this curious phenomenon is, we apprehend, not well founded; but as the subject is a very interesting one, we shall make it the subject of the next article.

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

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″ Dec.	
1	35 Piscium	0 6	7 49 N	60 46	*sf*	0 11.168	Unchanged.
2	38 Piscium	0 8	7 51 N	32 9	*sp*	4.967	Unchanged.
3	51 Piscium	0 23	5 57 N	7 11	*nf*	25.866	Changed in Position.
4	π Andromed.	0 27	32 43 N	85 26	*sf*	35.951	Unchanged.
5	α Cassiopeæ	0 30	55 33 N	7 52	*np*	———	Unchanged in Angle; Dist. probably increased
6	Andromed. 142	0 37	29 58 N	34 0	*sp*	46.464	Unchanged.
7	V. 82	0 37	50 7 N	11 29	*nf*	47.136	3° 41′ in Pos., and — 3″.706 in Dist.
8	η Cassiopeæ	0 38	56 51 N	7 56	*nf*	8.789	Binary + 0°.5133; mean annual motion.
9	65 Piscium	0 40	26 43 N	25 48	{ *np* *sf* }	5.960	Binary? —0°.117 = mean annual motion.
10	Nova	0 42	67 51 N	55 12	*sp*	3.151	
11	Andromed. 164	0 50	43 44 N	78 57	*sp*	7.520	
12	26 Ceti	0 54	0 24 N	14 39	*sp*	15.756	Unchanged.
13	77 Piscium	0 56	3 57 N	7 20	*nf*	32.069	Unchanged.
14	74 ψ Piscium	0 56	20 30 N	71 2	*sf*	30.340	Pos. unchanged.
15	Polaris	0 58	88 22 N	61 11	*sp*	18.701	Unchanged.
16	ζ Piscium	1 4	6 37 N	26 33	*nf*	24.648	Unchanged.
17	37 Ceti	1 5	8 45 S	62 27	*pn*	50.780	Pos. unchanged; Dist. much increased.
18	ψ Cassiopeæ	1 13	67 11 N	11 19	*sf*	33.347	Unchanged.
19	100 Piscium	1 25	11 38 N	9 35	*nf*	16.018	Unchanged.
20	γ Arietis 1 & 2	1 44	18 25 N	88 41	{ *np* *sf* }	9.109	Unchanged.
21	γ Arietis 1 & 3	—	——	4 46	*nf*	3 48.764	
22	47 Cassiopeæ	1 47	76 25 N	77 41	*sp*	1 33.594.	
23	λ Arietis	1 48	22 43 N	44 19	*nf*	37.889	Unchanged.
*24	Ceti 292	1 51	23 48 S	36 30	*np*	9.080	Much changed if the same star.
25	α Piscium	1 53	1 53 N	65 33	*np*	5.428	Unchanged.
26	γ Andromed.	1 53	41 28 N	25 14	*nf*	10.909	Unchanged.
27	59 Androm.	2 0	38 11 N	56 5	*nf*	17.157	Pos. unchanged.
28	ι Trianguli	2 2	29 27 N	12 2	*nf*	3.881	Pos. changed—7° 39′.
29	66 Ceti	2 3	3 17 S	43 55	*sp*	16.173	Dist. unchanged.
30	H. C. 124	2 4	29 34 N	22 50	{ *sp* *nf* }	6.067	
31	10, *a*? Trianguli	2 8	7 49 N	61 4	*sp*	14.347	
32	30 Arietis	2 26	23 52 N	2 26	*np*	38.445	Dist. increased.
33	33 Arietis	2 30	26 17 N	88 20	*nf*	29.185	Pos. unchanged.
*34	η Persei 1 & 2	2 38	55 8 N	29 53	*np*	28.959	Pos. Variable + 0°.25 per annum.
	——— 1 & 3	—	——	24 48	*np*	3 57.175	
35	π Arietis	2 39	16 42 N	32 29	*sf*	3.076	
36	41 Arietis	2 39	26 31 N	43 24	*sp*	2 7.557	Unchanged in Dist.
37	Ceti 499	2 59	6 46 N	73 25	*sf*	1 21.283	
38	32 Eridani	3 45	3 30 S	79 1	*np*	8.081	Sensibly changed.
39	ε Persei 1 & 2	3 46	39 29 N	79 38	*nf*	8.587	Pos. unchanged. Dist. increased sensibly.
	——— 1 & 3	—	——	54 0	*sf*		
40	φ Tauri	4 9	26 54 N	29 33	*sp*	56.841	Unchanged.
41	χ Tauri	4 12	25 11 N	66 4	*nf*	19.962	Unchanged.

».	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″ Dec.	
2	62 Tauri	4 13	23 52 N	19 37	*np*	29.052	Unchanged.
3	1 Camelopardali	4 18	53 31 N	36 26	*np*	10.450	
4	57. *m.* Persei	4 21	42 39 N	71 8	*sp*	1 50.193	Dist much increased + 13″.7.
5	88. *d.* Tauri	4 26	9 47 N	28 59	*np*	1 9.455	Dist. unchanged.
6	55 Eridani	4 35	9 9 S	48 20	{ *np* / *sf* }	10.510	Unchanged?
7	ω Aurigæ	4 47	37 36 N	82 1	*np*	7.892	Unchanged.
8	62 Eridani	4 48	5 28 S	15 16	*nf*	1 5.865	Position unchanged.
9	Orionis 26 1 & 2	4 49	14 15 N	34 36	*np*	38.827	
	——— 1 & 3	—	———	1 12	*nf*	. . .	
0	IV. 43	5 0	8 53½ S	10 6	*nf*	21.763	Position hardly changed.
1	Capella	5 4	45 48 N	78 2	*np*	7 34.206	
2	14 Aurigæ	5 4	32 28 N	45 37	*sp*	14.610	Dist. unchanged; Pos. —8°.0.
3	β Orionis	5 6	8 25 S	69 19	*sp*	8.878	Unchanged in Pos. hardly in dist.
4	23 Orionis	5 13	3 21 N	62 40	*nf*	33.043	Unchanged.
5	118 Tauri	5 18	25 0 N	75 59	*sp*	5.666	Unchanged.
6	32 Orionis	5 21	5 48 N	66 49	*sp*	< 1.300	BINARY? mean motion —0°.414.
7	Anonyma	5 21	3 11 N	62 41	*sf*	24.731	
8	III. 93	5 22	16 55 N	52 4	*sf*	9.790	Pos. unchanged.
9	33 *n* Orionis 1 & 2	5 22	3 9 N	63 21	*nf*	2.025	Unchanged.
	——— 1 & 3	—	———	55 54	*np*	4 19.734	
0	δ Orionis	5 23	0 27 S	89 57	*nf*	54.875	Unchanged.
1	Nova	5 23	2 39 N	83 9	*np*	1 8.912	
2	λ Orionis	5 25	9 48 N	49 14	*nf*	5.574	Unchanged.
3	σ Orionis AB	5 30	2 43 S	6 41	*nf*	12.912	Unchanged.
	——— AC	—	———	28 57	*nf*	42.765	Unchanged.
4	——— AD	—	———	52 57	*np*	3 30.805	
5	——— AG	—	———	33 44	*sf*	5 10.131	
	——— AH	—	———	31 11	*nf*	8 45.375	
6	——— DE	—	———	3 39	*sp*	11.136	Pos. unchanged.
	——— DF	—	———	68 11	*nf*	1 8.255	Very little changed.
7	ζ Orionis	5 32	2 3 S	60 3	*sf*	2.625	
	Comes	—	———	82 50	*nf*		
8	θ Aurigæ	5 47	37 11 N	82 16	*np*	2 5.051	
9	8 Monocerotis	6 14	4 41 N	64 39	*nf*	14.379	
0	15 Geminorum	6 17	20 54 N	65 21	*sp*	32.693	Unchanged.
1	11 Monocerotis A,B	6 20	6 55 S	39 29	*sf*	6.862	Unchanged.
	Ditto B and C			10 41	*sf*	3.243	Unchanged.
	Comes			67 20	*np*		
2	20 Geminorum	6 22	17 54 N	61 3	*sp*	19.454	
3	ν Canis Maj.	6 29	18 31 S	10 8	*sp*	17.240	Changed in Pos.; ? in Dist.
4	12 Lyncis	6 30	59 37 N	68 39	*sf*	2.593	BINARY — 0°.5574 per annum.
				36 50	*np*	9.849	Pos. changed; +0°.109 per annum.
75	56 Aurigæ	6 34	43 45 N	72 52	*nf*	55.386	Pos. unchanged.
76	38 Geminorum	6 44	13 24 N	84 24	*sf*	0 5.528	Dist. diminished.
77	ζ Geminorum	6 53	20 50 N	85 27	*np*	1 31.032	Pos. slightly changed.
78	19 Lyncis	7 8	55 37 N	43 5	*sp*	14.544	Scarcely changed.
				86 45	*sf*	3 33.357	
79	20 Lyncis	7 9	50 27 N	17 21	*sp*	16.988	
80	δ Geminorum	7 9	22 18 N	74 35	*sp*	7.218	Probably unchanged.

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″	
*81	α Geminorum 1 & 2	7 23	32 17 N	3 57 Ep. 1822. 16	sp	5.355 Ep. 1822. 10	BINARY. Mean mot. —0°.965.
	———— 1 & 3			71 34	sf	1 10.180	
	———— 1 & 4			45 45	sp	3 17.114	
*82	Canis Min. 31	7 31	5 43 N	37 8	sf	————	BINARY? Pos. changed —10°.
83	π Geminor.	7 36	33 51 N	69 55	np	1 33.984	
84	2 Argo Navis	7 37	14 15 S	69 27	np	19.660	Pos. unchanged
85	Geminor. 201	7 38	18 47 N	0 9	sp	6.384	Unchanged.
86	Urs. Maj. ? 2	7 46	63 34 N	6 48	nf	46.647	
87	14 Canis Min. 1 & 2	7 49	2 47 N	24 18	nf	1 16.021	Dist. increased greatly.
	———— 1 & 3	—	———	62 50	sf	1 52.168	Single measures.
88	11 Cancri	7 58	28 0 N	84 30	np	4.498	Unchanged.
89	29 Monocer 1 & 2	8 0	2 28 S	27 1	sp	1 6.503	
	———— 1 & 3	—	———	30 16	sp	3 18+	Distance an inaccurate estimation only.
*90	ζ Cancri	8 2	18 11 N	68 17	sf	6.241	BINARY? Mean mot = —0°.5813; —23° 42′ in Angle, and —1″.805 in Dist.
91	19 Argo Navis	8 3	12 24 S	14 3	sp	1 10.175	
*92	24. υ. Cancri	8 16	25 7 N	52 13	nf	6.046	BINARY? Mean mot —0°.514; Dist. increased 2″.
93	φ2 Cancri	8 16	27 31 N	58 47	{sp nf}	5.514	Unchanged.
94	Hydræ 18	8 26	7 15 N	65 57	nf	10.844	Scarcely changed in Pos
95	48 ι. Cancri	8 36	29 25 N	37 42	np	29.387	Unchanged (? colour.)
96	144 of the 145	8 39	71 27 N	58 51	{sp nf}	8.745	
97	IV. 111	8 41	15 29 N	34 16	sf	16.521	Position changed —5 16.
98	57. ι 2 Cancri	8 43	31 16 N	70 11	np	1.894	Unchanged.
99	17 Hydræ	8 47	7 17 S	86 8	{np sf}	5.723	Unchanged.
100	σ. 3. Cancri	8 49	33 7 N	24 49	np	1 29.731	Pos. unchanged.
101	67. ρ. Cancri	8 51	28 36 N	52 40	np	1 43.144	Pos. unchanged.
102	Cancri 194	8 57	23 42 N	68 37	sp	7.640	Pos. unchanged; Dist. —1″.19.
103	Urs. Maj. 53	8 59	62 24 N	64 49	nf	25.346	
104	38 Lyncis I. 9	9 7	37 34 N	27 20	sp	2.887	Unchanged.
105	27 Hydræ	9 42	8 48 S	59 21	sp	3 45.689	Pos. Unchanged.
106	τ Hydræ	9 20	2 0 S	86 49	nf	1 6.683	Pos. very slightly changed.
107	6 Leonis	9 22	10 30 N	15 27	nf	38.128	Scarcely altered.
108	7 Leonis	9 26	15 10 N	9 25	nf	44.199	Unchanged.
109	14 Leonis	9 32	10 43 N	53 38	nf	1 10.829	Changed in Pos. and Dist. ?
110	Felis 40	9 56	12 17 S	2 45	np	21.498	
111	α Leonis	9 59	12 51 N	37 16	np	2 54.906	Slight change in Pos.
112	145 of the 145	10 3	71 55 N	75 20	sf	16.843	
*113	γ Leonis 1 & 2			8 24	sf	3.243	BINARY. Mean mot + 0°.30; Epoch 1822.24.
	———— 1 & 3			27 30	np	————	Inaccurate.
114	Leonis 145	10 11	7 22 N	80 15	nf	6.723	Pos. changed 4° 47′; Dis unaltered.
115	Leonis 155	10 14	6 38 N	60 23	np	10 .387	Unchanged.
116	35 Sextantis 1 & 2	10 34	5 42 N	32 26	sp	0 7.869	
	———— 1 & 3	—	———	60 30	sp	5 33.500	Single measures.

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″	
117	54 Leonis	10 46	25 43 N	8 19	*sf*	7.023	Unchanged.
118	V. 111	10 49	59 50 N	51 46	*nf*	35.010	Dist. increased. ?
119	68 of the 145	11 6	53 44 N	75 29	*np*	13.144	
120	26 of the 145	11 8	6 8 S	7 37	*sf*	1 7.062	
121	φ Leonis	11 8	2 40 S	16 56	*np*	1 46.256	Much chan. in Pos. & D.
122	ξ Ursæ Maj.	11 9	32 33 N	11 33	*sp*	2.809	BINARY. Mot. =— 5.036. Annual mot.
				Ep. 1823.29		Ep. 1823.19	very variable.
123	Camelop. 201	11 17	82 2 N	43 13	*np*	21.876	
124	83 Leonis	11 18	4 0 N	61 7	*sf*	29.542	Pos. changed +6° 11′.
125	τ Leonis	11 19	3 50 N	79 8	*sf*	1 35.127	Much increased in Dist.
126	70 of the 145	11 21	42 21 N	0 21	*sf*	13.040	
127	88 Leonis	11 23	15 22 N	50 14	*np*	14.670	Scarcely altered.
128	90 Leonis 1 & 2	11 25	17 48 N	61 8	*sp*	4.452	No change.
	——— 1 & 3	—	———	36 41	*sp*	1 0.753	Pos. unchanged.
129	93 Leonis	11 38	21 13 N	86 15	*np*	1 14.897	
130	Nova	11 38	21 2 N	65 3	*nf*	I 16.861	
131	ξ Virginis 1 & 2	11 39	9 15 N	3 25	*np*	———	
	——— 1 & 3	—	———	53 19	*np*	———	
132	V. 60	11 44	16 26 N	75 57	*nf*	37.112	Pos. changed —5°.
133	65 Ursæ Maj. 1 & 2	11 46	47 29 N	55 26	*nf*	4.020	Unchanged.
	——— 1 & 3	—	———	24 17	*sf*	1 2.185	Scarcely altered.
134	2 Comæ Ber.	11 55	52 28 N	31 15	*sp*	3.685	Very little if at all
135	H. C. 354	12 3	24 28 N	46 19	*sp*	12.102	changed.
136	Camelop. 207	12 3	82 43 N	13 16	*nf*	1 3.445	
137	H. C. 152	12 6	6 15 S	18 9	*np*	9.225	
138	2 Canum Ven.	12 7	41 40 N	10 29	*sp*	11.534	Unchanged.
139	STRUVE 408	12 8	81 6 N	50 15	*sp*	15.389	
140	22 of the 145	12 9	2 56 S	72 58	*sp*	21.017	
141	Comæ Ber. 55	12 12	28 5 N	23 42	*sp*	9.453	
142	17 Virginis	12 13	6 19 N	69 36	*np*	20.937	change of + 11° 15′ in Pos., arising from proper motion.
143	12 Comæ Ber.	12 13	26 51 N	78 47	*sf*	1 5.950	Pos. unchanged.
144	H. C. 385	12 19	45 50 N	73 52	*sf*	11.079	
145	δ Corvi	12 21	15 30 S	56 27	*sp*	24.005	Unchanged.
146	H. C. 231	12 22	2 20 N	19 39	*np*	49.745	
147	118 of the 145	12 25	75 46 N	67 10	*nf*	5.865	
148	24 Comæ Ber.	12 26	19 22 N	2 7	*np*	20.647	Unchanged.
149	38 of the 145	12 32	12 1 S	29 26	*sf*	6.881	
150	γ Virginis	12 33	0 27 S	13 24	*sf*	3.794	BINARY. Elliptic orbit probably. Mean mot.
151	III. 53	12 36	2 54 S	78 15	*np*	16.766	—0°.667.
152	H. C. 230	12 40	4 48 N	75 38	*sp*	10.109	
153	IV. 58 1 & 2	12 43	20 9 N	67 49	*sp*	16.963	Unchanged.
	——— 1 & 3	—	———	59 23	*np*	4 9.666	
	——— 1 & 4	—	———	4 0	*sp*	10 31.644	
154	35 Comæ Ber.	12 44	22 14 N	38 18	*sf*	29.494	Unchanged.
155	H. C. 73	12 44	16 0 N	79 53	{ *sp* *nf* }	7.995	
156	II. 42	12 46	3 54 S	60 19	*sf*	0 6.758	Pos. changed +7°.55′.
157	PIAZZI XII. 221	12 47	12 29 N	73 43	*sj*	29 170	
158	12 Canum Ven.	12 48	39 18 N	43 2	*sf*	19.764	Unchanged.
159	STRUVE 430	12 46	55 1 N	15 15	*np*	4 136	
160	θ Virginis 1 & 2	13 1	4 34 S	77 9	*np*	8.301	Pos. changed +7 50′.
	——— 1 & 3			24 3	*np*		
161	54 Virginis	13 4	17 51 S	56 17	*nf*	6.774	Distance increased.

No.	Star's Name.	R. A.	Decl.	Angle of Position.	Quadrant.	Distance.	Remarks.
		h. m.	° ′	° ′		′ ″	
162	Piazzi XIII. 25	13 6	10 24 S	28 21	*nf*	44.847	
163	H. C. 506	13 15	3 38 N	13 39	{ *nf* / *sp* }	28.465	
164	ζ Ursæ Maj.	13 17	55 52 N	57 46	*sf*	14.455	Unchanged.
165	V. 128	13 23	11 46 S	11 13	*nf*	47.720	Distance increased.
166	H. C. 335 ?	13 26	27 10 N	24 51	*nf*	9.613	
167	81 Virginis	13 28	6 57 S	47 16	*nf*	4.020	Pos. changed —6° 4′.
168	H. C. 335 ?	13 41	27 52 N	70 25	*sf*	5.664	
169	η Bootis	13 46	19 19 N	29 27	*sf*	2 6.203	
170	H. C. 162	13 46	33 43 N	58 28	*np*	7.780	
117	τ Virginis	13 52	2 26 N	19 57	*np*	1 19.290	
172	82 of the 145	13 54	20 17 N	71 43	*sf*	21.392	
173	98 of the 145	14 5	6 14 N	79 20	*sp*	6.049	
174	κ Bootis	14 7	52 39 N	31 15	*sp*	13.136	Position slightly changed.
175	ι Bootis	14 10	52 12 N	56 36	*nf*	38.047	Very little changed.
176	Piazzi XIV. 62	14 13	6 56 S	77 6	*np*	5.880	
177	H. C. 334	14 14	9 16 N	83 24	*sp*	7.185	
178	H. C. 470	14 15	12 3 N	65 17	*np*	10.192	
179	χ Turdi Sol	14 15	19 8 S	25 49	*np*	35.121	
180	H. C. 165	14 22	29 6 N	7 36	*sp*	25 781	
181	π Bootis	14 32	17 12 N	7 53	*sf*	6.889	Unchanged.
182	ζ Bootis	14 33	14 31 N	36 58	*sf*	1.683	
183	II. 82	14 36	8 27 N	4 27	*sf*	7.335	Unchanged in Position.
184	73 Hydræ	14 36	24 40 S	46 40	*sf*	9.995	Changed 8° 25′ in Pos.
*185	ε Bootis	14 37	27 51 N	52 59 Ep. 1822.55	*np*	3.931 Ep. 1822. 55	Binary. Mean mot. + 0°.4378
186	α Libræ	14 41	15 15 S	44 33	*np*	3 50.853	
187	ζ Bootis	14 43	19 51 N	70 54	*np*	8.696 Ep. 1822. 63	Greatly changed, perhaps by proper motion both in Angle and Distance.
188	39 Bootis	14 44	49 27 N	45 55	*sf*	4.626	Probably changed in Pos. Our obs. rather dubious.
189	Bootis 346	14 55	48 2 N	68 53	*sf*	36.544	Unchanged.
190	28 of the 145	14 48	20 35 S	0 9	*np*	10.833	

(To be continued.)

Art. XV.—*On some Remarkable Affections of the Retina, as exhibited in its insensibility to indirect Impressions, and to the Impressions of attenuated Light.** By David Brewster, LL.D. F. R. S. Lond., and Sec. R. S. Edin.

Among the various phenomena of vision which were observed by the philosophers of the last century, those which arise from

* This paper formed the third section of a Memoir *On the Structure and Functions of the Human Eye*, which was read before the Royal Society of Edinburgh on the 2d December 1822.

indirect impressions, and from the influence of highly attenuated light upon the retina, seem to have escaped their notice.

If we look at a narrow slip of white paper placed upon a black or a coloured ground, it will never appear to vanish, however long and attentively we view it. But if the eye is fixed steadily upon any object within two or three inches of the paper, so as to see it only *indirectly*, or by oblique vision, the slip of paper will occasionally disappear, as if it had been removed entirely from the ground, the colour of the ground extending itself over the part of the retina occupied by the image of the slip of paper.

If the object seen indirectly is a *black* stripe on a white ground, it vanishes in a similar manner; and, what is still more remarkable, the same phenomena of disappearance take place *whether the object is viewed with one or with both eyes.*

When the indirect object is luminous, like a candle, it never vanishes entirely, unless it is placed at a great distance; but it swells and contracts, and is surrounded by a halo of nebulous light, so that the excitement must extend itself to contiguous portions of the retina which are not influenced by the light itself.

If we place two candles at the distance of about eight or ten feet from the eye, and about twelve inches from each other, and view the one directly and the other indirectly, the indirect image will be encircled with a bright ring of *yellow* light, and the bright light within the ring will have a pale blue colour. If the candles are viewed through a prism, the red and green light of the indirect image vanish, and leave only a large mass of yellow, terminated with a portion of blue light.

While performing this experiment, and looking steadily and directly at one of the prismatic images of the candle, I was surprised to observe that the red and green rays began to disappear, leaving only *yellow* and a small portion of *blue*; and when the eye was kept immoveably fixed on the same part of the image, the yellow light became almost pure white, so that the prismatic image was converted into an elongated image of white light.

If the slip of white paper, viewed indirectly with both eyes, is placed so near as to be seen double, the rays which proceed from it no longer fall on corresponding points of the retina. In this case, the two images do not vanish simultaneously; but when the one begins to disappear, the other begins soon after it, so that they sometimes appear to be extinguished at the same time.

In order to ascertain whether or not the accidental colour of an object seen indirectly would remain after the object itself had disappeared, I placed a rectangular piece of a *red* wafer upon a white ground, and having looked steadily at an object in its vicinity, the wafer disappeared, and though the accidental colour showed itself just before the wafer had vanished, yet no trace of colour was visible afterwards.

The insensibility of the retina to *indirect impressions* has a singular counterpart in its insensibility to the *direct impressions* of attenuated light. When the eye is steadily directed to objects illuminated by a feeble gleam of light, it is thrown into a condition nearly as painful as that which arises from an excess of splendour. A sort of remission takes place in the conveyance of the impressions along the nervous membrane; the object actually disappears, and the eye is agitated by the recurrence of excitements which are too feeble for the performance of its functions. If the eye had, under such a twilight, been making unavailing efforts to read, or to examine a minute object, the pain which it suffers would admit of an easy explanation; but, in the present case, it is the passive recipient of attenuated light, and the uneasiness which it experiences can arise only from the recurring failures in the retina to transmit its impressions to the optic nerve.

The preceding facts respecting the affections of the retina, while they throw considerable light on the functions of that membrane, may serve to explain some of those phenomena of the evanescence and reappearance of objects, and of the change of shape of inanimate objects, which have been ascribed by the vulgar to supernatural causes, and by philosophers to the activity of the imagination. If in a dark night, for example, we unexpectedly obtain a glimpse of any object, either in motion or at rest, we are naturally anxious to ascertain what it is, and our curiosity calls forth all our powers of vision. This anxiety, however, serves only to baffle us in all our attempts. Excited only by a feeble illumination, the retina is not capable of affording a permanent vision of the object, and while we are straining our eyes to discover its nature, the object will entirely disappear, and will afterwards appear and disappear alternately.* The same phenomenon may be observed in day light by the sportsman, when he endeavours to mark, upon the monotonous heath, the particular spot where moor-game has alighted. Availing himself of the slightest difference of tint in the adjacent heath, he keeps his eye steadily fixed upon it as he advances; but whenever the contrast of illumination is feeble, he invariably loses sight of his mark, and if the retina is capable of again taking it up, it is only to lose it again.

Since the preceding paper was read, Mr Herschel and Mr South † have described a very curious fact, which has some analogy with the phenomena now described.

"A rather singular method," they remark, "of obtaining a view, and even a rough measure of the angles of stars, *of the last degree of faintness*, has often been resorted to, viz. to *direct the eye to another part of the field.* In this way, a faint star, in the neighbourhood of a large one, will often *become very conspicuous*, so as to bear a certain illumination, which will yet *totally disappear*, as if suddenly blotted out, when the eye is turned full upon it, and so on, *appearing* and disappearing alternately, as often as you please. The lateral portions of the retina, less fatigued by strong lights, and less exhausted by perpetual attention, are probably more sensible

* An analogous phenomenon, but arising from a quite different cause, must have often been observed by persons who are very long-sighted. In a dark night, the pupil dilates to such a degree as to deprive the eye of its power of adjusting itself to moderate distances. (See this *Journal*, vol. i. p. 80.) Hence, if an object presents itself within that distance, the observer must see it with a degree of indistinctness which cannot fail to surprise him, especially as all distant objects, particularly those seen against the sky, will appear to him with their usual sharpness of outline.

† See the *Phil. Trans.* 1824, part iii, p. 15, and page 283 of this Number.

to faint impressions than the central ones, which may serve to account for this phenomenon." *

As it is with much diffidence that I venture to controvert any opinion entertained by Mr Herschel, I have been at some pains to investigate the subject experimentally. I was, at first, disposed to ascribe the evanescence of the faint star, solely to the same cause as the evanescence of faintly illuminated surfaces, and the reappearance of the star by indirect vision, to the circumstance of the retina recovering its tone, by contemplating another object sufficiently luminous for vision; but this opinion was not well founded.

If a given quantity of light, which is unable to afford a sustained impression when expanded over a surface, is concentrated into a luminous point, it is still less fitted for the purposes of vision. It then acts upon the retina somewhat in the same way as a sharp point does upon the skin. The luminous point will alternately vanish and reappear; and if the retina is under the influence of a number of such points, it will be thrown into a state of painful agitation. The same effect is produced by a sharp line of light; the retina is, in this case, thrown into a state of undulation, so as to produce an infinite number of images parallel to the luminous line; and when this line is a narrow aperture held near the eye, a sheet of paper, to which it is directed, will appear covered with an infinity of broken serpentine lines parallel to the aperture. When the eye is stedfastly fixed, for some time, upon the parallel lines which are generally used to represent the sea in maps, the lines will all break into portions of serpentine lines, and *red*, *yellow*, *green*, and *blue* tints will appear in the interstices of them.

The evanescence of stars, therefore, of the last degree of faintness, must be ascribed, both to their deleterious action upon the retina as points of light, and to the insufficiency of their light to maintain a continued impression upon the retina.

* If we recollect rightly, a similar fact, with regard to the satellites of Saturn, is recorded in a late number of the *Ann. de Chimie*, and a similar explanation given. It was, we think, noticed by some of the astronomers in the Royal Observatory of Paris; but we have not the Number at hand to refer to.

When the same star is seen by indirect vision, it reappears with a degree of brightness which it never assumes when seen directly by the eye. When the eye is adjusted to the distinct perception of an object placed in the axis of vision, an object placed out of the axis cannot be seen with the same distinctness, both from the pencils not being accurately converged upon the retina, and from the expansion of the image, which, as we have already described, accompanies indirect vision. A luminous point, therefore, seen indirectly, swells into a disk, and thus loses its sharpness, and acts upon a greater portion of the retina.* In order to determine whether this expansion, and the image of the luminous point, was the cause of its superior visibility, I turned my eye full upon a luminous point till it ceased to be visible, and then, re-adjusting my eye, so as to swell the point into a circular disk by direct vision, I invariably found that its visibility was instantly increased. If this explanation of the phenomenon be the correct one, the practical astronomer may, with direct vision, obtain a clearer view of minute and faint stars, either by putting the telescope out of its focus, or by adjusting his eye to nearer objects.

Allerly, *September 5th* 1825.

Art. XVI.—*On the Action of Poisons on the Vegetable Kingdom.*† By Mr F. Marcet.

Although the great work of M. Orfila contains a complete and precise history of poisons, and of their action on the animal economy, yet M. Marcet considered, that it would be desirable to make some experiments of the same kind on plants, the tissue, and some of the organs of which, have such a striking analogy with those of animals.

M. G. F. Jaeger, had previously published some interesting

* The eye is not capable of observing correctly the *colours* of luminous points seen indirectly. A *blue* luminous point, for example, appears nearly *white*.

† This interesting paper, is a translation and abstract of a Memoir, which will appear in tom. iii. part i. of the *Mem. de la Soc. de Phys. et d'Hist. Nat. de Geneve*. It was read on the 16th December 1824.

experiments on the action of arsenic upon vegetables;* and Mr C. J. Th. Becker, whose work we have noticed in this *Journal*, vol. i. p. 376, performed some experiments on the action of prussic fluid upon plants; but these authors have scarcely, if at all, anticipated the curious results which are to be found in Mr Marcet's Memoir.

1. Metallic Poisons.

The *first* series of Mr Marcet's experiments was made with *metallic poisons*, such as *arsenic*, *mercury*, *tin*, *copper*, and *lead*, and he, in general, administered them to robust plants of the *Phaseolus vulgaris*, or French bean.

ARSENIC.

Exp. 1.—Two or three plants of the *French bean* were watered with a solution of six grains of oxide of arsenic in an ounce of water. By two ounces of the solution, the plants were completely withered at the end of twenty-four or thirty-six hours, the leaves faded, and some of them had even become yellow: an appreciable quantity of arsenic was afterwards discovered in the leaves and stalk of the plant.

Exp. 2.—A branch of a rose tree, with a flower at its extremity, just beginning to blow, was introduced into a similar solution of arsenic, on the 31st March. On the 1st April, the exterior petals of the flower had become flabby, and of a colour slightly purple. Some of the petals were covered with deep purple spots, and the leaves had begun to fall. It had now absorbed $\frac{12}{100}$dths of a grain of arsenic.

On the 3d April, the petals were still more flabby, and much withered, their colour was of a deeper purple, and the external petals were covered with purple spots; the flower had lost a portion of its smell, and the leaves were quite withered. The next day the branch was perfectly dead, the plant having absorbed altogether the *fifth* part of a grain of oxide of arsenic. The purple colour of the petals was found to vary in intensity, as the primitive colour of the rose was more or less deep, or the rose itself more or less blown.

Exp. 3.—On the 1st June, M. Marcet made a cut about an inch and a half long in a lilac tree, whose stalk was an inch in

* "*Dissertatio Inauguralis de affectibus arsenici in varios organismos.*"

diameter. The cut penetrated to the pith. Into the cut he inserted fifteen or twenty grains of oxide of arsenic, diluted with some drops of water. The cut was then tied up with twigs of osier. On the 8th June, the leaves of the tree began to close, and to curl up at the extremity. On the 15th, the leaves were withered, and the branches had begun to dry. On the 28th, the branches were dry, and in the second week of July, the whole of the stem was quite dry, and the tree completely dead. Another lilac-tree, with a similar cut, but without poison, suffered no injury. This lilac had another trunk or stem, which joined it a little above the ground. This trunk also became dry, about fifteen days after the other, having presented the same appearances.

When arsenic was introduced below the bark of another lilac, the principal branches of the tree nearest the wound were quite dry at the end of 15 days; but the leaves of the other branches did not fade till the ordinary period.

MERCURY.

Exp. 1.—On the 5th of May two or three French bean plants which grew in a pot were watered with about two ounces of water, holding in solution twelve grains of muriate of mercury. Next day the leaves drooped, and the stems were of a yellowish brown colour. The watering being continued on the 6th, the stalks were quite yellow on the 7th, and the leaves withered and dry.

Exp. 2.—On the 3d April, a branch of a rose tree, with two or three rose-buds half developed, had its extremity introduced into a flask containing a solution of six grains of muriate of mercury in an ounce of water. On the 5th April, specks of a yellowish brown colour appeared along the ribs of the leaves; the external petals faded, but the flower notwithstanding seemed to be a little blown. Twenty-four grains of the liquid were absorbed. On the 6th, the streaks were larger, and of a deeper colour, and the leaves very unhealthy. On the 7th, the streaks covered the whole leaf, except the margin, and the branch was quite dry. The internal petals were not withered, but seemed to have become of a deep colour.

Exp. 3.—On the 10th May 1824, Mr Marcet introduced into a hole in the stem of a cherry tree, which penetrated into the pith, some drops of metallic mercury, and covered up the hole. On the 10th March 1825, the tree had *suffered no injury*, although it has been said that trees are killed by that process.

TIN.

On the 13th April, a rose tree branch with two or three buds, was introduced into a solution of muriate of tin, of the same strength as the preceding solution. On the 15th, brown streaks appeared along the ribs of the leaves, larger and of a deeper colour than those produced by muriate of mercury. On the 16th the branch was dead, and the leaves almost all yellow.

Tin acted upon French beans exactly like the muriate of mercury.

COPPER.

In a solution of sulphate of copper, of the same strength as the preceding one, a French bean plant, taken from the ground, was immersed by its roots. The bean withered at the end of a day; but it required several waterings, and more copper, to kill it completely.

LEAD.

A French bean was introduced by the root into a solution of acetate of lead, of the same strength as the preceding. The lower leaves withered at the end of two days, but it did not die till the end of the third.

The same thing happened with the MURIATE OF BARYTES.

Mr Marcet next tried the effects of *sulphuric acid*, *potash*, and *sulphate of magnesia*.

French bean plants being introduced by the root into *sulphuric acid* diluted with three times its weight of water, they began to droop at the end of a few hours, and, at the end of a day, they withered.

The same effect was produced by the action of liquid potash diluted with the same quantity of water.

Plants of French beans were not, in the slightest degree, injured by the same treatment, with a solution of sulphate of magnesia, although Professor Carradori of Florence supposes that this earth exercises a poisonous action upon vegetables.

II.—Vegetable Poisons.

As most of the poisons from the vegetable kingdom destroy animal life by exercising a particular action on the nervous system, Mr Marcet was anxious to examine their action on vegetables.

OPIUM.

On the 10th May, at 9 A. M. a French bean plant was introduced by its root into a solution of five or six grains of opium in an ounce of water. In the evening, the leaves began to droop. Next day, about noon, the plant was completely dead, and the leaves withered, without change of colour.

The aqueous extract of nightshade acted exactly like opium, but with more rapidity.

NUX VOMICA.

On the 9th May, at 9 A. M. a French bean plant was introduced into a solution of five grains of the aqueous extract of *nux vomica* in an ounce of water. At the end of an hour, the plant became unhealthy. At 10 o'clock the leaves had not changed colour until the small branches to which they were attached were bent, and, as it were, broken in the middle. In the evening the plant was dead.

On the 15th July, Mr Marcet introduced fifteen grains of the above extract, diluted with water, into a cut $1\frac{1}{2}$ inch long, made in a lilac tree, about one inch in diameter, as far as the pith.

On the 28th, the leaves of the two great branches of the tree near the cut had begun to dry. On the 3d April, the two branches were quite dry. The other branches dried in the course of the autumn.

Both *opium* and *nux vomica* produce death in animals, by acting on the nervous system. The first, according to M. Orfila, acts specially on the brain, and the nux vomica on the spinal marrow.

SEEDS OF THE COCULUS MENISPERMIS.

A French bean plant was introduced by the root into a vessel containing a solution of ten grains of the aqueous extract of the seeds of the *Coculus menispermis* in two ounces of water. In a few seconds, the ends of two leaves nearest the stalk became slightly crisp, and the extremity of each curled up on the upper surface of the leaf.

After some hours, the leaves nearest the lower part of the stalk changed their position, so as to bend downwards from the top of the leaf stalk. The leaves grew stiff in this position, and remained so for some hours. At the end of a certain time they began to become flabby; and at the end of twenty-four hours, the plant was quite dead, all the leaf stalks being bent in the middle, and all the leaves withered.

PRUSSIC ACID.

Exp. 1. On the 12th May, at 8^h A.M. the root of a French bean plant was put into prussic acid. The leaves did not become crisp, as with some of the preceding poisons, but the leaf stalks began to bend at the middle, and the leaves to hang down at the end of two or three hours, as in the case of opium. At the end of twelve hours the plant was dead, and all the leaf stalks were as if they had been crushed and bent downwards by the middle.

Exp. 2. One or two drops of concentrated prussic acid were poured on the extremity of a branch of the sensitive plant, (*Mimosa pudica*) to which some leaves were attached. After some seconds all the leaves closed. It sometimes happened, however, that all the little leaflets of each leaf were not dead, but only those which were nearest the extremity of the branch on which the prussic acid had been poured. The leaves opened again at the end of a quarter of an hour, but they had lost the greatest portion of their sensibility, which they did not recover till after some hours.

When the prussic acid was held in a dish a little below the leaves of the plant, some of the leaves shut after a few seconds. Nay, even when the flask of prussic acid was held out open to a leaf, the leaflets closed almost instantly. In both these cases, the leaves subjected to experiment did not completely regain their primitive sensibility till the end of some hours. It appears also, that even the vapour of the prussic acid exerts an action on the leaves of the sensitive plant.

DISTILLED LAUREL WATER.

On the 8th May, at noon, the root of a French bean plant was introduced into laurel water. At the end of some seconds some of the leaves became crisp at their ends, bending back upon themselves. This state of crispness lasted about half an hour, at the end of which the leaves bent back again, and became quite flabby. In the evening the plant was entirely dead. In the repetition of the experiment several times, the crispness of the leaves varied according to circumstances, and sometimes the plant died without any crispness taking place.

BELLADONNA.

On the 9th May, at 9^h A.M. M. Marcet introduced the root of a French bean into a solution of five grains of the aqueous extract of belladonna in an ounce of water. He did not perceive any crispness in the ends of the leaves; but after some minutes the two lower leaves attached to the stalk changed their position, bending downwards from the top of the leaf stalk. At 9^h P.M. the leaves had reapproached to their natural state, but had become a little flabby. Next morning they resumed their bent down position. In this state they remained twenty-four hours, when the upper leaves had begun to droop. On the 11th, the inferior leaves, which had also changed their position, had begun to become yellow. This yellowness began at the extremities, and gradually extended itself over the greater part of the leaves. On the 13th the plant was entirely dead.

The belladonna appears to kill plants more slowly than other vegetable poisons; but it does not act upon them the less distinctly, and often produces very singular effects. This poison, according to Orfila, exerts on animals a local action by no means violent, but it is absorbed and carried into the circulation, and occasions death, by acting on the nervous system, and principally on the brain.

ALCOHOL.

The root of a French bean was introduced into alcohol, diluted with an equal volume of water. At the end of twelve hours it died, and the bean was withered and flabby.

When the fluid used was half an ounce of alcohol, having in solution three grains of camphor, the plant died at the end of twelve hours, and in addition to the withering of the leaves, the leaf stalks had the appearance of being broken through the middle, as in the case of the nux vomica.

OXALIC ACID.

Exp. 1. On the 12th April, at 10^h, a branch of a rose tree, having a flower at its extremity, was detached from the tree, and put into a solution of five grains of oxalic acid in an ounce of water. Next day the colour of the external petals had become deeper, and the leaves had begun to fade. On the 14th, the leaves and the stalk of the branch were completely dry, and the petals of the flower quite faded. During the forty-eight hours, only the tenth of a grain of pure oxalic acid had been absorbed.

This poison, when administered to animals in large quantities, acts like the mineral acids, by destroying the tissue of the stomach. It kills, however, very quickly when it is administered in small quantities, and it then appears to act powerfully on the nervous system.

Exp. 2. The root of a French bean was put into a similar solution of oxalic acid, and at the end of twenty-four hours it was dead.

HEMLOCK.

On the 14th May, the root of a French bean plant was put into a solution of five grains of the aqueous extract of hemlock in an ounce of water. At the end of some minutes a crispness was observed in two of the lower leaves. Next day these two leaves had begun to grow yellow at the ends, the superior leaves not being dead. On the 16th May, almost all the surface of the two lower leaves had become yellow, and the leaves were quite dry. The upper leaves were all withered, but without any change of colour.

PURPLE DIGITALIS.

On the 10th May, at 9^h A. M. the root of a French bean was introduced into a solution of six grains of this substance in an ounce of water. At the end of a few seconds there was a slight crispness at the end of some of the leaves. In the evening the ends of the leaves were withered, and in twenty-four hours more the plant was quite dead.

The two last poisons, when administered to animals, destroy life by acting on the nervous system.

From these experiments it seems to be satisfactorily demonstrated.

1. That the metallic poisons act on vegetables nearly in the same manner as they act on animals. They appear to be absorbed and carried into the different parts of the plant, and alter and destroy the tissue of it by their corrosive power.

2. That vegetable poisons, and particularly those which are demonstrated to destroy animals by their action on the nervous system, produce also the death of plants. But as we can scarcely conceive that poisons, which do not in any way attack the organic tissue of animals, could alter that of vegetables in such a degree as to kill them at the end of a few hours, it appears to me very probable that there exists in vegetables a system of organs which is affected by certain vegetable poisons nearly in the same manner as the nervous system.

Mr Marcet concludes his very interesting memoir, by an account of some experiments on the action of different gases on the roots of vegetables. Carbonic acid gas was found to exert a more deleterious action than hydrogen, and the action of azote was much more rapid than any of the gases which he tried. The nitrous oxide acted a little more rapidly than hydrogen.

ART. XVII.—*On Two Newly determined Species of the Genus Gypsum-haloide of the System of Mohs.* By WILLIAM HAIDINGER, Esq. F. R. S.E. Communicated by the Author.

I. *Hemi-prismatic Gypsum-haloide.*

FORM, hemiprismatic. Fundamental form, a scalene four-sided pyramid. $P = \left\{ \begin{matrix} 139^\circ\ 17' \\ 119^\circ\ 39' \end{matrix} \right\}, 129^\circ\ 21', 97^\circ\ 8'$. Inclination of the axis $= 24^\circ\ 56'$, in the plane of the short diagonal. Plate VII, Fig. 1.

$$a : b : c : d = 2.15 : 2.24 : 1.49 : 1.$$

Simple forms. $\frac{P}{2}\ (l) = 139^\circ\ 17'$; $P + \infty\ (f) = 117^\circ\ 24$; $-\frac{P-1}{2}\ (n) = 141^\circ\ 8'$; $(P + \infty)^3\ (g) = 157^\circ\ 5'$; $-\frac{\bar{P}r-1}{2}\ (o) = 83^\circ 14'$; $\mathring{P}r + \infty\ (P)$.

Combinations. 1. $\frac{\bar{P}r-1}{2} \cdot -\frac{P-1}{2} \cdot P + \infty \,.\, \mathring{P}r + \infty$. Fig. 2, 2. $\frac{P}{2} \cdot -\frac{\bar{P}r-1}{2} \cdot -\frac{P-1}{2} \cdot P + \infty \,.\, (\bar{P} + \infty)^3\ \mathring{P}r + \infty$ Fig. 3.

The crystals are lengthened in the direction of the edges of combination between *o*, *n*, and *P*, and attached at one of the extremities, in most cases several together, so as to form stellated or divergent groups. On the disengaged termination of the crystals, one of the faces of *f* is enlarged, so as generally to make the other entirely disappear. The appearance of Fig. 4 is then produced.

Cleavage, parallel to $\mathring{P}r + \infty$, highly perfect and easily obtained; traces in the direction of $-\frac{\bar{P}r}{2} = 54^\circ\ 55'$, and $\bar{P}r + \infty$, very faint, fracture uneven.

Surface, the prisms parallel to the axis streaked in the direction of that line; $\mathring{P}r$ parallel to its intersections with $-\frac{\bar{P}r}{2}$. The faces of $-\frac{\bar{P}r-1}{2}$ and $-\frac{P-1}{2}$ are deeply streaked parallel to their common edges of combination.

Lustre vitreous. $\mathring{P}r + \infty$ slightly inclining to pearly, both upon faces of cleavage, and of crystallization.

Colour white, inclining to yellowish. Streak white. Transparent or translucent. Index of refraction nearly 1.6, measured through *f* and P; no separation of images.

Fig. 1.

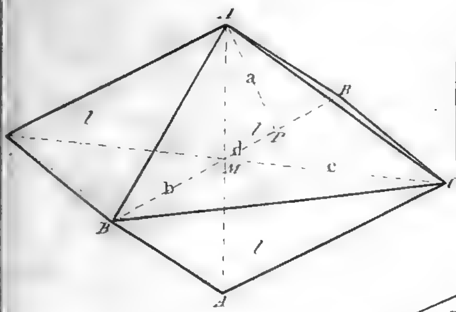


Fig. 2.

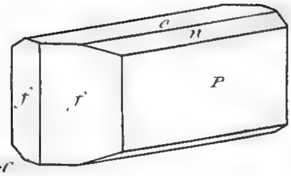


Fig. 3.

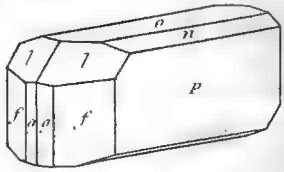


Fig. 5.

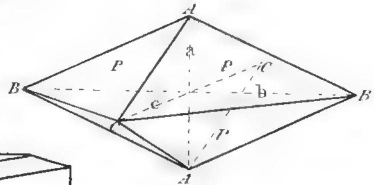


Fig. 6.

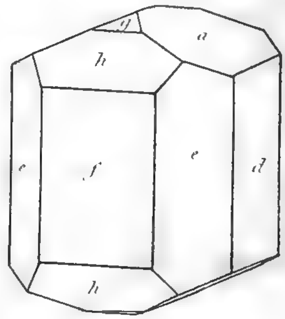


Fig. 4.

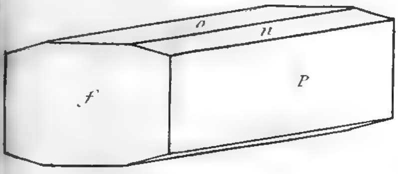


Fig. 8.

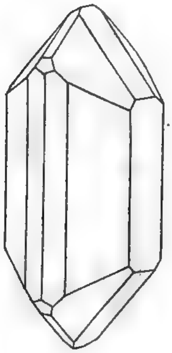


Fig. 7.

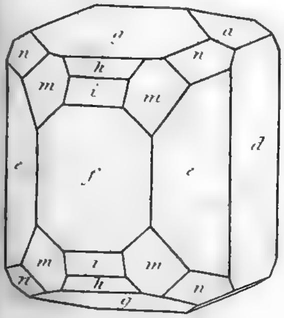


Fig. 9.

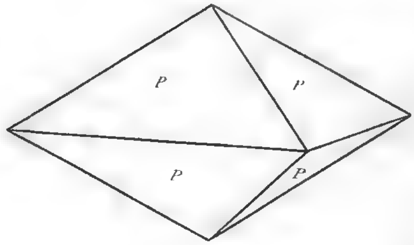


Fig. 11.

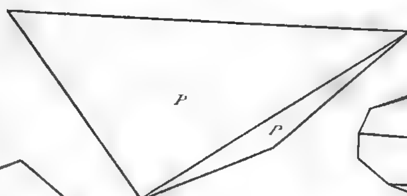


Fig. 12.

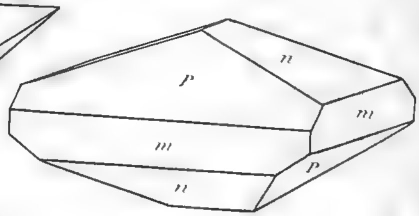


Fig. 10.

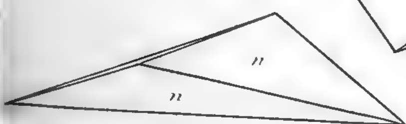


Fig. 14.

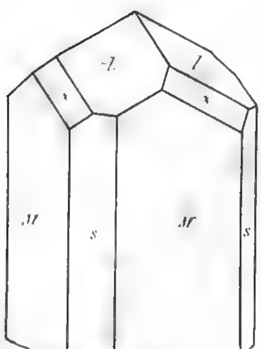


Fig. 15.

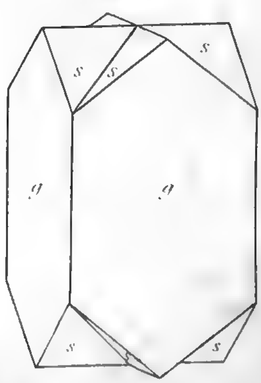
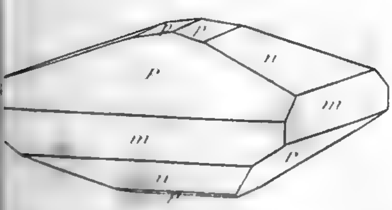


Fig. 13.



Sectile. Thin laminae are flexible in a direction nearly perpendicular to the edges between *o*, *n*, and *P*.

Hardness = 2.0 . . . 2.5, nearer the latter. The perfect faces of cleavage are even below 2.0, since they may be scratched by rock-salt, particularly when applied in a direction corresponding to the elongation of the crystals. Sp. Gr. = 2.730, in a number of detached crystals.

2. *Diatomous Gypsum-haloide.*

Form prismatic. Fundamental form, a scalene four-sided pyramid. P = 133° 35′, 123° 59′, 75° 35′ Fig. 5.
$a : b : c : = 1 : \sqrt{4.02} : \sqrt{2.83}$.

Simple forms. $(\bar{P}r.+1)^{3}$ (*m*) = 137°41, 61° 27′, 137° 35′; $(\bar{P}+1)^{\frac{5}{4}}$ (*n*) = 126° 46′, 59° 32′, 121° 37′. P+∞ (*c*) = 100° 0′; $\mathring{P}r$ (*a*) = 126° 58′; $\mathring{P}r+\infty$ (*d*); $\bar{P}r-1$ (*g*) = 146° 53′; $\bar{P}r+1$ (*h*) = 80° 8′; $\bar{P}r+2$ (*i*) = 45° 36′; $\bar{P}r+\infty$ (*f*).

Combinations. 1. $\bar{P}r-1$. $\mathring{P}r$. $\bar{P}r+1$. P+∞. $\mathring{P}r\ \infty$. $\bar{P}r+\infty$. Fig. 6.

2. $\bar{P}r-1$. $\mathring{P}r$. $\bar{P}r+1$ $(\bar{P}+1)^{\frac{5}{4}}$. $\bar{P}r+2$. $(\bar{P}r+1)^{3}$. P+∞. $\mathring{P}r+\infty$. Pr+∞. Fig. 7.

Cleavage, highly perfect, and easily obtained in the direction of $\mathring{P}r+\infty$. Surface, $\mathring{P}r$. smooth, $\mathring{P}r$. ∞ smooth, or faintly streaked in a longitudinal direction. The measurement of the terminal edge of $\mathring{P}r$ is on that account much more accurate than that of P+∞, the faces of which are rather irregularly streaked parallel to the axes of the crystals. The horizontal prisms, belonging to the short diagonal, are almost all rough, particularly $\bar{P}r-1$, which is at the same time slightly rounded. The pyramids are rounded, though smooth.

Lustre vitreous. Colour white. Streak white. Transparent, in small crystals, tranluscent. Double refraction observable through *c*, and the opposite face of *f*, making an angle of 40°. The two indices of refraction are about 1.62 and 1.67. The less refracted image disappears, when the axis of the tourmaline is perpendicular to the edge of the refracting prism.

Sectile. Thin laminae are flexible in a direction nearly perpendicular to the edges between *o*, *n*, and *P*.

Hardness = 2.0...2.5, nearer the latter. The perfect faces of cleavage are even below 2.0, since they may be scratched by rock-salt, particularly when applied in a direction corresponding to the elongation of the crystals. Sp. Gr. = 2.730, in a number of detached crystals.

2. *Diatomous Gypsum-haloide.*

Form prismatic. Fundamental form, a scalene four-sided pyramid. P = 133° 35′, 123° 59′, 75° 35′ Fig. 5.

$a : b : c : = 1 : \surd 4.02 : \surd 2.83$.

Simple forms. $(\bar{P}r.+1)^3 (m)$ = 137°41, 61° 27′, 137° 35′; $(\bar{P}+1)^{\frac{5}{4}} (n)$ = 126° 46′, 59° 32′, 121° 37′. $P+\infty$ (c)=100° 0′; $\breve{P}r$ (a) = 126° 58′; $\breve{P}r+\infty$ (d); $\bar{P}r-1$ (g) = 146° 53′; $\bar{P}r+1$ (h) = 80° 8′; $\bar{P}r+2$ (i) = 45° 36′; $\bar{P}r+\infty$ (f).

Combinations. 1. $\bar{P}r-1$. $\breve{P}r$. $\bar{P}r+1$. $P+\infty$. $\breve{P}r\ \infty$. $\bar{P}r+\infty$. Fig. 6.

2. $\bar{P}r-1$. $\breve{P}r$. $\bar{P}r+1$ $(\bar{P}+1)^{\frac{5}{4}}$. $\bar{P}r+2$. $(\bar{P}r+1)^3$. $P+\infty$. $\breve{P}r+\infty$. $Pr+\infty$. Fig. 7.

Cleavage, highly perfect, and easily obtained in the direction of $\breve{P}r+\infty$. Surface, $\breve{P}r$. smooth, $\breve{P}r.\ \infty$ smooth, or faintly streaked in a longitudinal direction. The measurement of the terminal edge of $\breve{P}r$ is on that account much more accurate than that of $P+\infty$, the faces of which are rather irregularly streaked parallel to the axes of the crystals. The horizontal prisms, belonging to the short diagonal, are almost all rough, particularly $\bar{P}r-1$, which is at the same time slightly rounded. The pyramids are rounded, though smooth.

Lustre vitreous. Colour white. Streak white. Transparent, in small crystals, tranluscent. Double refraction observable through *c*, and the opposite face of *f*, making an angle of 40°. The two indices of refraction are about 1.62 and 1.67. The less refracted image disappears, when the axis of the tourmaline is perpendicular to the edge of the refracting prism.

Sectile. Thin laminæ, slightly flexible.

Hardness = 2.0 . . . 2.5, exactly the same as in the hemisprismatic; here also the face of perfect cleavage admits of being scratched by rock-salt. The two species scratch each other mutually. Sp. Gr. = 2.848, of several fragments of crystalline coats.

Observations.

A specimen, containing both the species described above, forms one among the numerous interesting objects which the mineralogist admires in the cabinet of Mr Ferguson of Raith. It was there placed with gypsum, to which, in fact, it is very nearly allied in regard to form and general appearance, and described in the following manner on a ticket accompanying it:—"Selenite × en prismes tetraedres tronqués en biseau, et en hexaedres, dont ni les faces ni les troncatures son prononcées distinctement (quelques uns des × × son deja decomposés et changés en platre) sur du quarz ×, qui pose sur une croute tres mince ondulée brune de calcedoinne, celle ci sur une autre d'argil verte, celle si sur une autre de baryte rouge, dans le centre de laquelle se trouve un fragment de petrosilex gris, de ———." As there is no locality given, I am the more particular in quoting the exact orthography of the ticket, as it may perhaps be of use in enabling some mineralogist, who happens to be acquainted with that kind of descriptions, to trace the specimen to its original source. The description itself will, however, require some farther comment.

The crystals of "*selenite*" are those of the hemiprismatic gypsum haloide, the first of the two species described above, some of which are nearly half an inch long, and a line in thickness It is very likely not an entirely new species, but a variety of pharmacolite, now observed for the first time in crystals large enough both to admit of measurement, and to allow the characters derived from hardness and specific gravity to be ascertained to a considerable degree of exactness. The pharmacolite itself cannot be called a species which we know, since the whole of our information respecting its natural-historical properties is confined to its occurring in exceedingly delicate white capillary crystals, aggregated in globules, the specific gravity of which is = 2.64.* The lower specific gravity might perhaps be accounted for by the delicacy of the crystalline groups employed. In other respects, the opinion that the variety described above, and the acicular globules of pharmacolite, belong to the same species, is grounded solely on the analogy of resemblance existing between the former with crystals of gypsum, and between the latter and the radiated groups so frequently observed in the same species. That they both contain arsenic acid should not enter at all into this comparison, as long as the species are not perfectly established, though it was an experiment, proving this substance to form one of the constituents of the hemi-prismatic crystals, which suggested to me the propriety of comparing them with the pharmacolite. However slight, therefore, the reasons may be in themselves for uniting the two substances, they are sufficiently strong to prevent us from establishing them both as distinct species, as long as we are so much in want of accurate information with respect to one of the varieties.

The decomposed crystals, said to be "*selenite already changed into plaster*," do not, in fact, belong to, nor are they derivable from the preceding species. They are white, opaque, and dull, and cannot bear the slightest touch without crumbling into pieces, like laumonite. From what I could collect in observing several crystals, most of them half fractured, their form belongs to the prismatic system, and nearly resembles Fig. 8. These also give a sublimate of arsenic, when mixed with charcoal, and exposed in a glass tube to the heat of the spirit-lamp. It is probable that, previous to their decomposition by the loss of water, they have belonged to a distinct species, which it would be very interesting to discover in nature.

The "*quarz*" is nothing else but the second one of the two species described in the beginning of this paper, the diatomous gypsum-haloide. It forms crystalline coats, of a near-

* Klaproth's *Essays, Transl.* vol. ii. p. 220. Klaproth says, "Its specific gravity, in the botryoidally aggregated crystals, I found to be =2.640. Mr Selb, who probably weighed for the same purpose single or detached crystals, states its specific gravity only at 2.536." Hence we may infer, that the pharmacolite from Wittichen, the variety analyzed by Klaproth, sometimes occurs in crystals.

ly botryoidal disposition, and its crystals are very small, but possess a higher degree of lustre than the larger ones of the hemi-prismatic species. The stratum immediately below it, (mentioned as calcedony,) is a kind of the ironsinter of Werner; it is very thin, and covers a rose-red variety of the macrotypous lime-haloide of Mohs, which resembles very much the red manganese from the mine Krieg and Frieden near Freiberg. It is less compact, and full of fissures lined with a greenish substance, where it approaches to the covering of the brown ironsinter. A small fragment of the rock, a rather compact claystone, containing some quartz, and called "*petrosilex*" in the ticket, is attached to the brown-spar.

If we reflect on the remarkable degree of resemblance prevailing among the two species, and those contained in the genus gypsum-haloide of the system of Mohs, we cannot hesitate a single moment, to refer them likewise to that genus, whatever may be the kind or manner of combination of their constituent parts. Nay, the determinations of natural history appear more independent, and deserving of greater attention, by seeming to be at variance on certain points with the results of other sciences, though we may always look forward with perfect security, that the laws will ultimately be discovered, according to which each apparent discrepancy may be explained.

Art. XVIII.—*On the Composition of the Minerals described in the preceding Paper.* By Edward Turner, M. D. F. R. S. E., &c. Lecturer on Chemistry, and Fellow of the Royal College of Physicians, Edinburgh. Communicated by the Author.

Being obliged, in the execution of the following analyses, to operate on very small quantities of each substance, and as in such cases a slight error has an important influence on the result, I cannot presume to publish them as absolutely exact. They may be regarded, however, as good approximations, and will be found, if I mistake not, to give a satisfactory view of the composition of the two minerals described by Mr Haidinger in the preceding paper.

They are both arseniates of lime, and contain water of crystallization. The water quickly comes into view when they are exposed, in a clean glass tube, to the flame of a spirit-lamp; but a red heat is requisite to expel the last portions of it. The water, as it condensed on the cold parts of the glass, was carefully tested, but it did not affect the most delicate litmus-paper in the slightest degree. The arseniates, in losing their water of crystallization, become opaque and white, but can afterwards bear an intense heat without further change, requiring the strongest temperature which can be given with the common blow-pipe for fusion. From this cause, it is difficult to decompose them on charcoal; but when intimately mixed with charcoal powder, and heated in a glass tube, a distinct layer of metallic arsenic is readily procured.

When reduced to powder, and boiled in distilled water for one or two hours, a small quantity is taken up, though the greater part remains undissolved. The solution gives a brick-red precipitate with nitrate of silver, and a white one with nitrate of lead and oxalate of ammonia. Nitric acid, whether strong or diluted, dissolves them readily without effervescence, and the salts of silver, lead, and oxalic acid, occasion the same precipitates as just mentioned, when the excess of acid is neutralized to a sufficient degree. They contain nothing but water, lime, and arsenic acid; the absence of magnesia and phosphoric acid, in particular, having been proved by careful examination.

Analysis of the First Species.

3.455 grains were heated to redness in a green glass tube, and lost 0.72 grains, or 20.839 per cent. of water.

2.175 grains were treated in like manner, and lost 0.46 gr. or 21.149 per cent. of water. The mean is 20.994.

6.18 grains of the anhydrous mineral were dissolved in water by aid of the smallest possible quantity of pure nitric acid. Nitrate of lead in slight excess was added, and the whole brought, by a gentle heat, to perfect dryness. The soluble parts were taken up by water, and the precipitate collected on a filtre. The arseniate of lead, after being ignited, weighed 11.32 grains, equivalent to 4.033 grains, or 65.259 per cent. of arsenic acid.

The excess of lead, in the solution, after the separation of arseniate of lead, was removed by sulphuretted hydrogen; and the lime, after neutralizing exactly, was separated by oxalate of ammonia. The oxalate of lime was exposed to a white heat, and 1.885 grains, or 29.466 per cent. of pure lime, were thus procured.

The crystallized mineral is accordingly composed of

Arseniate of lime -	79.01
Water - -	20.99

And the anhydrous of

Arsenic acid -	4.033	65.259
Lime - -	1.885	29.466
	5.928	94.725

There has been considerable loss in this analysis, and therefore it cannot be relied on for showing the actual composition of the mineral itself. It will be obvious, however, in comparing the results of this and the next analysis together, that the arsenic acid and lime are in both minerals united in the same proportion.

Analysis of the Second Species.

The analysis was conducted as the preceding. In one experiment, 2.495 grains lost from ignition 0.405 grains, or 13.965 per cent. of water. In another, 0.995 gr. lost 0.145 grains, or 14.673 per cent. The mean is 14.319.

From 3.29 grains of the anhydrous mineral, I obtained 6.26 grains of ignited arseniate of lead; equivalent to 2.23 grains, or 67.781 per cent. of arsenic acid.

The lime weighed 1.09 grains, which is 34.343 per cent.

The crystallized mineral is hence composed of

Arseniate of Lime -	85.681
Water - - -	14.319
	100.000

And the anhydrous of

Arsenic acid -	2.23	67.78
Lime - - -	1.09	33.13
	3.32	100.91

The data upon which these calculations were founded are those of Dr Thomson. Arseniate of lead is supposed to be a compound of 112 oxide of lead and 62 arsenic acid; and arseniate of lime, of 28 lime and 62 acid.

Making a fair allowance for the minute quantities operated on, we must infer that the subject of each analysis is composed of the same ingredients, united, with respect to the acid and lime, in the same proportion. If we suppose that this arseniate, which forms the basis of both minerals, contains an atom of each constituent, it will be composed of

Arsenic acid,	62	68.89
Lime, -	28	31.11

If we regard Mr Haidinger's second species,—the diatomous gypsum-haloide, as composed of two atoms of water, with one of the arseniate of lime; and the hemiprismatic of three atoms of water to one of the salt, they will be composed of—

	Diatomous.		Hemiprismatic.	
Arseniate of lime,	90	83.34	90	76.92
Water, -	18	16.66	27	23.08

It is probable that Klaproth's pharmacolite from Wittichen, as also that from Andreasberg, analysed by John, is identical in composition with the hemiprismatic gypsum-haloide of Mr Haidinger. The analyses are,

	Klaproth.	John.
Arsenic acid,	50.54	45.68
Lime, -	25.00	27.28
Water, -	24.46	23.86
	100.00	96.82

Mr Haidinger has pronounced, from mineralogical considerations, that the decomposed substance, found on the same specimen with the two preceding minerals, did not arise from the decomposition of either of them. The accuracy of this observation is confirmed by analysis. The first point of difference is, that it contains, even in its effloresced state, considerably more water than either of the other species. For in one experiment, 1.445 grains of it lost from ignition 0.43 gr. or 29.065 per cent. of water; and in a second, 1.60 grains lost 0.545 gr. or 34.062 per cent. of water.

But its chemical composition, besides, is different, since it is an arseniate of lime and magnesia. I possessed too small a quantity for determining the relative quantities of the lime and magnesia to my own satisfaction, but the arsenic acid amounts to 74.43 per cent. In containing magnesia, it is analogous to the picropharmacolite from Riegelsdorf in Hessia, analyzed by Professor Stromeyer; but obviously differs from it, first, in containing no oxide of cobalt; and, secondly, in the proportion of its constituents.

ART. XIX.—*On the Chemical Characters of Zinc Ores*, examined in the manner of Berzelius, by means of the Blow-Pipe. By M. NILS NORDENSKIOLD of Abo.

DEAR SIR, 19 CHARLOTTE SQUARE.

I BEG to send you a copy of some memoranda of M. Nordenskiold's, relating to the chemical properties of some of the Zinc ores he found in my Cabinet. As these minerals are not very well known, they may be useful to your readers, as pointing out very simple means of discriminating substances which bear a strong analogy to each other.

Yours sincerely,

To Dr BREWSTER. T. ALLAN.

THE mineral from Aachen contains two different substances, viz. the CARBONATE OF ZINC, and the SILICEO-CARBONATE OF ZINC.

The former presents the metastatique crystal of a pale yellow colour. In a matrass it gives off easily carbonic acid, without any trace of water; the crystals preserve their form after being heated, they do not fuse; and produce in a strong heat an intense light of a yellowish white tint.

With *salt of phosphorus* it unites with ease, turns opaque in cooling, and leaves a white ring of oxide of zinc on the charcoal round the globule. If the quantity of the mineral be small in proportion to the salt, it will be clear even in cooling, and none of the fumes of zinc can be driven from the globule, even by a strong heat.

With *borax* it readily unites; the glass takes a great quantity of the mineral to render it opaque in cooling. *Soda* produces scarcely any effect upon the mineral, if exhibited in a mass. The soda sinks into the charcoal without the oxide of zinc being condensed on its surface. With *cobalt solution* a greenish colour is produced.

The SILICEO-CARBONATE OF ZINC, from Aachen, is crystallized. Alone, in a matrass, it affords nitre and carbonic acid, and falls to pieces without fusing.

With *salt of phosphorus* it decomposes with difficulty. A skeleton of silica is distinctly seen before the glass is cold; it turns opaque in cooling, and deposits a ring of zinc fumes. With *borax* it comports itself like the carbonate; with *soda*, a half melted scoria is produced, along with a great quantity of zinc fumes; with *solution of cobalt*, it produces a blueish colour on the edges.

SILICEO-CARBONATE OF ZINC, Derbyshire. This mineral occurs in clear prismatic crystals. Alone, in a matrass, it decrepitates, gives off carbonic acid, and but a very minute portion of water. In a strong heat it melts only on the edges. With *salt of phosphorus* it melts with facility; the glass does not become opaque, in combination with so small a quantity as the former. No skeleton of silica is to be seen.

CUPREOUS SILICATE OF ZINC, Siberia. This is a combination of two minerals. The specimen consists of two distinct layers; the upper one is colourless, and comports itself like the siliceo-carbonate of Aachen. The under layer exposed to heat in the matrass, affords nitre and carbonic acid. On charcoal it turns black, and melts slightly on the edges, and communicates a green tint to the flame; with *salt of phosphorus* it gives a glass which exhibits the colour of copper. A small metallic globule, generates on the side of the array, which, as the glass cools, spreads itself over the surface, and gives it a white metallic lustre.

SILICEO-CARBONATE of ZINC AND IRON, Siberia.—This mineral turns black in the matrass, falls to pieces, yields carbonic acid and a little water, and becomes magnetic; *with salt of phosphorus*, it decomposes easily, leaves a skeleton of silica, and tinges the glass the colour of iron; is opaque on cooling, and leaves a white ring of zinc fumes; with *borax*. produces a glass coloured with iron; with soda, a brownish half melted scoria. This mineral has been improperly named a silicate of zinc.

SILICATE OF ZINC, Bohemia.—This mineral is crystallized. Alone in the matrass, it turns opaque, and thickens in the direction of the cleavage; gives no trace of carbonic acid, but a slight trace of water with *salt of phosphorus;* decomposes with difficulty, and leaves a skeleton of silica full of bubbles; with *borax* and *soda*, it comports itself in the same manner as the siliceo-carbonate; with *solution of cobalt*, it affords a greenish blue colour. This is consequently a true silicate of zinc with a little water of crystallization.

ART. XX.—*Account of a Meteorological Phenomenon, which was observed at the Summit of Ben-Nevis on the 27th June last.** By the Rev. JOHN MACVICAR, Dundee. In a letter to Dr BREWSTER.

DEAR SIR,

IN consequence of the suggestion of Professor Hooker, I send you an account, as circumstantial as my notes and recollection admit, of a meteorological phenomenon, which was observed at the summit of Ben-Nevis on the 27th June last.

The weather, for some days previous, was extremely rainy and disagreeable; for the temperature was low, and the rain was accompanied with a fog and a fresh breeze of wind. On Saturday morning, however, the rain ceased, and the clouds hung in the atmosphere in the form of immense cumuli and cumulostrati. The nimbus also was seen in various quarters, and before mid-day, the district of Ben-Nevis was visited by one of these clouds, which poured rain almost without interruption, during the greater part of the day. About 2000 feet of the altitude of the mountain were immersed in the cloud; and from the observations of those who ascended to the summit, it appears that this was not much less than its general thickness, for they frequently saw its upper surface. On Sunday, the weather improved; and, on the morning of Monday the 27th, it was still better, though it was not yet

* Phenomena, bearing some analogy to the very interesting one described in this paper, will be found in the *Edinburgh Encyclopædia*, Art. ELECTRICITY, vol. viii. p. 491.—ED.

changed. As the morning advanced, however, the sky became more overcast, and about ten o'clock a shower came on, and rain continued to fall suddenly, and with much interruption, during all the forenoon. The wind was constantly varying, and had a different direction in every glen, but the prevailing course was from the south-east. The temperature was low, so that the people about Fort-William thought that it was very cold.

On the summit of Ben-Nevis, about mid-day, the thermometer, with wet bulb, stood at 36°.5° Fahr. in the cloud. The temperature soon after rose to 39°, and the cloud in which we stood was partly evaporated, partly borne away, leaving a view of the sublime scenery by which we were surrounded. The dense clouds on every side hung down like curtains around the panorama, and their under margins were so definite, and the atmosphere otherwise so clear, that one felt disposed to stoop down as if to see farther into the distant landscape, which was illuminated by the sunshine. The altitude of this magnificent accumulation of vapour, was between 3000 and 4000 feet above the level of the sea. But it was far from uniform, at least the profile of its under surface was alternately elevated and depressed, so that at one time we saw beneath it the mountains of Perthshire and the Hebrides; and, in a few minutes after, our view was confined to the valleys surrounding Ben-Nevis. Soon after mid-day, the weather became more unsettled. Sometimes a cloud rose suddenly on the face of the mountain, and rolled down the valley. Sometimes one came from the neighbouring summit of Corry-Rignson, as if urged by a violent wind; and at other times the condensed vapour ascended rapidly in immense volumes from the centre of the valley below, and was aptly compared by one of the party to the smoke from a town on fire. The magnificence and variety of these clouds amply compensated for the loss of the terrestrial scenery.

The summit of Ben-Nevis, for a considerable extent, was covered with snow. Not only was there a ravine in the immense precipice on the north side of that mountain, containing an upfilling of snow almost entitled to the name of a glacier, and several beds of great depth lying fully exposed to the sun, but there was a general covering of about three inches depth, which had fallen since the same party was there two days before. This was easy to be conceived, for about one o'clock, the temperature fell to 33°.5, a fresh breeze having arisen from the south-east, bringing a nimbus along with it. When the storm reached us, it proved to be snow, which continued to fall very heavily for about two hours. Soon after it began, our attention was attracted by a very singular noise, which was heard every where around us. It exactly resembled the hissing sound which proceeds from a point on an excited prime conductor, or a strongly-charged Leyden phial of an electrical apparatus, indicating the emission of a pencil of electric light, which, had the daylight not overpowered it, should certainly have been visible. This sound was always loud, and more or less distinct for about an hour and a half. It seemed to proceed from every point near us. But amidst the general hissing, I was convinced that I could specify the summit of my umbrella and several points of the rocks from which I heard it issuing. On removing to the cairn on the highest point of the mountain, the phenomenon became remarkably manifest, and we could almost determine the stones from which the pencils were proceeding.

Though this sound of the electric fluid is so completely *sui generis*, as scarcely to be confounded with any thing else, an accident now occurred, which afforded another evidence of the nature of the action which occasioned it, when we were seeking for none. One of the party having fallen behind the rest, in examining some parts of the mountain, came up to the others while they were wondering at the sound, and trying to find shelter from the storm beside the cairn; and were it not, that complacency and fortitude are unalterably expressed in his countenance, we should certainly have concluded, either that he had seen "the angry spirit of the storm," or something else very terrific; for, as is always stated of persons having witnessed such sights, "steterunt comæ,"—the hair of his head stood on end—not indeed all his hair, but those locks only which enjoyed something of their natural freedom to move, having withstood the pelting action of the snow and rain several hours. For botanists, contrary to the practice of the vulgar, sometimes find it more convenient to wear their caps in their pockets. Several other gentlemen, then, by uncovering their heads, gave their hair an opportunity of exhibiting the beautiful phenomena of electrical attraction and repulsion.

As to the state of the electricity of the mountain, with reference to that of the cloud, nothing can be inferred from these motions of the hair; but the hissing noise seems to indicate that it was positive,—that the electric fluid was streaming from the mountain in pencils characteristic of electricity in that state.

Experiments would lead us to infer,* that when vapour ascends into the atmosphere, it induces a negative state on the surface of the ground, and theory would lead us to expect that the clouds in general are positive with respect to the surface of the earth beneath them. But observation must decide which of the two states prevails. Not only does the phenomenon alluded to countenance the opinion that in this instance the earth was positive, but we afterwards learned that about the same time there had been a thunder storm at Inverary, in the direction of which we heard two peals of thunder, and that there the lightning was seen to ascend. Of the possibility of observing the direction of lightning, at least in certain cases, I think there can be no doubt. An electrical discharge through a very long circuit of conductors, is indeed simultaneous; but when it has to pass through a long column of dense air, I think a good eye, uninfluenced by any theory, may be able to say, whether it was ascending or descending, particularly if the mass of electric fluid was not very great. This I had an opportunity of observing last summer, during a lightning storm in Paris, when the ascent of the electric fluid from several spires, and particularly from the dome of St Genevieve, was not less distinct, than the form of the beautiful coruscations which flashed in the shape of pencils from the conductors of the Thuilleries. A flame of sheet-lightning, too, often condensed into a flash of forked

* Davy's *Chem. Phil.* p. 138.

lightning, the course of which through the air, could be distinctly traced.

The thunder storm of the 27th June, came from the south-east, and seems to have had a very wide range. Fortunately its force was nearly spent before it reached the highest point of Scotland; otherwise, instead of witnessing it in an evanescent state, perhaps we might have afforded a melancholy decision of the question, whether lightning ascending into the clouds, is equally fatal to the objects it leaves, as the descending fluid is to those which it strikes.

In the afternoon the weather cleared up. Most of the clouds evaporated, leaving the fine sky. The sun shone very bright, and the evening became very warm. Three hours ago, on the top of the mountain, we had been chilled by cold and covered with snow; and now, in the valley below, we could look up with admiration to its cloudless summit, in a climate where we were severely bit by the Tabanus cæcutiens. The following day was very fine, and during the greater part there was not a cloud to be observed in the atmosphere.

I am, Dear Sir, yours sincerely and respectfully,

JOHN MACVICAR.

DUNDEE, *September* 10, 1825.

ART. XXI.—*Description of Edingtonite, a New Mineral Species.* By WILLIAM HAIDINGER, Esq. F. R. S. E. With an Analysis by EDWARD TURNER, M. D. F. R. S. E. &c. Lecturer on Chemistry, and Fellow of the Royal College of Physicians, Edinburgh. Communicated by the Author.

FORM pyramidal. Fundamental form, an isosceles four-sided pyramid of 121° 40′, and 87° 19′ = P. Plate VII, Fig 9.

$$a = \sqrt{0.905}.$$

Simple forms. P—2 (n) = 144° 38′; P (P); P+∞ (m).

Character of combinations. Hemi-pyramidal, with parallel faces. $\frac{P-2}{2}$ = 129° 8′, 35° 22′. Fig. 10. $\frac{P}{2}$ = 92° 41′, 58″ 20′. Fig. 11.

Combinations observed similar to Fig. 12, consisting of all the foregoing simple forms, and to Fig 13, which, moreover, contains the alternating faces of a very flat four-sided pyramid, *p*, *p*, which allows of no measurement.

Cleavage. Pretty distinct, parallel to the rectangular four-sided prism, *m*. In other directions, there is small and imperfect conchoidal fracture; sometimes it is uneven. Surface of $\frac{P}{2}$ and $P+\infty$ generally smooth, the other faces curved and without lustre.

Lustre vitreous. Colour greyish-white. Semi-transparent, generally only translucent. Streak white.

Brittle. Hardness = 4.0 . . . 4.5, nearer the latter. Sp. gr. = 2.710, of a number of small crystals, forming together, 243 milligrammes.

Observations.

1. Among a great number of interesting minerals from the neighbourhood of Glasgow and Dumbarton, in the possession of Mr Edington of Glasgow, with the inspection of which I have been lately gratified, I observed some crystals disposed in the cavities of Thomsonite, which at first I expected would belong to that species; but I soon found that their faces could not be identified with those mentioned in the descriptions of it, as given by Messrs Brooke* and Phillips.† Mr Edington had the kindness of entrusting me with the only specimen of the substance which I could discover in his collection, and to which the preceding description refers. It is in compliment to that gentleman that the name of Edingtonite is here proposed for designating the species.

2. The regular forms of Edingtonite, even if we do not attend to the interest attached to every novelty, are highly deserving of notice on account of their forming the only second instance, among natural crystals, of hemi-pyramidal forms with inclined faces; the first example observed being the species of pyramidal copper-pyrites. Hemi-pyramidal forms are in general very rare; the pyramidal scheelium-baryte of Mohs, (tungstate of lime,) is the only well authenticated instance

* *Ann. of Phil.* vol. xvi. p. 193.

† *Mineralogy*, p. 39.

of such as have parallel faces. Perhaps pyramidal felspar also belongs to this class. There is a variety of it in the possession of Mr Nordenskiöld, from Pargas in Finland, which shows the form represented, in Fig. 14, having only one of the apices disengaged.* This kind of distribution of faces is, however, quite different from that in the Edingtonite, from which it likewise considerably differs in its angles, though the specific gravity of the two substances, and their cleavage, are nearly the same.

3. Edingtonite occurs in crystals, the largest about two lines in diameter, implanted upon crystallized Thomsonite, in the Kilpatrick hills, near Glasgow. It is accompanied by calcareous spar, and a curious variety of harmotome, (the paratomous Kouphone spar of Mohs,) in twin crystals, of the form Fig. 15. In these, the faces of the four-sided pyramids, visible in most other crystals, have entirely disappeared, and the re-entering angles at the summit are produced solely by the faces of a horizontal prism. It may be considered in this respect as the last term of a series of varieties, some of whose members were first described by Professor Weiss.† The crystals of the Edingtonite itself are far from possessing such a degree of perfection, that the angles given above could be regarded as anything more than approximations, although their general form is well defined. They resemble greatly certain varieties of prehnite and felspar, but we must wait for the discovery of other varieties of it, which may afford a more extensive knowledge of the species, to enable us to determine the genus in the Order Spar of the system of Mohs, to which it might be referred.

Analysis of Edingtonite.

It yields water when exposed to heat, and becomes at the same time opaque and white. Before the blow-pipe it fuses into a colourless glass, though a pretty strong heat is necessary for that purpose.

Muriatic acid acts upon it, separating silica in a gelatinous

* Mohs' *Treatise on Mineralogy, Transl.* vol. ii. p. 265.

† *Magazin der Gesellschaft naturforschender Freunde zu Berlin.* viii. 33.

state; but the action did not appear sufficiently perfect for the purpose of analysis.

2.365 grains of the mineral (the whole quantity in my possession) were heated to redness, and lost 0.315 of a grain, or 13.319 per cent. of water of crystallization.

The residual 2.05 grains, which crumbled easily into powder, were mixed with six grains of carbonate of soda, and kept at a red heat during half an hour. The ignited mass was quite white, and had not fused. Dilute muriatic acid dissolved the whole of it, except a few flocculi of silica. The solution was brought to dryness, and the silica, after being collected on a filtre and heated to redness, weighed 0.89 of a grain, which is 35.09 per cent.

The solution, thus freed from silica, was treated with a slight excess of carbonate of soda at a boiling temperature, when a white precipitate subsided. It was digested in pure potash, to dissolve any alumina that might be present, and the alkaline solution, when boiled with an excess of muriate of ammonia, yielded a portion of alumina, which, after exposure to a white heat, weighed 0.655 of a grain, being 27.69 per cent.

The matter which did not dissolve in potash proved to be an earthy carbonate; for it dissolved with effervescence in muriatic acid. On neutralizing the solution exactly, and adding oxalate of ammonia, a white precipitate subsided, which yielded 0.3 of a grain, 12.68 per cent. of pure lime.

To the solution, after the separation of lime, carbonate of ammonia and phosphate of soda were added. No precipitate formed, and hence no magnesia was present. Iron and manganese were likewise absent.

The Edingtonite hence contains,

Silica, -	35.09
Alumina, -	27.69
Lime, - -	12.68
Water, -	13.32
	88.78

As the various substances found to exist in this mineral do not account for the quantity submitted to analysis, it doubtless contains about 10 or 11 per cent. of some alkali, the nature of which I have not been able to ascertain.

Art. XXII.—*Description of a New Hygrometer, depending on the Affinity of Acids for Water.* * By Professor Aug. de la Rive.

In the course of some researches on the different degrees of heat, occasioned by the affinity of acids for water, I was led to recognize in that phenomenon a very exact indication of the degree of humidity of the atmosphere.

If we plunge the ball of a thermometer into a concentrated acid, such as the nitric acid, but particularly the sulphuric acid, it will be seen that, as soon as the ball is withdrawn from the acid and exposed to the open air, the thermometer will rise considerably. This phenomenon is owing to the condensation of the aqueous vapours produced by the affinity exerted on these by the thin stratum of acid which adheres to the ball. The heat produced is very considerable with sulphuric acid, because in this case there are two sources of caloric, 1st, That which proceeds from the condensation of the vapour; and, 2d, That which is owing to the mixture of the water and the acid.

Having noticed that the quantity of heat, indicated by the thermometer when taken out of the acid, varies with the humidity of the air, other circumstances remaining the same, I sought to determine whether or not these variations of heat might serve to measure different degrees of humidity.

Every hygrometer, or apparatus for measuring variations in the humidity of the air, ought to possess the following qualities.

1. To agree with itself, or, on the return of the same state of the humidity of the air, to indicate the same degree of its scale.

2. That its variations be proportional to those of humidity,

* This paper is a translation and abstract of a Memoir read to the Natural History Society of Geneva, on the 21st April 1825, and appeared in the *Bibl. Univ.* Avril 1825.

so that, in similar circumstances, a double or triple number of degrees indicate constantly a double or triple quantity of vapours existing in the atmosphere.

The hygrometer of Saussure, the most perfect of all, possesses, in an eminent degree, the first quality. It is constant in its indications, comparable, and of extreme sensibility; but its variations are not proportional to those of the absolute humidity of the atmosphere. For example, towards extreme dryness, it moves nearly 3° for *one unit* of difference in the tension of the vapour; and, on the contrary, towards extreme humidity, it moves only 1° for *three units* of difference in the same tension. Thus, when the hygrometer marks 75°, for example, at 0° of the centigrade thermometer, this does not denote that the vapours in the air are the same, when at 15° of the thermometer it stands at 75°, but only that, in the two cases, the ratio between the humidity of the air, and extreme humidity at the same temperature, is the same.

In order that we may deduce from the indications of the hygrometer exact notions on these two last points, we must take the assistance of tables formed from a numerous series of delicate experiments. Such are the tables contained in the *Essai sur L'Hygrometrie;* such also is the table constructed from the experiments of M. Gay Lussac, which gives for the temperature of 10° centig., the degree of the hair hygrometer, when we know the tension of the aqueous vapour actually existing in the air, and *vice versa.* *

From these considerations, we shall proceed to study the results to which we may be led by employing the process which I have indicated above.

I plunge the ball of a delicate thermometer into sulphuric acid;—I draw it out, giving it a slight shake, so that there may remain around the ball only a thin film of adhering acid. The thermometer rises immediately a certain number of degrees above that which it indicated before its immersion in the acid; then it immediately stops and begins to fall. I suppose, however, that we have determined how many degrees it rises for extreme humidity at the same temperature;

* Biot, *Traité de Physique,* tom. i. p. 532.

then, taking the ratio of these two numbers of degrees, we find the exact ratio between the tension of the vapour existing in the air, and the total tension at the same temperature.

The thermometer, for example, marks 12° cent. when immersed in sulphuric acid; exposed to the air, it rises to $25\frac{1}{2}$°, that is $13\frac{1}{2}$°; placed in a vacuum, in which the air is at extreme humidity, at the same temperature of 12°, it rises to 27°, that is 15°; the ratio of $13\frac{1}{2}$° to 15°, or 90 to 100, expresses that of the tension of the vapour existing in the air to the total tension at 12° of temperature. If we now seek, in the table of Gay Lussac, the degree of the hygrometer corresponding to the tension 90, we shall find 95° 43, and the hygrometer in the above experiment indicated 95° 50.

Several other experiments have given me analogous results; but if, in place of operating at the temperature of 12°, we make the experiment at another temperature, for the same degree of the hygrometer of Saussure the thermometer will rise as much more as the temperature is elevated; which arises from this, that the absolute quantity of aqueous vapours in the air increases with the degree of heat. The number of degrees which the thermometer will rise for extreme humidity will vary also; and, consequently, we must determine it for each degree of the thermometer in order to know the ratio required at every temperature. I have made the determination for temperatures sufficiently remote; and it appears to me that we may, without sensible error, content ourselves with determining the number of degrees which the thermometer rises in the case of total humidity, for two extreme points such as 0° and 20° centig., and divide the difference equally between the intermediate degrees. A great number of experiments, made at different temperatures in the way above explained, have given me satisfactory results. Let us suppose, then, a thermometer, on the scale of which is marked, opposite to each degree, the number which shows how much, at this degree of temperature, the thermometer taken from the sulphuric acid rises when exposed to extreme humidity; then, if we wish to know the humidity of the air, we divide the number which expresses the rise of the thermometer by that which is marked at the end of the degrees on the scale, and the quotient will express the ratio of the tension at the time of the experiment, to the total tension regarded as unity.

Some experiments appear to me to indicate, that the numbers which express the rise of the thermometer at different temperatures, for different degrees of humidity, follow, without any sensible error, the same ratio as the tensions of the vapours at these same temperatures: For this comparison, I employed the table constructed from the experiments of Dalton. From this it followed, that the thermometer, taken out of the acid, and exposed to the air, would indicate, by the number of degrees it rose, two things at once; 1st, The ratio between the tension of the vapour in the air, and the total tension at the same temperature; and, 2d, The absolute tension of the vapour in the atmosphere at the time of the experiment.

Along with the advantages which I have mentioned, the preceding process presents some inconveniences. In the first place, it is not an instrument, but an apparatus which must be employed, as an experiment is necessary to obtain an indication. In the next place, the employment of the process requires some precautions. We must, as much as possible, make use of a thermometer whose bulb is very small, both on account of the great sensibility of the instrument, and because the quantity of acid that adheres to the surface of the bulb remains always the same. We must also employ an acid of the same degree of concentration, though I have, however, not observed that a small difference in the degree of concentration has a very great influence. We must, likewise, during the experiment, endeavour to avoid every cause of heat foreign to that which alone ought to act. On this account, it it is proper to have, beside the thermometer in use, another which will indicate the temperature of the air at every instant.

Before concluding this notice, I shall say a few words on the fact, which constitutes the principle of it, viz. the remarkable difference between the quantities of heat developed by the condensation of vapours on sulphuric acid, according to the degree of humidity of the atmosphere.

It would seem at first sight, that however small be the quantity of vapours in the atmosphere, there ought to be a quantity sufficient to saturate the stratum of acid adhering to the bulb of the thermometer, and consequently to develope the same quantity of heat.

But we must remark, that there is a struggle between the force of affinity of the acid for the vapour, and the tendency which the water possesses to remain under that form of vapour,—a tendency which increases as the quantity of vapour in the atmosphere diminishes. Hence it follows, that the greater the humidity, the more facility will the water have to condense the vapour, the more rapid also will the condensation be, and, consequently, the more considerable will be the heat developed. The thermometer will not stop, therefore, till the cooling occasioned by the difference of temperature between the air and the thermometer bulb shall compensate the quantity of heat produced by the condensation of the vapour, and the term at which that limit takes place will depend on the greater or less degree of the humidity of the air.

When the thermometer ceases to rise, we must say that its stopping is owing to the equilibrium which is then established between the heat produced and the cooling, which ought to take place at this temperature; but still the acid does not cease to condense the vapour. We may prove this by suspending the thermometer to a sensible balance, when it will be seen that its weight increases by the condensation of the aqueous vapour round the bulb, even after the thermometer has ceased to rise. It is easy also to measure exactly the quantity of water which is attracted by a known quantity of sulphuric acid. For this purpose, the thermometer is first weighed in its natural state;—it is then weighed after it is plunged in the acid, by placing its bulb in a receiver dried by the muriate of lime. The difference between these two weights gives that of the thin stratum of acid adhering to the bulb. The receiver is then removed, and exposed to the open air, and condenses on the acid which envelopes it a certain quantity of water, the weight of which it is easy to appreciate, as I have often ascertained.

Of all the acids, the sulphuric acid is, without doubt, the most proper for these experiments, on account of its great affinity for aqueous vapours. This affinity is such, that, even in a receiver dried by muriate of lime, I have seen the thermometer rise from 15° to 18° centig., that is to say, 3°, but it cannot rise higher.

The nitric acid produces also heat by the condensation of aqueous vapours, but in a much less degree. A thermometer, for example, whose bulb had been plunged into that acid, rose only in extreme humidity from 13½° to 17½° centig., that is, 4°, and exposed to an average humidity, it rose only 3°, the temperature of the air being 14°.

The hydrochloric acid presents a singularity when it is employed for the same purpose. A thermometer whose bulb has been plunged in that acid begins by descending, and this rises higher than the part from which it set out. At the temperature of 15°, for example, the thermometer descends at first to 14°, and then rises to 17°: but when placed in a receiver dried by muriate of lime, the thermometer descended from 15° to 12°, and did not rise higher than the point from which it set out. From this it seems to follow, that the first tendency of the water contained in the hydrochloric acid is to evaporate,—a tendency to which it yields entirely when the air is very dry,—and that afterwards the acid, become more concentrated by the privation of the water which is evaporated, tends to take some of it again, by condensing the aqueous vapours of the atmosphere, and consequently producing heat; or may not the phenomenon be owing to the disengagement of the hydrochloric acid gas, which, in quitting the water with which it was united, tends to produce cold, a cold which is soon more than compensated by the condensation of the water attracted by the acid round the bulb? However this may be, the phenomenon seems to present a kind of contradiction which it is not easy to solve.

I shall not enter at present into any further details respecting the heat produced by the affinity of acid for aqueous vapours, trusting that I shall resume the subject, and treat it more profoundly, when I have finished the experiments on this subject with which I am at this moment occupied.

Art. XXIII.—*On the Locality of Acmite.* By N. B. Möller, Esq. of Porsgrund, Norway.*

Many years ago, Mr Brataas, one of the captains in the mining district of Kongsberg, had discovered this mineral at Eger, and showed it to Professor Ström, who was, at that time, the clergyman of the place, and who, in his description of the parish of Eger, mentioned it under the name of *crystallized hornstone or shorl.*†

Some time afterwards, a peasant brought some crystals of it to Professor Esmarck, but as he had found them only detached, he could give no information in regard to their true locality. Professor Esmarck himself considered these crystals as staurolite, a mineral which in fact they much resemble when found without their terminations, which was the case with those which he possessed.

Mr P. Ström, a manager of several of the Kongsberg mines, found the mineral *in situ*, from the instructions given by Captain Brataas, and took several specimens with him to Stockholm, where it was immediately suspected to be something new; and this was perfectly confirmed by the subsequent analysis by Mr Ström himself, and by Professor Berzelius, for ascertaining the quality and quantity of the ingredients.

Since Mr Ström always kept the place a great secret, it is probable that mineralogists would have long remained uncertain in this respect, had I not had the good fortune of becoming acquainted with Mr Brataas, who took me to the real locality, which is Rundemyr, about two English miles distant from Bisseberg Mine, in the parish of Eger, near Kongsberg. It occurs in considerable quantities, imbedded in quartz and felspar; many of the crystals being upwards of a foot in length. They are, however, not easily disengaged

* Extracted from the manuscript account with which we have been favoured by the author, and which is intended for the "*Magazin fur Naturvidenskaberne*" of Christiania.—Ed.

† Strom. *Eger Beskr.* p. 50. The identity of these crystals with the Acmite, has been placed beyond a doubt, by the comparison of the very specimens described by Professor Ström, which are at present in the possession of Mr Otto Tank, of Fredrikshald.

from the matrix, on account of their great fragility. They do not, all of them, possess that dark brownish-black colour, which is generally quoted in the descriptions of Acmite, but they are sometimes greenish-grey, and of all the intermediate shades between this and the brownish-black colour. In this case, also, their lustre is not so high, and they approach very much in appearance to Mussite, a variety of pyroxene, with which species their regular forms likewise very closely agree. Generally the crystals are macled, and very often bent.

Art. XXIV.—*Account of two newly discovered Mineral Species.* * By Professor J. J. Berzelius. M. D. F.R.S. Lond. and Edin. &c. &c.

1. *Phosphate of Yttria.*

This mineral has been discovered by Mr Tank junior, near Lindesnaes, in Norway, in a vein consisting chiefly of a coarse-grained granite. He obtained only one specimen, consisting of an aggregate of crystals of half an inch or an inch in diameter, but much engaged among each other. They belong to the pyramidal system of Mohs, and are similar to Fig. 16, Plate VI.† Cleavage takes place parallel to the faces *l*, *l*, in two directions perpendicular to each other, and is easily obtained. The cross fracture is uneven and splintery. Its colour is yellowish-brown, similar to certain varieties of the zircon from Frederieksvärn; the streak very pale brown. "Sp. Gr.=4.5577, at a temperature of 16° centigr. Hardness =4.5 . . . 5.0, between fluor and apatite, nearer the latter." It possesses resinous lustre, the higher degrees of it upon the faces of cleavage, the surface of the crystals being nearly dull, and faintly translucent.

Before the blow-pipe, it resembles very much phosphate of

* Extracted from *Kongl. Vetenskaps Acad. Handlingar* for 1824, p. 334. and Poggendorf's *Annalen der Physik.* 1825, ii. p. 203.

† The figures of these crystals, and that of the crystals of Polymignite, were observed by Mr Haidinger, on specimens in the possession of Mr Tank.

lime; it is distinguished from it, however, by its being infusible without addition, and much more difficultly soluble in salt of phosphorus. With boracic acid, and a piece of iron-wire, it gives much phosphuret of iron. It is insoluble in acids, even when they are concentrated.

The analysis was conducted in the following manner: The mineral, having been melted with carbonate of soda, was digested in water, which left a pale yellow earthy substance undissolved. The alcaline solution was saturated with acetic acid, evaporated to dryness, redissolved in water, (by which process, a trace of silica was obtained,) and then precipitated by acetate of lead. As the precipitate, produced in this manner, is always the combination expressed by the formula $\ddot{P}6^3\ \dddot{P}^2$, which, in the present instance, was likewise verified by actual analysis, the relative quantity of phosphoric acid could be thus ascertained. Since we must suspect the presence of fluoric acid in almost every natural body containing the phosphoric acid, a small quantity of the mineral was analyzed, for the purpose of ascertaining its existence; and, in fact, some very distant, though slight indications of this substance were obtained. The earthy powder left from the first process, was digested in muriatic acid, which left behind a small quantity of silica, and undecomposed mineral. The solution was added in drops to a solution of carbonate of ammonia, which dissolved entirely the precipitate that had been formed in the beginning. The fluid was now evaporated, and the muriate of ammonia driven away, the residue again dissolved in muriatic acid, and then brought to dryness. Upon redissolving it in water, a dark brown substance remained, which was phosphate of iron, with excess of base, and which seems to be the colouring matter in the mineral. It did not contain any cerium. That the earthy base, united with the phosphoric acid was yttria, appears from the character, that the solutions possess a taste as sweet as sugar, as also from the amethyst-coloured difficultly soluble salt, which it formed with sulphuric acid, and which effloresced and became milk-white, without losing its form.

The proportion of the ingredients is

Yttria, - - -	62.58.
Phosphoric acid, with a little fluoric acid, -	33.49.
Phosphate of iron, with excess of base, -	3.93.

The corresponding formula is, $Y^3 \overset{.:.}{P}{}^2$, analogous to the native phosphate of lime.

2. *Polymignite.*

The name of this mineral is derived from πολὺς much, and μιγνύω I mix, in allusion to the great number of substances of which it is composed. It occurs in more or less regular imbedded crystals, from a line to upwards of an inch in length, in the zircon syenite of Frederikovärn in Norway. The specimens analyzed were collected by Mr Tank.

Its regular forms belong to the prismatic system of Mohs; one of the varieties is represented in Fig. 15, Plate VI. They are generally compressed between *T* and *T*, and lengthened in the direction of the axis. The cleavage is very imperfect, though sometimes traces of it are visible parallel to *T* and *M*; the fracture is highly perfect conchoidal. The surface of the crystals is sometimes longitudinally streaked, but possesses a considerable degree of an imperfect metallic lustre, which is still higher in the fracture. Its colour is black; the streak dark brown, rather paler when the mineral is much comminuted. It is opaque. The hardness is = 6.5, between quartz and felspar, the specific gravity = 4.806

Before the blow-pipe it remains entirely unaltered. It does not give out water. To glass of borax, in which it is readily dissolved, it communicated the colours produced by iron, and if it is added in a rather large proportion, the globule may be rendered opaque by flaming, and then it assumes a nearly orange-yellow colour. With tin it yields a reddish-yellow colour. It is dissolved likewise by salt of phosphorus. In the reducing flame the globule becomes reddish, and is not altered by the addition of tin. It does not melt with carbonate of soda, but is changed into a reddish-grey mass. It yields traces of tin by reduction.

Only 0.658 grammes could be subjected to the chemical analysis, and it is therefore not to be expected, that from so small a quantity, both the nature and the relative proportions of the ingredients could be ascertained with perfect exactness, particularly as we are yet in want of exact methods for separating zirconia and titanic acid, or yttria and protoxide of manganese.

The analysis itself was conducted in the following manner:

A. As the mineral may be decomposed by sulphuric acid, it first underwent that process. The sulphates dissolved in water, left behind a white powder, which was well lixiviated with hot water, and then exposed to a red heat. Upon the supposition, that it was tantalic acid, it was melted together with sulphate of potash with excess of acid, and yielded a transparent yellow mass, from which the salt was extracted by water, leaving the white substance undissolved. The latter became green, when hydro-sulphuret of ammonia was poured on it. The filtrated fluid being evaporated, left a trace of a metallic sulphuret, which seemed to be sulphuret of tin. The green substance was soluble in muriatic acid, with the exception only of a slight trace of the metallic sulphuret mentioned above; and, therefore, it could not be tantalic acid.

The solution was yellow. First tartaric acid, and then an excess of ammonia were added, in order to precipitate the white substance, and to retain the oxide of iron, but no change ensued. The iron was therefore precipitated by hydro-sulphuret of ammonia, the precipitate dissolved in nitro-muriatic acid, and again precipitated by caustic ammonia.

B. Muriate of lime was added to the remaining fluid, the precipitate washed, exposed to a red heat for decomposing the tartaric acid, and freed from lime by muriatic acid. A white powder remained, which appeared yellow while hot, but became perfectly white on cooling. Before the blow-pipe it proved to be titanic acid.

C. The solution in sulphuric acid (A) and the water, with which the precipitates had been washed, were precipitated by caustic ammonia; the precipitate filtered and washed. Lime was precipitated from the fluid by oxalate of ammonia, and then transformed into carbonate of lime. The remaining fluid, evaporated and exposed to a red heat, gave a saline mass, containing potash and magnesia.

D. The precipitate obtained in C by ammonia was partly soluble in dilute sulphuric acid. A substance remained undissolved, which turned pale yellow on being exposed to a red heat.

E. The solution in sulphuric acid, (D) and the water of edulcoration, were nearly neutralized with ammonia, and while boiling hot, sulphate of potash was dissolved in them, as long as any precipitate formed. The precipitate washed, first with pure water, and then with ammoniacal water, and then exposed to a red heat, became yellow. It was now melted, along with the substance obtained in D, and a little sulphate of potash with excess of acid, and digested in water, which became but slightly nebulous by ammonia. It was placed upon a filter, and washed first with tartaric acid, and then with concentrated muriatic acid, as the whole of it had not been dissolved by the former. What had remained undissolved, even in the latter, proved to be titanic acid. From the solutions in the tartaric and muriatic acids, nothing was precipitated when ammonia was added in excess. Sulphuret of iron was precipitated by hydro-sulphuret of ammonia, and afterwards it was converted into oxide of iron. The remaining fluid was evaporated to dryness, and the salts decomposed by a red heat. A white earthy substance was thus obtained, insoluble in muriatic acid, but soluble in concentrated sulphuric acid, and in every respect similar to zirconia. This substance, however, still contained a little titanic acid, as also the titanic acid obtained above a little zirconia.

F. The fluid, which in E had been precipitated by means of sulphate of potash, was now mixed with tartaric acid, supersaturated with ammonia, and precipitated by hydro-sulphuret of ammonia. The sulphuret of iron thus obtained was transformed into oxide, the remaining saline mass was evaporated, and then exposed to a red heat, along with an addition of saltpetre to prevent the formation of sulphurets. The salts, with an excess of alkali, were dissolved in water, and the remaining earthy substance was soluble in muriatic acid in the cold. With caustic ammonia the fluid gave a precipitate, which became yellowish-brown upon the filter, and black on being exposed to heat. The ammoniacal fluid yielded a precipitate with oxalate of ammonia, which became black in a red heat, and was oxide of manganese mixed with a little lime.

G. What had been precipitated by ammonia, was soluble in muriatic acid, giving out a slight odour of chlorine, and after being saturated with sulphate of potash, the solution gave a lemon-yellow precipitate of sulphate of cerium and potash, which was decomposed by caustic potash, and yielded oxide of cerium. The remainder proved to be yttria, mixed with a little oxide of manganese.

In this manner, the following proportions among the ingredients were obtained:

Titanic acid,	46.3
Zirconia,	14.14
Oxide of iron,	12.20
Lime,	4.2
Oxide of manganese,	2.7
Oxide of cerium,	5.0
Yttria,	11.5
Total	96.3

With traces of magnesia, potash, silica, and oxide of tin. The loss is in reality greater than it appears in comparing the numbers of the result, because the manganese and iron, and probably also the cerium, exist in the mineral in the state of protoxides. No calculation can, therefore, be grounded on this analysis, only so much may be inferred, that the mineral is a titanate of zirconia, mixed with other isomorphous titanates.

Art. XXV.—*On some new Localities of rare Minerals.** By Professor J. J. Berzelius, M. D. F. R. S. Lond. and Edin. &c. &c.

Several remarkable minerals, the orthite, zircon, and soda-spodumene, have been discovered in the island of Skepsholm in Stockholm, during the blasting of some rocks upon it, in the course of the summer of 1824. They do not occur in regular veins, but are here and there disseminated through the

* From the "*Ansberättelse om framstegen in Physik och Chemie,* 1825," p. 193 and 220.

rock, particularly where the grain of the granite is larger. The orthite so much resembles gadolinite, that it was, at first, considered as a variety of it, till Dr Wöhler, the first who observed the orthite in the quarry of Skepsholm, found its chemical composition to be exactly the same as that of the orthite from Gottliebsgang, at Finbo near Fahlun. Its fracture is either glassy, or it is granular, and almost metallic, like that of yttro-tantalite; its colour is sometimes yellowish-brown, and even approaching to red, yet according to the experiments of Dr W., these, and the black varieties, do not present any essential difference in their composition. The zircon is rather rare. Generally the crystals, which are dark brown, are very small, but some of them have been found half a line in diameter, and two lines long. The soda-spodumene, the same mineral which I formerly (Ansber. 1824. p. 160.) mentioned as a new species found at Danvikgate, near Stockholm, is met with here in abundance, sometimes of a snow-white colour, and distinguishable from felspar by its stronger lustre. The variety from Skepsholm, has been analyzed by Mr Arfvedson, who found its chemical composition to agree with the result I had obtained last year.

These minerals do not, in general, appear to be very rare in the rocks in the vicinity of Stockholm. The soda-spodumene is probably a very common mineral, but often mistaken for felspar. I have seen it in the granites of Norway. Orthite is found at Danvik, also in the Diurgard, (deer-park,) and almost in every place where rocks have been newly blasted. I have seen a roundish mass in Skepsholmen of two inches diameter. In a granite block, taken from a wall near Orkelliunga in Scania, I likewise discovered orthite, and Mr Tank communicated to me large orthites from Lindisnaes, in Norway, where they are found along with the phosphate of yttria. These varieties have not yet been analyzed, but their exterior appearance, and the characters which they exhibit, when exposed to the action of the blow-pipe, so very nearly agree with those of orthite, that I do not doubt their composition will be found identical.

A mineral, which seems to be Pyrorthite, since it entirely agrees with it in its characters, when examined before the blow-pipe, has been discovered by Dr Wöhler. It occurs at Grigisholm, near Stockholm, and at Skinnskatteberg, near Riddarhyttan, so that it is no longer confined to the locality of Kararfvet, near Fahlun.

Carbonate of cerium has been discovered at Bastnaes, near Riddarhyttan, accompanying the cerite, on which it forms white crystalline coatings. According to an analysis by Mr Hisinger, it is composed of

Oxide of cerium, - -	75.7
Carbonic acid, - - -	10.8
Water, - - -	13.5

which corresponds to the formula $\ddot{C}e\ \ddot{C}+2$ Aq. From a want of sufficient material, it has been impossible to repeat the analysis, which is called for in particular by the uncertain proportion of water. Along with it is found also fluate of cerium, of a nearly orange-yellow, or wax-yellow colour, and semi-transparent. It does not change its appearance, when exposed to a slight red heat, by which it loses 19 per cent. of its weight. It is exceedingly rare.

Art. XXVI.—ZOOLOGICAL COLLECTIONS. *

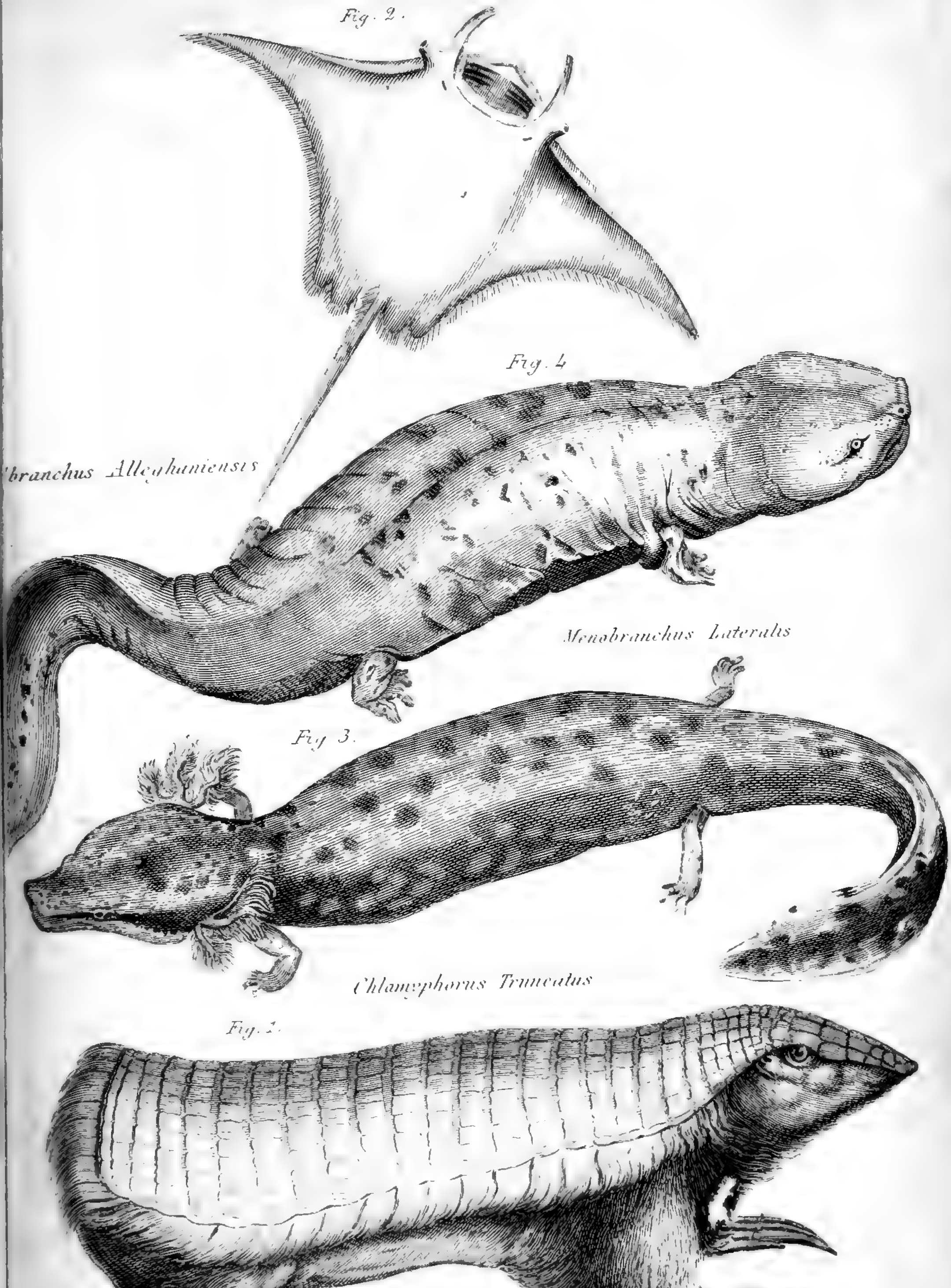
Chlamyphorus truncatus. Plate VIII, Fig. 1.

Corpore, supra testâ coriacea, postice truncata, squamis rhomboideis, lineis transversis dispositis, conflata, subtus capillis albis, sericeis, obtecto; capite supra squamis testa dorsali continuis, adoperto; palmis, plantisque pentadactylis; unguibus anterioribus longissimus, compressis; marginibus externis, mucronibusque acutis; cauda rigida, sub abdomine inflexa.

Dimensions.

	Inch.
Total length - - - -	5·2
Length of the head - - - -	1·6
Breadth between the eyes - - -	·8
Depth of the posterior truncated portion of the shell -	1·3
Greatest breadth of the same - - -	1·8
Girth posterior to the shoulders - - -	4·
Length of the sole of the foot, including the nails -	1·2
Breadth of the foot - - -	·3
Length of the nails - - -	·2

* The following New Animals are described in the *Annals of the Lyceum of New York*, vol. i.



Published by W. Blackwood 1825.

Length of the hand - - - -	1·4
Breadth of ditto - - - -	·4
Length of the longest nail - - - -	·7½
Length of that portion of the tail which is free, and curved beneath the body - - - - -	1·2

The shell which covers the body is of a consistence somewhat more dense and inflexible than sole leather of equal thickness. It is composed of a series of plates of a square, rhomboidal, or cubical form; each row separated by an epidermal or membranous production, which is reflected above and beneath over the plates; the rows include from fifteen to twenty-two plates; the shell being broadest at its posterior half, extending about one half round the body; this covering is loose throughout, excepting along the spine of the back and top of the head; being attached to the back immediately above the spine, by a loose cuticular production, and by two remarkably bony processes (to be described hereafter) on the top of the os frontis, by means of two large plates, which are nearly incorporated with the bone beneath; but for this attachment, and the tail being firmly curved beneath the belly, the covering would be very easily detached. The number of rows of plates on the back, counting from the vertex, (where they commence) is twenty-four; at the twenty-fourth the shell curves suddenly downwards, so as to form a right angle with the body; this truncated surface is composed of plates nearly similar to those of the back; they are disposed in semicircular rows, five in number: the lower margin, somewhat elliptical, presents a notch in its centre, in which is attached the free portion of tail, which makes an abrupt curvature, and runs beneath the belly parallel to the axis of the body; the free portion of tail consists of fourteen caudal vertebræ, surrounded by as many plates, similar to those of the body; the extremity of the tail being depressed, so as to form a paddle; the rest of the tail compressed. The caudal vertebræ extend up to the top of the back, beneath the truncated surface, where the sacrum is bent to meet the tail. The superior semicircular margin of the truncated surface, together with the lateral margins of the shell, are beautifully fringed with silky hair.

Head: posterior half, broad, anterior half, before the eyes, tapering; the occiput is covered by the five first rows of the *back plates*, with which they are continuous; the occiput not distinguishable externally. The anterior half of the top of the head is covered, first, by a row of large plates, five in number, which are firmly attached to the bone beneath; particularly the two outer;—secondly, by a smaller row, six in number, anterior to which, that is to say, the top of the snout, is covered with smaller plates irregularly disposed.

External ear, consists of a circular, somewhat patulous opening, directly posterior to the eye, surrounded with an elevated margin; and communicating with a bony canal, to be more fully described hereafter. *Eye,* minute, totally black; and, like the ear, nearly hidden by long silky hair *Mouth,* the rictus small. *Nose,* the extremity of the snout is furnished with an enlarged cartilage, as in the hog; the anterior nares opening downwards, at the inferior border.

The whole surface of the body covered with fine silk-like hair, longer and finer than that of the mole, but not so thick set. The anterior of the chest is large, full, and strong; the anterior extremities, short, clumsy, and powerful; the hair is continued for some distance on the palm—the phalanges of the hand united; five powerful nails rising gradually one above the other; the external shortest and broadest; the whole so arranged as to form a sharp cutting instrument, somewhat scooped; very convenient for progression under ground; and such as must very much impede motion on the surface. Hind legs weak and short—feet, long and narrow; the sole resembles considerably the human foot, having a well defined heel, which rests flat upon the ground, and being arched in the middle; toes separate, nails flattened horizontally.

Skull. At first view, the bones of the cranium and face would appear to constitute one solid case, the remnants of sutures are indistinctly visible in some parts only. The cavity of the cranium is capacious; the greatest breadth, which is from ear to ear, is one inch; greatest depth five-tenths; length of the cavity, seven-tenths. One of the most remarkable peculiarities of this skull consists in the two processes of bone above alluded to, which project obliquely, forward, upward, and outward; from the os frontis, anterior to the cavity of the cranium, and directly above the malar bone; giving to the front of the skull an aspect totally unique; these prominences are hollow, communicating with the frontal sinuses, and must contribute in a great measure to enlarge the organ of smell; there exists a considerable concavity between them, which, in the recent state, was filled with an adipose, gristly mass, which served to unite the skull to the plates above. The snout commences anteriorly to these processes, and is rapidly attenuated and depressed. The ossa nasi are broad and strong, slightly arched transversely, extending anteriorly beyond the os incisivum, as does likewise the osseous septum narium. The zygomatic processes are laterally arched; a small pointed process, descending near the malar bone, (somewhat like that in the sloth); the zygomatic fossæ are large.

The labyrinth is protuberant, and occupies the usual situation at the base of the skull; joined to which is the tympanum;—to the last is attached a bony cylinder, stretching first upwards behind the zygomatic process of the temporal bone, around which it makes a sudden curve, and runs forward and upwards to terminate at the external ear. This structure, which I believe is peculiar to the animal before us, will be better understood by referring to the plate.

Lower jaw. Anterior portion shaped like that of the elephant, much elongated; the general form and proportion resembles very closely the lower jaw of the sheep, the base being considerably arched, and the curve at the posterior part, forming with the base nearly a right angle, projecting obliquely outwards: the base is marked by eight slightly elevated protuberances, occasioned by the roots of the teeth; the condyloid process is longer than the coronoid; in the sheep, this is reversed: the articulation at the glenoid cavity is such as to admit of great freedom of motion. Length of the base of the lower jaw one inch; length of the angle five-tenths; greatest width two and a half tenths; width of the angle three-tenths.

Teeth. Incisors, none in either jaw; molars, eight in number, on either side of the upper and lower jaws, all approximate; disposed in separate alveoli; the crowns of the two first only, approach to a point, and thus much resemble canine teeth; the six remaining are all nearly flat on the crown; their structure is simple; a cylinder of enamel, of equal thickness throughout, surrounds a central pillar of bone, there being no division into body and root; the lower half is hollow, the cavity representing an elongated cone. In the lower jaw, the teeth penetrate its whole depth;—length of the teeth, about three tenths of an inch: two tenths of which are buried in the sockets—diameter, about one-tenth They are somewhat flattened on the sides, and in a slight degree curved externally, to be adapted to the shape of the jaw. The teeth of the inferior maxilla are directed forwards and upwards; those of the superior maxilla are directly reversed in their direction, so that the crowns meet each other obliquely; and the posterior margin of the lower teeth, and the anterior margin of the upper, present their angles to the object of mastication.

We have been presented in the subject before us with a *new form:* an animal combining in its external configuration a mechanical arrangement of parts which characterizes, respectively, the armadillo, the sloth, and the mole; constituting in themselves, individually and separately, of all other quadrupeds, those which offer the most remarkable anatomical characters. Pursuing the investigation step by step, with the skeletons of the above named animals before me, it was not until after I had completely finished every point of observation, that I perceived in the skull alone, of the new animal, a reunion, more or less complete, of all those remarkable traits that an external view of the animal had offered for contemplation; which, taken collectively, furnishes us with an example of *organic structure,* if not unparalleled, at least not surpassed in the history of animals.

This animal is a native of Mendoza in Chili; in the Indian language it is termed 'Pichiciago.' It had been obtained on the spot in a living state, but it continued to live in confinement only a few days. Its habits resemble those of the mole, living for the most part under ground, and is reputed to carry its young beneath its scaly cloak.—*Prof. Harlan.*

2. *New and gigantic species of the genus Cephalopterus, of Dumeril.* Plate VIII. Fig. 2.

C. Vampyrus. Char.—Breadth of the body exceeding its length; mouth nearly terminal, without teeth; a vertical fin on each side of the mouth, projecting forwards; tail unarmed. *

* Supposed to be the same animal described by M. Lesueur, under the name, C. Giorna. This description we had not seen.

Taken near the entrance of Delaware bay, by the crew of a smack, after a long and hazardous encounter. Its weight was supposed to be between four and five tons.

Dimensions.—Length from the fore margin of the head to the root of the tail 10 feet 9 inches. The breadth from one extremity of one pectoral fin to the other, measuring along the line of the belly, 16 feet; when measured across the convexity of the back 18 feet. The mouth nearly terminal, and not situated on the under side. Its breadth from corner to corner 2 feet 9 inches. There were two upper lips, both destitute of teeth. There was a single lower lip, beset with small rough processes, resembling those of a rasp, instead of teeth. There was in this huge mouth no appearance of a tongue.

Branchial openings on each side beneath, *five*, and with the gill covers of different lengths, from 12 to 24 inches, and varying in breadth from 7 to 10. The greatest breadth of the scull, or osseous part of the head, 5 feet. Distance between the eyes 4 feet 2 inches; between the nostrils 2 feet 3½ inches; between the eye and ear 11 inches; between the eye and nostril 1 foot 1 inch; between the corner of the mouth and eye 1 foot 1½ inches. The *rostral* fins were 2 feet 6 inches long, 12 inches deep, and 2½ inches thick in the middle, whence it tapered toward the edges, which were fringed before with a radiated margin. Each contains 27 parallel cartilaginous rows. The natural flexibility and elasticity of these were greatly increased by articulations alternating with each other through every gristle and every part of the structure. Motion was communicated to these cartilages with admirable effect, by means of muscles attached to them, and lying under the common integuments which enveloped them. The fin or wing so constituted could, from its flexibility, bend in all directions, and be made in many respects to perform the function. The phalanges of this fin were attached by strong ligaments to the upper jaw and to the point of articulation with the lower jaw. These two organs, which we may suppose rendered essential services to the animal, were 5 feet 9 inches apart, and could almost be made to meet in front, or be bent into the mouth. There was no proper bone in the skeleton, except in one spot a hump or knob, about the size of a hen's egg, at the root of the tail behind the dorsal fin. The most remarkable parts of its organization were the pectoral fins, or rather wings.

There was a scapula, humerus, ulna, carpus, and an uncommon number of phalanges of the before mentioned cartilaginous structure. All these limbs or joints were articulated with each other; but the articulations, like those of the human sternum, had very little motion. This series of stiff joints was fixed in the flesh, and proceeded somewhat obliquely backward. From this articulated but fixed extremity, proceeded obliquely backward seventy-seven rows of cartilage of different lengths, but of almost same parallelism, and not at all radiated. They were all articulated, and the joints were very numerous. In the longest row they amounted to twenty-seven, and in the shorter ones proportionally fewer; the cartilages, with their articulations, were so alternated and diversified, that they, with the yielding and bending quality of the cartilage, were susceptible of all manner of flexion, and enabled the fish to assume all the attitudes requisite for its life and habits. In one of the wings or pectoral fins, the number of joints amounted to 623; from which some judgment may be formed of the vast variety of motions these organs are capable of performing, and how admirably they are adapted to connect strength with speed. We can hence understand the reason why they fly swiftly and powerfully through the water; why they can raise a spray, or foam, around them when they flap their wings on the surface; and they are able, huge as they are, to gambol with agility, and even to leap out of the water for a considerable distance. This species is viviparous.—*Prof. Mitchill.*

3. *Two New Genera of Reptiles Proposed.*

Professor Harlan, who has paid much attention to the Batracian reptiles, has established two new genera. The first of these, from its most prominent character, he has named MENOBRANCHUS.

Gen. Char.—Persistent branchiæ; four-footed, four toes to each foot; clawless.

M. lateralis.—A black vitta from the nostrils, passing through the eyes, and dilated on the sides, becoming obsolete on the tail. Plate VIII. Fig. 3.

Two rows of teeth in the upper jaw and one in the lower, and one rib less than the true Salamandræ. This species is the Triton lateralis of Say, in Long's Expedition. To this species, Professor Harlan refers the animal mentioned by Professor Mitchill as a Proteus, and confounded by him with the Salamandra Alleghaniensis of Michaux, and also the animal from Lake Champlain, described by Schneider.

M. tetradactylus.—Two rows of teeth in each jaw; duplicature of skin, forming a collar on the superior part of the neck, immediately anterior to the branchiæ. Syn. Protée tetradactyle of Lacepede.

ABRANCHUS.

Gen. Char—Destitute of branchiæ at all periods of its existence; four strong legs, five toes to the posterior, four to the anterior extremities; the outer edge of the feet fimbriated; two outer toes of the hind feet palmated; clawless.

A. Alleghaniensis, Plate VIII. Fig. 4. Salamandra Alleghaniensis of Michaux and Latreille, S. gigantea of Barton.

4. *Bilobites.*

In the cabinet of the Lyceum of New York, there are some fossils from New Jersey, and the Catskills, labelled with the name, Bilobites.

They are imbedded in a loose friable sandstone, which seems to be almost wholly composed of organic remains, such as productus, terebratula, &c. The general outline of the fossils may be considered as elliptical, one extremity being much narrower than the other. The length varies from 1.2 to 1.5 inch. The average thickness is about five lines. The superior or dorsal surface is divided into two unequal lobes, by a longitudinal furrow, in the course of which a raised zig-zag line is observed. The lobes, with respect to each other, are unequal in size and thickness; they gradually become thinner towards the circumference, and more particularly towards the posterior or larger extremity. The lobes are marked transversely by 18-30 distinct costae, which become more elevated as they approach the raised zig-zag line. These costae do not terminate at the edges, but are continued at the anterior extremity, on the under surface. Faint longitudinal impressions are observed, at unequal distances, crossing the transverse costae nearly at right angles. The inequality of the lobes is not always constant; in one specimen, (See Plate VI. Fig. 11.) the smaller lobe is compressed in such a manner as to produce a crest, and approximating nearly to the shape of a trilobite. The under surface is extremely irregular. The edges, as before mentioned, are very thin, and are elevated about two lines above the inferior surface. This, however, is not uniform throughout the whole circumference; the anterior portion, comprising one-third of the fossil, is without such a raised border. In this part, the dorsal costae are continued beneath, and meet each other at angles of about 45°. The line of junction has not yet been rendered visible by the most careful dissection. The posterior portion of the under surface presents a series of concentric lines, interrupted by a carina directly beneath, and in the direction of the dorsal furrow. These fossils were at first supposed to be remains analogous to the Trilobites, but are at present referred to the Productus of Sowerby—*Dr Dekay.*

See Plate VI. Fig. 11, 12, 13, and 14.

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

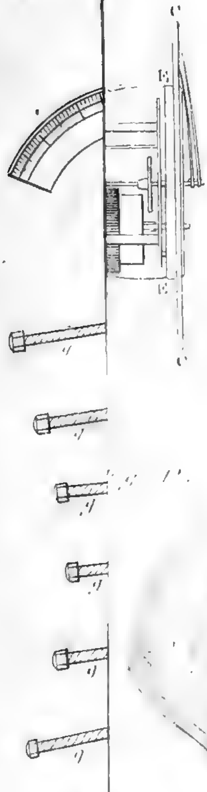
1. *Method of giving the Epicycloidal Form to the Teeth of Wheels.* By Peter Lecount, Esq. Midshipman, R. N. *in a Letter to the Editor.*

H. M. S. Queen Charlotte, Portsmouth Harbour,
Dec. 5, 1822.

Sir,

I have to apologize to you for not having earlier sent you the account of the method I propose to use in forming the teeth of the wheels and pinions of chronometers in the shape of an epicycloidal curve. The fact is, I have been waiting to get a sight of the engine now used for cutting watch wheels, in order so to adapt my plan to that instrument as to leave it capable of performing all its former offices, and that the machinery for giving the epicycloidal form may be put to it or taken away at pleasure.

In the instruments now used for cutting the teeth of watch and chronometer wheels, there is a circular brass plate (called the dividing plate) about seven inches in diameter, having a steel axis in its centre (called the mandrill) five or six inches long; this is fixed in a frame with the axis perpendicular, the wheel to be cut is fixed to the top of the mandrill, and the plate is turned round the required distance for each tooth by



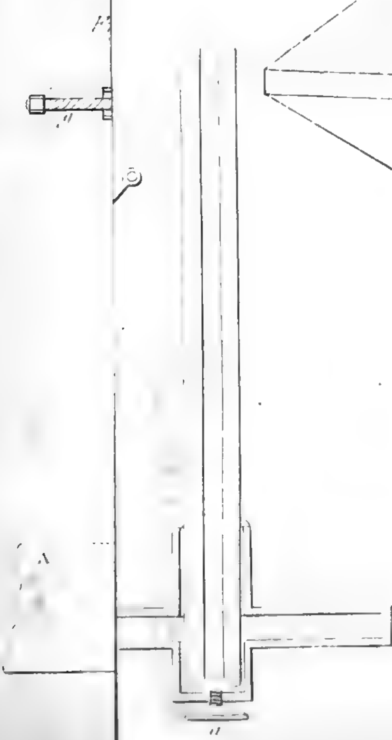


Fig. 7.

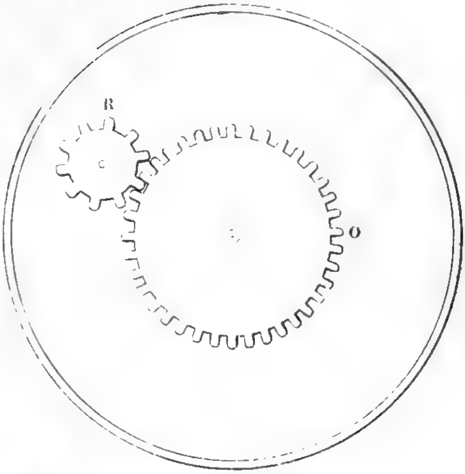


Fig. 14.

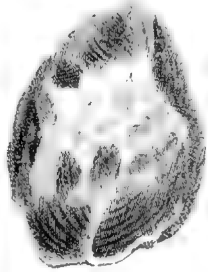


Fig. 16.
Phosphate of Yttria.

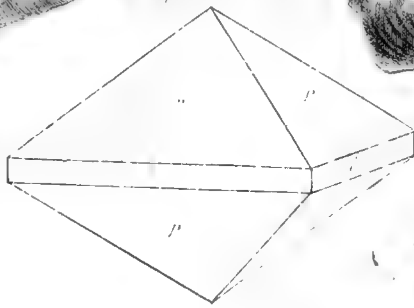


Fig. 11.

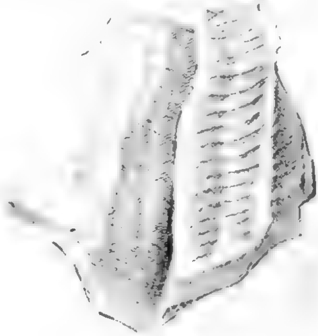


PLATE XI.

a contrivance (called the blind man's guide) which, when once set to that distance accurately, is stopped by a bolt, and the plate can be turned all round by it one of the said distances at a time, without the trouble of looking at the divisions again. Towards the top of the frame which holds the mandrill and dividing plate, there is a horizontal dovetail slide of brass running back from the mandrill about six inches, on which slide an upright back (or cock) holding the cutter frame is drawn backwards and forwards by means of a screw in a horizontal direction from the top of the mandrill, where the wheel is so that the cutter may enter the wheel any required depth to form the tooth. In the drawing, Plate I. Fig. 4, (given in last Number,) *a, a,* represents the top of this upright back, and to two brass chocks, *b, b,* the cutting frame is fixed as represented, but does not come forward farther than *c, c,* and is formed in the direction of the dotted line. Between *d, d,* a steel axis is swiftly turned round by a lathe, and on this axis is the cutter. This cutter frame may be moved upwards and downwards in the chocks *b, b,* turning thus by means of steel hollow cones, into which the inner ends of the screws *f, f,* enter on the inside of the chocks—after the cutter frame is brought forward on the dovetail slide, so that the cutter will enter the wheel on the top of the mandrill, the requisite quantity, the frame is then turned a little up, and the lathe set in motion, and the cutter is by this means turned swiftly round in the frame; the frame is then turned downwards, and the cutter passes through the circumference of the wheel cutting into it the required depth.

I now propose, that after the first cut into the wheel is thus made, the cutter-frame *c, c, c, c,* is taken out of the chocks *b, b,* for which purpose the screws *f, f, g, g,* may be for convenience made with large round heads, with milled edges, similar to *h, h,* as they can then be turned by hand; the upright back and chocks are then to be drawn back on the dovetail slide, and the frame *k, k,* is to be fixed in the chocks *b, b,* exactly the same as the frame now used was done, taking out the screw *m,* and opening the part out marked *n, n,* which has a hinge at *o,* and adjusting the hole *p,* to the mandrill, by the screw to the dovetail slide,—then shut up the mandrill in the hole *p,* by closing the part *n, n,* and screwing fast the screw *m,*—this plate *k, k,* is to be of solid brass, and about half an inch thick. The frame *k, k,* when thus fixed, must be in a plane parallel to that of the surface of the dividing plate, the top of the mandrill, with the wheel on it standing nearly an inch above the upper surface of the frame.

On this frame, I propose to fix a pentagraph, constructed to diminish in any required ratio,—the tracing end to be towards the chocks *b, b,* and the marking end towards the mandrill and wheel at *p,*—at the end next *p,* the cutter is to be fixed, so that its edge next *p,* is precisely in the marking point of the pentagraph,—at the end of the plate next the chocks *b, b,* where the tracing end of the pentagraph comes, an epicycloidal curve, similar to that required for the teeth of the wheel, is to be deeply cut; when, therefore, the tracing end of the pentagraph is carried through this curve, the edge of the cutter describes, or is carried through a similar curve, but smaller in any required ratio to which the pentagraph may be set,—the cutter is to be connected with the latter, and turned swiftly round by it, exactly in the manner now done in these engines.

Now, supposing the length of that part of the epicycloidal curve, which is required for the tooth of the wheel, to be one-twenty-fourth of an inch, which is nearly the size for the smallest sized chronometers, or those worn in the pocket, than if the pentagraph diminished twenty times, the same portion or the curve next the chocks, which is to be cut into the brass frame, would be about an inch in length, which size is sufficient for it to be constructed mechanically with sufficient accuracy, as any trivial errors in that mechanical construction, when decreased twenty times, would become insensible.

The best kind of pentagraph, I should think, would be the eidograph invented by Professor Wallace, and which is made by Bate, in the Poultry, London, as it is found to be peculiarly accurate, and to possess several other advantages, and for the suggestion of employing this pentagraph I am indebted to P. Barlow, Esq., of the Royal Military Academy. It ought to be made of steel and hardened, to prevent it bending by the resistance opposed to it, which, however, is not great, as the motion of the cutter is very swift.

There are several little things to be attended to in putting this method in practice, all of which would immediately strike the practical mechanic, but some of which I shall mention. The mandrill would have to be lengthened a little, to enable its top, with the wheel on it, to stand above this second frame. This may be done by unscrewing the part which holds the wheel out of the mandrill, after the first cut is made in it by the old cutting-frame, and then screwing on an additional piece to the mandrill, and again screwing it, the piece holding the wheel on the top of this additional piece, or the second frame might have shoulders standing up above its upper surface, at the end next the chocks *b, b,* to receive the hollow steel cones, into which the inner conical ends of the screws *f, f,* come, which would hav- the same effect. The approaching and receding motion of the pentagraph must be exactly horizontal, or more properly speaking, it must be in a plane parallel to that of the upper surface of the dividing plate,—the middle of that part of the circumference of the cutter which is next the wheel, must be the part which gives the cut,—when all is accurately set as to depth, &c. every time the blind man's guide turns round the requisite portion of the dividing plate, the tracing end of the pentagraph will have to be moved by hand through the deeeply cut curve at the back part of the frame, the same under similar circumstances, as the cutter frame now used, has to be brought down by hand, to cut through the circumference of the wheel.

There is a method a little different from the above, by which the teeth of wheels might be curved epicycloidally, but I think it would be found more difficult to use it with accuracy. I will, however, state it, and should any public-spirited chronometer maker be inclined to this essential improvement in his machines, it will be for him to determine on this, and many parts in the practical applications of the plans I give, which he will be much more qualified to do than I am.

In order to explain this, Fig. A, Plate I, shows the axis *t t,* of the cutter as now used, which fixes in the cutter-frame *d d*, by the screws *v*, *v*, which have conical holes in their ends at *d*, to receive the ends *t*, *t*, of the axis of the cutter, and large round heads, with milled edges, similar to those proposed for the screws *f*, *f*, the screws *v*, *v*, are fixed tight by others, *w*, *w*, *y* is a brass virrel, round which the line passes from the cutter, and communicates the motion, *x* is the cutter, which is a circular piece of steel fixed on the axis with its surface perpendicular to the length of the axis, and around its edge are sharp teeth for cutting the teeth of the wheel.

Suppose now, that the second frame, with its attached pentagraph, as before described, is fixed to the cutting machine, and instead of the wheel to be cut being fixed on the top of the mandrill at *p*, let a piece of steel be placed there, and by the action of the pentagraph, as before described, let this steel be cut into the shape of the required part of the epicycloidal curve wanted for the teeth of the wheel,—this piece of steel, when properly shaped otherwise, may then be fixed on the axis *t*, *t*, and, with the cutting-frame as now used, may be employed as the cutter for the wheels, and their teeth will still have the required form; the dotted lines at *z*, show the shape which this cutter would have, instead of its presenting a thin edge as at *x*.

The difficulty in this method, appears to me to lie in making teeth to this cutter, so as not to injure the true form of the curve,—an ingenious mechanic may find himself capable of overcoming this. Perhaps, after the teeth have been cut by the method I first proposed, an instrument, of the form of the dotted lines at *z*, with its curves highly polished, may, with advantage, be used as a burnisher, to prevent the injuring the true form of the teeth, by finishing them up by any other method.

I am, Sir,

Your obedient Servant,

To Dr Brewster. Peter Lecount,

Midshipman Royal Navy.

2. *Description of a Single Weather Sluice, invented by* Robert Thom, Esq. *Rothesay*, Plate VI. Fig. 9.

One of the purposes to which this apparatus is applicable, is to regulate the supply of water between a reservoir and mill, or other works, where the former is at a great distance from and high above the latter; where several streams fall into the aqueduct between them, and where the adoption of apparatus, Vol. III. Plate I. Fig. 9, might be considered too expensive. But it may also be applied to several other purposes, as will readily occur to such as may have occasion to adopt it.

AB, part of an aqueduct, (close behind the tunnel of the reservoir,) in which the water is always kept at the same level by an apparatus like that of Vol. II. Plate IV. Fig. 5 or Fig. 6, placed upon the tunnel of the reservoir. The communication between this part of the aqueduct and that below is opened or closed at pleasure by

BC, a small sluice, (and several others of the same kind, which are not represented in the drawing,) that turns upon pivots at C.

DE, a light can of copper, (or tin plate painted,) open at top, with a small aperture in its bottom.

F, a pulley.

G, a lever attached to sluice BC.

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

IK, the section of a rivulet, near where it enters the reservoir, in the vicinity of AB.

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

OP, another pipe, which communicates between pipe LMN and a second can, the same as DE, not shown on the drawing.

QR, a third pipe, which communicates between pipe LMN and a third can, the same as DE, not shown on the drawing.

1, 2, 3, apertures that communicate between rivulet IK and pipe LM.

When can DE is full of water, it shuts sluice BC, but when empty, the pressure of water in front of BC throws it open. The aperture in the bottom of the can DE keeps it always empty, except when the quantity running into it is more than that aperture can pass.

Before proceeding with the description, it may be proper to explain more fully the object in view. It has been already mentioned, that in this case a number of streams fall into the aqueduct between the reservoir and the mills. When the weather is very wet, these streams furnish a sufficient supply of themselves; and at such times, therefore, no water should be allowed to flow from the reservoir. But, when less rain falls, these streams only furnish a part, and the rest must be supplied by the reservoir; and when the weather is very dry, these streams cease to flow altogether, and then the whole supply must come from the reservoir. Now, this apparatus is so contrived, that, when these streams are entirely dry, it sends down the whole supply from the reservoir; when these streams furnish a part, it sends down the remaining part, whatever it may be; and when these streams furnish the whole supply, it shuts the reservoir altogether, so that the mills have always an equal supply, whether the weather be wet or dry.

To accomplish this, the whole number of sluices, BC, &c. placed on the aqueduct AB, are calculated so as just to pass the whole quantity of water wanted at the mills; and as more or less water is produced by these streams, a greater or lesser number of these sluices will open or shut, so as to keep the quantity at the mills always equal. The number of these sluices will be more or less, as the case may require; in this we suppose three, as being sufficient to illustrate the principle.

Let us suppose, then, the weather very dry; the streams between the reservoir and the mills quite dried up; and the sluices BC, &c. all open; rain comes, and these streams begin to flow; but the same rains that swell these streams, swell also the rivulet IK; and by the time the first produce a quantity equal to what one sluice (BC) can pass, the last will have risen so as to flow out at aperture 1, thence down pipe LMN into can DE; which shuts sluice BC. When these streams increase, so as to produce as much water as two of the sluices (BC) can pass, then the rivulet IK will have swollen so as to flow out at aperture 2, and thence through P into a second can, which shuts a second sluice. When they increase so as to produce a quantity equal to what three of the sluices (BC) can pass, then the water in the rivulet IK will have risen so as to flow out at aperture 3, and thence through R into a third can, which shuts a third sluice.

Again, suppose the weather to become fair, and the streams begin to decrease, by the time they fall short, a quantity equal to what one sluice, (BC) can pass, the water in the rivulet IK will have fallen so as not to flow out at aperture 3, and, of course, one can will be empty, and one sluice open; by the time they fall short, a quantity equal to what two sluices can pass, the water in the rivulet IK will have fallen so as not to flow out at aperture 2, and a second can will have become empty, and a second sluice open. When they shall have fallen short a quantity equal to what three sluices can pass, the water in the rivulet IK will have fallen so as not to flow out at aperture 1, and a third can will have become empty, and a third sluice open, &c. &c.

In this way the water may be regulated at pleasure; and if a small reservoir were made near the works to retain the water that flows during the night, (or when the mills are not at work,) not a drop would be lost.* The purpose, however, for which this apparatus was invented was different. Having occasion to cut an aqueduct round the bases of some hills, to collect water and convey it to a reservoir at a considerable distance, I found, that, to make the aqueduct large enough to convey all the water as it fell during floods, would be very expensive; it therefore occurred to me, that, if a part of the water could be detained during floods, and brought away gradually afterwards, a much smaller, (and, of course, much less expensive,) aqueduct would answer the purpose. I therefore made a small reservoir at a convenient place, and contrived these sluices to shut during very heavy rains, and open again as they became lighter, which answered the purpose completely, and was the origin of all these weather sluices.

3. *On coarse Paint made with Potatoes.*

Take a pound of potatoes, skinned and well baked. Bruise them in three or four pounds of boiling water, and then pass them through a hair sieve. To this add two pounds of good chalk in fine powder, previously mixed up with four pounds of water, and stir the whole together. This mixture will form a sort of glue capable of receiving any kind of colour, even

* The apparatus, Vol. III. Plate I. Fig. 9, will accomplish the same thing without this small reservoir; but, in most cases, (particularly where the elevation of the reservoir above, and its distance from, the works is great,) the expence would be much greater than in this.

that of powdered charcoal, brick, or soot, which may be used for painting gates, palings, and other articles exposed to the air.

4. *Method of preventing the Fracture of Glass Chimneys.*

The glass chimneys which are now in such extensive use, not only for oil lamps, but also for the burners of oil and coal-gas, very frequently break, and not only expose to danger those who are near them, but occasion very great expence and inconvenience, particularly to those who are resident in the country. The bursting of these glasses very often arises from *knots* in the glass where it is less perfectly annealed, and also from an inequality of thickness at their lower end, which prevents them from expanding uniformly by heat. The best method of detecting the knots is to examine the glasses by polarized light, and reject those that exhibit at the knots the depolarized tints.

M. Cadet de Vaux (*Bull. des Sc. Tech.* Mars 1825. p. 180,) informs us, that the evil arising from inequality of thickness may be cured by making a cut with a diamond in the bottom of the tube, and he remarks that, in establishments where six lamps are lighted every day, and where this precaution was taken, there was not a single glass broken for nine years.

5. *Description of Griebel's Portable Night Clock.*

This clock, constructed by M. Griebel of Paris, is represented in Plate VI. Fig. 3 and Fig. 4, the former showing it in perspective, and the latter in section. A is the globe which contains the clock movement and the lamp B. The dial-plate C has a rim of ground glass with the hours painted upon it between E and C, Fig. 4.; EE is a plate in the centre of the ground glass ring to which the movement is fixed, F is a globe to protect the wheel-work from dust. The rays of light BG, BG issuing from the lamp B, illuminate the rim EC of the dial on which the hours and minutes are painted. *Bull. des Sciences Technol.* Jan. 1825, p. 40.

It would, we think, be an improvement on this clock to place a mirror between GG, to intercept all the rays that do not fall upon the rim of ground glass, which, by means of another mirror behind B, would throw some additional scattered light on the rim itself, while it would protect the wheel-work from the direct radiation of the lamp.

6. *Description of M. Allard's Universal Bevel.*

This useful and ingenious bevel, which is represented in Plate VI. Fig. 2, is composed of two rules *a, b,* which open and shut round the joint *a*. The shortest of these two *b,* carries a portion of a circle *c,* which passes through a slit in *d,* where it may be fixed by a screw *d*. The other branch *a,* is perforated with rectangular mortises in which are nuts, *e,* of the same form, moving on a transverse pin *f,* in order to allow the screw *g,* which passes through them, to incline itself and change its position as may be required. One of these screws is shown separately in Fig. 8. Near *a* is fixed a flexible plate of steel *hhh,* which is jointed by caps *ii,* and rivetted to the ends of the screws *g*. In the openings of each of these caps is placed a piece *k*, with two points, and with the end of the screw fixed in the middle of it, so that the plate *hhh*, may, by means of the screws, be made to apply to any curve, and retained in that position so as to be transferred to another substance. *Bull. des Sc. Technol.* Jan. 1825, p. 41.

7. *Method of Consuming the Smoke of Steam-Boiler Furnaces.* By Mr G. Chapman.

As this contrivance has been found to answer the purpose of consuming the smoke, it has been honoured by the London Society of Arts with the large silver medal. Mr Chapman heats the air which promotes the combustion of the smoke before it is admitted into the furnace, by making the grate-bars hollow from end to end, and causing the cold air to pass through them into two boxes, one in front of the grate, and the other behind it. In the ordinary method of supplying the grate with fuel by the front-door, about forty or fifty cubic feet of cold air is admitted into the furnace. Mr Chapman, on the other hand, uses a cast-iron hopper from which the coals are introduced in a moment without letting in any perceptible quantity of cold air. When fresh coals are put in, the smoke has at first the appearance of a light-gray vapour, but in a few seconds it becomes nearly invisible. A drawing and a fuller account of this furnace will be found in the *Transactions of the Society of Arts for* 1824, vol. xlii. p. 32.

8. *Menstruum for Biting in on Steel Plates for Fine Engravings.* By Mr Edmund Turrell.

This useful process, for which Mr Turrel has received the large gold medal of the London Society of Arts, has been the result of a great number of well-directed experiments, made for the purpose of discovering a menstruum, which should corrode the steel with great facility, while it produced a beautiful, clear, and deep line. The following is the compound fluid which he found the most perfect.

Take four parts by measure of the strongest pyroligneous, (chemically called *acetic acid,*) and one part of alcohol or highly rectified spirits of wine; mix these together, and agitate them gently for about half a minute, then add one part of pure nitric acid; and when the whole are thoroughly mixed, the menstruum is fit to be poured upon the etched steel plate.

This fluid holds the oxide of the metal in perfect solution, so that the whole of the lines appear beautifully bright, and continue so till the biting in is completed. Very light tints are corroded in about one minute and a half, and a considerable degree of colour is produced in about fifteen minutes. When this mixture is poured off the plate, it should be washed with one part of alcohol, and four of water, and the stopping out should be effected by asphaltus dissolved in essential oil of turpentine, so as to flow freely from a hair pencil. In making the above menstruum, the purity of the ingredients is a matter of great importance.

The steel plates used for engraving may be saved from rust, by warming the plate, and rubbing sheep's suet (from the animal) over it, and keeping it near a fire, or in a dry room. The best steel plates are those manufactured by Mr Rhodes and Mr Hoole of Sheffield. See the *Transactions of the Society of Arts*, 1824, vol. xlii. p. 50.

9. *Description of Lenormand's New Chronometer.*

This very singular piece of mechanism, which excited much interest at the expositions of French industry in 1819 and 1823, is represented in Plate VI. Figs. 5, 6, 7. The principle of this chronometer consists in the continual displacement of the centre of gravity of the arm of a lever. This lever has the form of an arrow AB, Fig. 5. which is capable of moving round a horizontal axis O, fixed in the middle of a dial-plate divided into twelve hours. The two arms AO, BO are unequal, and at the end B is fixed a round box. If we place in the box a small weight, which has the power of moving round the interior circumference of the box, and if it is placed as at B, the arrow will remain in the position AB, and point to IX^h. If the small weight is placed as at D, so as to be at the greatest possible distance from the centre O, the arrow will point to XII^h, and so on at the other quarters, as at E and F in Fig. 6. In like manner, intermediate positions of the little weight will cause the arrow to point to intermediate hours. If we now could fix in the box a piece of wheel-work to displace this weight in a regular manner, so as to describe the circumference of the box in twelve hours, the arrow AB would revolve in twelve hours, and would point them out on the dial-plate like the hand of a clock. If the wheel-work should carry the weight round the box in an hour, the arrow would mark minutes on the dial. The additional weight which we have used for the purpose of explaining the principle of the machine, is not actually used. It exists naturally in every watch, as the centre of gravity of every watch is at a distance from its centre of form, on account of the weight of the main-spring box and fusee. We require, therefore, only to place a watch in the box B, Fig. 5, in such a manner, that it cannot go without communicating its motion to the arrow AB. This may be done in two ways, 1, The axle of the central wheel, at the place where it comes out of the plate in which it moves, carries a square which is laid hold of by one of the two cross pieces between which the watch is carried, which cross pieces are fixed to the box. The other end of the axle, which is round, moves in a hole perforated in the opposite cross piece. This method, though the most simple, is not always so convenient as the following: 2, On one of the cross pieces above mentioned is fixed a wheel O, Fig. 7. which cannot turn round. Above the plate of the watch passes the axle of a wheel, on which is fixed a pinion R, which works in the wheel O. The wheel-work actuated by the spring not being able to turn the wheel O, turns quite round it, and, consequently, carries the centre of gravity of the watch quite round the interior circumference of the box B, Fig. 5, and this changes at every instant, and in a regular manner, the centre of gravity of the arrow. If the axle of the wheel, which carries the pinion R, turns round in one hour, and if we wish AB to revolve in twelve hours, then R must have eight teeth, and O 96, or R 10 and O 120. If AB is to revolve in one hour, then R and O must have the same number of teeth. *Bull. des Sc. Technol.* Jan. 1825, p. 42.

10. *On the Construction of Chimneys.*

Mr. Tredgold, in his work on warming and ventilating apartments, has given the following rule for proportioning the upper orifices of chimneys to their heights and the magnitude of the fire-places:

Multiply by 17 the length of the fire-place in inches. Divide the product by the square root of the height in feet, and the chimney above the fire. The quotient will be the area of the upper orifice in square inches.

Thus, if the fire is 15 inches wide, and the height of the chimney be 9 feet, we shall have $\frac{17 \times 15}{7} = 36\frac{1}{2}$ square inches nearly, which is a rectangle of 6×6 inches, in a circle of nearly 7 inches in diameter. In chimneys already existing, the upper orifices may be contracted to their proper size by Parker's cement. The contraction of the lower end of the vent above the fire should be nearly the same as the upper orifice; and the throat or lowest opening should not exceed the length of the bars. The length of the front of the fire should be an inch for every foot of the room's length, and the depth one-half the length. If the length of the chamber should be such as to require a grate more than 30 inches long, two fire-places should be constructed.

11. *M. Ventau's Gigantic Meteorological Eolian Harp.*

Captain Haas of Basle has designated by these names, an apparatus which emits of itself a variety of sounds during a change of weather. Since the year 1787, he had stretched above his garden *fifteen* iron wires, 320 feet long, and at the distance of about two inches from one another; the largest wire two lines in diameter, the smallest one line, and those of intermediate size one and a half line. They were situated towards the south, and are inclined 20° or 30° to the horizon, being stretched by means of rollers properly arranged for the purpose. Whenever the weather changes, these wires sound with such loudness, that it is impossible to go on with a concert in the house. The sounds sometimes resembled the hissing noise of water rapid in ebullition, sometimes that of a harmonicon, and sometimes that of a distant chime, or an organ.

The inventor of this curious apparatus is M. Ventau, provost at Burkli, not far from Basle. He sometimes shot at a mark from his window; and in order that he might not go to the mark after each shot, he attached to it a long iron wire to draw it to him at pleasure. He remarked more than once, that that wire sounded exactly an octave; and he found that every iron wire, stretched in a direction parallel to the sounds, emitted this tone at every change of weather.

A brass wire did not produce any sound, nor did an iron wire, when it was stretched from east to west.

M. Dobereiner of Jena conceives that the phenomenon now described is the effect of an electro-magnetic action; and he proposes to try if the brass wire would not sound when it communicates at its extremity with an energetic electrometer. *Bullet. des Sc. Techn.* &c. July 1824, p. 51.

12. *Natural Lamp by Incandescence.*

In using a spirit of wine lamp, M. Dobereiner observed, that when the spirit of wine was nearly consumed, the wick became carbonised, and that the flame disappeared, yet the carbonised part of the wick became incandescent, and continued red while a drop of alcohol remained, provided the air in the apartment was tranquil. In one experiment it continued red twenty-four hours; a disagreable acid vapour, however, was formed.

Dr Brewster long ago observed an analogous fact in the small green wax tapers in common use. When the flame is blown out, the wick will continue red for many hours, and the wax and wick are burned down as in its ordinary combustion, only with extreme slowness; a very disagreeable vapour being formed during the imperfect combustion. Dr Brewster has observed also, that the same effect is not produced when the taper is made of *red wax*. This probably arises from the colouring matter of the two tapers. There can be little doubt, however, that the same result will be obtained with different kinds of wax, and even with tallow, provided the quantity of wax is properly proportioned to the diameter of the wick.

13. *Oil for Chronometers, Clocks, and Delicate Wheel-work.*

It has long been a desideratum among watchmakers to procure good oil, that retained its fluidity for a length of time, without acting upon the metals which it lubricated, and without becoming thick or freezing with cold. For this purpose, every kind of acid, or of mucilage, must be taken from it. In short, it should be pure *elaine*, without any trace of stearine.

In order to extract the elaine from fixed oils, M. Chevreul treats it in a matrass, with seven or eight times its weight of alcohol nearly boiling, decanting the liquid, and exposing it to the cold. The stearine will then separate in the form of a crystallized precipitate. The alcoholic solution must then be evaporated to the fifth of its volume, and the remainder will be elaine, which ought to be colourless, insipid, almost without smell, without any action on the infusion of turnsole, having the consistence of white olive oil, and coagulable with difficulty. M. Peclet's method of procuring elaine, consists in pouring upon oil a concentrated solution of caustic soda, stirring the mixture, heating it slightly to separate the elaine from the soap of the stearine, pouring it on a cloth, and then separating by decantation the elaine from the excess of alcaline solution. Some excellent observations on the effects of oil in jewelled holes, &c., will be found in the *Edinburgh Encyclopædia*, Art. Horology, vol. xi. p. 137.

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

I. *On the Transverse Strain and Strength of Materials.* By Mr Eaton Hodgkinson. (*Manchester Memoirs,* vol. iv. p. 225. Lond. 1824.)

We slightly mentioned this article in our third number, and, at the same time, stated our intention of examining it more at length in the present Journal. It appears to have been read in March 1822, but the author, at that time, not having seen Mr Barlow's "*Essays on the Strength of Materials,*" &c. it was afterwards withdrawn, in order to make some notes and additions considered necessary, in consequence of certain discrepancies between the two theories, viz. the one adopted by Mr Barlow, and that by Mr Hodgkinson; of these we shall take some notice as we proceed, observing only in this place, that the points in dispute relate principally to what may be called, the mechanism of the transverse strain, viz. to the operations going on in the interior of a piece of timber at the moment of rupture, as at the time of the greatest strain, and the relation between the resistance of the timber, when strained transversely, and its power of direct cohesion, but which, however, does not affect the computed strength of timber as deduced from experiments made on the transverse strength; for all parties agree, that whatever may be the exterior operations, the proportional strength of similar beams is directly as the breadth, and the square of the depth, and inversely as the length, so that the point in question may be considered as one rather of curious philosophical inquiry, than of actual importance in these kind of experiments.

Mr Hodgkinson, after a short introduction, commences his paper with the following inquiry. Suppose a beam fixed firmly in a wall, and to be then broken by a weight suspended at its other end, what are the circumstances attending the rupture? admitting, in the first place, that the timber is wholly incompressible, and that it resists fracture by its tension only.

Even this simple question has given rise to some controversies amongst early writers on this subject. Galileo, who led the way in these researches, assumed, that the fibres of the timber, from the lower edge of the beam, about which it was supposed to revolve, to produce fracture, acted in such a way, that their united effect was the same, as if the whole of their actions took place at the centre of gravity of the surface; that is, he supposed, the resistance of each fibre to be the same, at whatever distance it was situated from the axis of motion, except so far as depended on its leverage. But Mariotte, Leibnitz, and others, assert, and apparently with good reason, that, according to the law, *ut tensio sic vis*, the resistance of each fibre is proportionate to its tension, independent of the leverage, and, therefore, introducing the latter, the effect of each will be as the square of its distance from the fulcrum.

To meet these cases, Mr Hodgkinson assumes the resistance to vary as an indeterminate power (v) of the distance of the fibres, and hence deduces a very simple and general formula, involving this indeterminate index v, to which, giving the different values 0, 1, &c. he arrives at the several results obtained by these writers, for beams of all forms and dimensions. These, as we have before stated, differ essentially from each other, when the results are made dependent on the strength of direct cohesion, although with similar formed beams, and under similar circumstances, the proportions deduced from each are the same.

One of the most remarkable differences in these deductions is, that, admitting the law of Galileo, which is equivalent to making $v=o$, an equilateral triangular beam will be twice as strong, broken with its edge downwards, as when reversed, so as to make the base the fulcrum of motion, the edge leaning upwards. And, according to Leibnitz, the proportions of strength in the two cases is as 1 to 3; whereas, by experiments reported by Mr Barlow, it appears that the strength in the two cases is nearly equal, what difference there is, being on the opposite side to that deduced from theory. From this, therefore, it is demonstrated, as was before asserted by Coulomb, Dr Robison, and others, that both hypotheses are erroneous, the errors in each arising from considering the material as incompressible, and thereby supposing the beam to turn about its lower edge, whereas, in fact, it is partly compressed, and partly extended, the motion being about an intermediate line, now commonly denominated the *neutral axis,* because the fibre, situated at this place, is supposed to be neither extended nor compressed. The investigation of this question is the next object of the author, who, adopting the theory of Coulomb and Dr Robison, arrives at this formula:

$$\text{breaking weight} = \frac{T \times D + T \times \Delta}{L \times C}$$

Where T =, the sum of the forces arising from tension, D and Δ, the distance of the centres of tensions, and compression from the neutral axis, L, the length of the beam, and C, the cosine of its deflection; and here we fall upon the principal question, arising out of the paper under review, viz. the theory of Coulomb, Hodgkinson, and others, *versus* Barlow's. It is not our intention to give any decision on this subject, but we shall endeavour to lay the question fairly before our readers, and leave them, or those most practically conversant with these subjects, to decide, in order to do which, however, we must quote at some length from the Memoir in question.

After showing, as we have done above, that there must be in the beam a certain neutral line, Mr H. proceeds.

" If then, in Plate II. Fig. 4, (given in last Number,) in which *adbc* is intended to represent the surface of fracture, *ab* be the neutral line, or that of which we have been speaking, and if *abd* be the surface of extension and *acb* that of compression, it is evident that the extensions, or compressions of any particles, within those surfaces, will be as their distances from the line *ab;* and the forces necessary to produce them may be considered as in proportion to some powers v and w of those distances.

And in order to estimate the strength of the piece, whose section is *acbd,* if F and *f* represent the points at which the forces, rising from extension and compression, being collected, would produce the same effects as they do at their respective distances from the neutral line: *f* will be the fulcrum, on which all the horizontal forces may be conceived as sustained, and Ff one arm of a bended lever, while the length of Gf is the other, (the points F and G being supposed to be connected by the chain FG, merely to give the lever the appearance of greater strength.) And to obtain the strength of the body we shall have

$$W \times fG = \text{sum of the forces in } abd \times Ff.$$

Whence $W = \frac{\text{sum of the forces in } abd \times Ff}{\text{the length } fG}$, where the deflection of the beam is neglected; or introducing that, as in Art. 9, we have W (the weight) $= \frac{\text{sum of the forces in } abd \times (FP + Pf)}{\text{Length} \times \text{cosine of Deflection}} = \frac{T \times D + T \times \Delta}{L \times C}$, where T = sum of the forces rising from tension, D and Δ the distances of the centres of tension and compression from the neutral line, L the length of the piece, and C the cosine of its deflection.

"A necessary consequence of this reasoning is, that the sums of the forces of extension and compression are just equal to one another:* For the weight W, acting in the direction of GW, parallel to the surface of fracture *adbc*, can have no influence in pushing the piece toward or draw-

* "The mode of reasoning adopted above has been objected to by Mr Barlow, who conceives that the forces in F and f, or those of extension and compression, instead of being equal, should be inversely as their distances from the neutral line, or that the forces in F $\times$ PF = forces in $f \times Pf$, and that these taken collectively are = the rectangle under the weight and the length of the beam, which is supposed to turn as on a pivot round the neutral line. Whence L $\times$ W = the forces in F $\times$ PF $\times$ forces in $f \times Pf$ = twice the forces in F $\times$ PF. The mode of estimating the strengths of bodies, as deduced from this, is very simple and easy; it is in effect this:—Find the neutral line—suppose *that* the fulcrum—estimate the strength of the area of tension, as was done in incompressible bodies, and double that for the answer.

But this rule, it appears to me, contains within itself a fundamental error which will become very apparent by the following consideration.—It is supposed to be general whatever the situation of the neutral line may be. Let then the body be incompressible; the neutral line will in that case be extremely near the edge, and the strength as estimated by this rule will be double what from incontestable principles it ought to be: a consequence which the ingenious author could have had no idea of, when he proposed this theory. The error too will be found to exist, though in a less degree, in almost every other position of the neutral line, and may be very plainly seen, if we estimate by this rule, strengths of bodies that suffer a slight compression, and compare the results with the known strengths of the same bodies, if they had been wholly incompressible.

For example:—The strength of an incompressible joist, broke by a weight hung at one end, being $\frac{2sba^2}{l(v+2)}$, (articles 4th and 9th,) where s is the longitudinal strength of the fibres in a unity of surface, b the breadth of the piece, a its depth, l its length, and v the index of extension: the strength of a compressible one, according to Mr Barlow, will be $\frac{2sbd^2}{l(v+2)}$, where d is the depth of the area of tension, and the rest as before.

ing it from the wall: and therefore the pressure on the fulcrum f must just be as great as the resistance in F, all the horizontal forces being supposed collected into those two points.

"For the first outline of this subject, see the valuable treatise of Dr. Robison, referred to above."

Before entering more particularly on this subject, it may be proper to state, that we do not conceive Mr Hodgkinson has, by any means, succeeded in proving, by the calculations he has made, the inaccuracy of the theory in question. Mr Barlow obviously assumes, that the operation of breaking consists of two distinct forces, namely, that necessary to produce extension, and that of compression, and that the strength will be greater as either of these are greater; and it is, therefore, quite consistent

$$\text{Suppose } d = \frac{1}{8}a \text{ then } \frac{2sbd^2}{l(v+2)} = \frac{1}{32} \times \frac{sba^2}{l(v+2)}$$

$$d = \frac{2}{8}a \text{ .... } = \frac{4}{32} \times \frac{sba^2}{l(v+2)}$$

$$d = \frac{3}{8}a \text{ .... } = \frac{9}{32} \times \frac{sba^2}{l(v+2)}$$

$$d = \frac{4}{8}a \text{ .... } = \frac{16}{32} \times \frac{sba^2}{l(v+2)}$$

$$d = \frac{5}{8}a \text{ .... } = \frac{25}{32} \times \frac{sba^2}{l(v+2)}$$

$$d = \frac{6}{8}a \text{ .... } = \frac{36}{32} \times \frac{ba^2}{l(v+2)}$$

$$d = \frac{7}{8}a \text{ .... } = \frac{49}{32} \times \frac{sba^2}{l(v+2)}$$

$$d = \frac{8}{8}a \text{ .... } = \frac{64}{32} \times \frac{sba^2}{l(v+2)}$$

The last three terms of which must be false, since they all give the strengths greater than $\frac{sba^2}{l(v+2)}$, which is that of the joist when every fibre is submitted to tension, and the preceding five terms (setting aside accidental coincidences) must be erroneous too, since they lead in a regular progression to the last three.

Now, as Mr Barlow has offered no reasons against the theory in the text (further than that it does not agree with his own, which we have just been examining,) we see no cause why it should be rejected, especially since it seems to us to be every where consistent and just.

It may not be improper to mention that M. Coulomb, in his paper on this subject (*Memoires presentés à l'Académie des Sciences*, tom. vii.) makes L $\times$ W = the forces in F $\times$ PF + the forces in f $\times$ Pf, and endeavours to show that the forces in F and f, or those of tension and compression are equal: the theory of Mr Barlow then differs from that of the French philosopher in this last particular, but we conceive that the latter must be right;—the results from it are the same as from that in the text, though it is much less convenient in its use. We particularly refer the reader to the above paper of M. Coulomb, as he has given a very minute analysis of the transverse strain: and the reason why this matter has been so long overlooked, seems to be that both M. Coulomb and Dr Robison have contented themselves by giving a bare outline of it."

with his theory, that where the resistance to compression is considerably greater than that to extension, the strength of the beam will be greater, than if all the fibres acted by extension only: the only direct contradiction appears in the last case, where the resistance to compression is infinite, viz. in a case which cannot occur, and which the theory in question is invented on purpose to avoid. That it should fail here is obvious, because, in this case, there are no forces acting under the neutral line, as the theory supposes; and it is singular Mr Hodgkinson did not perceive, that precisely the same want of generality applies also to his theory, by taking the opposite imaginary case, viz. of the material being infinitely inextensible; for in this case, the area of tension being zero, the breaking weight would be zero, or taking any small area of tension, then the strength would be infinite, both inconsistent results.

The question is not, therefore, to be decided in this way, but by a reference to first principles, and it seems to be within narrow limits. Mr Hodgkinson, following the theory of Coulomb, considers the resistance to fracture as a single mechanical effort, measured by the area of tension, multiplied by the tension on the unit of measure, and by the distance between the centre of tension and compression; whence he deduces

$$W = \frac{\text{sum of the forces in } abd \times Ff}{LC}$$

$$W = \frac{\text{sum of the forces in } abd \times (FP + fG)}{LC}$$

$$W = \frac{T \times D + T \times \Delta}{LC}$$

Whereas Mr Barlow considers the operation as compound, and estimates the resistance to compression and tension separately. So that, denoting the resistance to compression by R, his expression is

$$W = \frac{T \times D + R \times \Delta}{LC}$$

In order to reduce this formula to a state proper for further investigation, it is necessary to establish the relation between the two parts, $T \times D$, and $R \times \Delta$, and he assumes them to be equal, observing "that it is this equality only which determines the relation to take place about the point P," whereas the other theory assumes $T = R$, which of course gives Mr Hodgkinson's numerator, $T \times D + T \times \Delta$. The question is thus reduced to this very narrow limit, viz. Whether, from the nature of the operations, we ought to take $T = R$, or $T \times D = R \times \Delta$, or whether the one of these equalities may not belong to the first part, and the other to the last part of the operations by which the fracture is produced. It is stated by Mr Tredgold, that the neutral axis does not remain permanent during the operation of fracture, but that the area of compression gradually increases; and if so, a different law must have place at the beginning and end of the process. At all events, we have reduced the question to its narrowest limit, and we leave it thus for the decision of those most conversant with these matters, and proceed to an examination of the experimental part of the paper.

The first experiments we meet with, were made on slips of yellow pine and Baltic fir, with a view to ascertain the law observed between the deflections or extensions, and the weights or forces employed to produce them; and in order to avoid compression, an artificial fulcrum was contrived for the beam to turn about, whereby all the fibres might act by extension only. The following are the results in one of those cases.

Weights.	Deflections.	Weights.	Deflections.
5	8	60	98
10	15	65	109
15	21	70	120
20	28	75	133
25	34	80	146
30	41	85	163
35	51	90	177
40	61	95	195
45	70	100	222
50	79	105	241
55	87	110	It bore this about ½ a minute, and then broke.

" The two first of these experiments are the concluding ones of a series of a similar kind, and were made with great care. Previous to their commencement, a considerable weight, but still such as would not injure the elasticity of the wood, was laid upon it, to make the iron recede as much as possible. The weight was then taken off, and a small slip of thin tin forced in between the ends of the iron.

" The deflections in both of them, and consequently the extensions are, through their whole ranges, very nearly in the proportion of the forces. The same may be said of the last experiment, and of every other we made, during the earlier stages of flexure; but as we continued the experiment, and arrived nearer to fracture, the extensions always increased faster than the forces.—We will seek for the ultimate value of the index v in the last experiment, and for that purpose shall select one of the earlier weights, as 20lb., with its deflection 28, and the last weight it bore or 105lb., with its deflection 241; and since the forces were supposed to be as the v power of the extensions, we have 20lb. : $(28)^v$: : 105lb : $(241)^v$. But v in the two cases is different, and in the former is $= 1$ (since then the extensions were as the forces,) and hence we have $20 : 28 :: 105 : (241)^v$, or $(241)^v = \frac{28 \times 105}{20} = 147$. And by taking the Logarithms we have $v \times$ Log. 241 $=$ Log. 147, and $v = \frac{\text{Log. } 147}{\text{Log. } 241} = \frac{2.1673173}{2.3820170} = \frac{9098}{10000} = .91$ nearly.

And pursuing the same mode with respect to the two former experiments, and considering the tabular deflections as integers, since the result will be the same, we shall have—

In the first,

$$60\text{lb.} : 19 :: 240\text{lb.} : (83)^v = \frac{19 \times 240}{50} = 76. \text{ Whence } v = \frac{\text{Log. } 76}{\text{Log. } 83} = \frac{1.8808136}{1.9190781} = .98.$$

In the second,

$$90 : 20 :: 270 : (53)^v = 60. \therefore v = \frac{\text{Log. } 60}{\text{Log. } 53} = \frac{1.7781512}{1.7242759} = 1.03.$$

"And taking the mean, we have $\frac{.98 + 1.03 + .91}{3} = .97 =$ ultimate mean value of v. A number which so nearly approaches to unity, the index of perfect elasticity, that it seems unnecessary to assume any other law."

We cannot here subscribe to the author's decision; for admitting $v = 1$, we should have 20 : 28 :: 105 : 147, (taking his own example,) whereas the experimental number is 241, instead of 147, which is too great a difference to allow us to use this law in any physical inquiry. The fact unquestionably is, that woody fibres differ very essentially from bodies perfectly elastic; their extension, for a certain time, is nearly or exactly proportional to the existing force; but beyond a certain point, they diminish in their resistance as they are more extended, and in the particular example in question, a part of the fibres still retained their entire elastic force, while the outward ones were considerably reduced in their resisting power, and consequently the deduction made by considering them all as in one state is fallacious. The same remark applies to the experiments on the law of compression. With respect to the chapter employed in deducing the neutral line, it is so involved in the question on which we have already entered at some length, that we must pass it over in this place; observing only, that the relations deduced with respect to the area of tension and compression, differ considerably from what is shown to be the actual case in Willow, by Duhamel, and in Fir, by Mr Barlow, by direct experiment. The former of these experimenters cut his bars three quarters through, filling up the cut by a wedge, without diminishing the strength, and the latter cut his fir beams 5-8ths through, with but a very slight diminution. The discrepancy, however, is, we conceive, sufficiently accounted for by the author; viz. that his computations relate to beams moderately strained, and the others to the breaking strains. The author having thus first investigated the question on general principles, as explained in the leading part of this paper, and then deduced successively the laws of tension and compression; and, lastly, the position of the neutral line or axis, proceeds to the solution of several examples somewhat parallel with those given by Mr Barlow in his Essay, with a view of connecting the direct resistance of materials with their resistance to a transverse strain, and, admitting his previous deductions, with great ingenuity and precision; but the accuracy of the whole is involved in the doubtful position which we have endeavoured to examine in the early part of this article. Fortunately, however, this doubt affects only what may be considered the curious side of the question, the useful part being in a great measure independent of it; for in all practical determinations, engineers, architects, and others concerned in such inquiries, naturally make their calculations from experiments of a similar kind to the case in hand; as, for example, where the question is a *tie*, they look to experiments on direct cohesion, when pressure to experiments on this strain, and when transverse strains are to be resisted to experiments on the transverse strength. There is, therefore, in these cases, no question concerning the relative resistance to compression, extension, neutral ones, &c. At the same time, the other inquiry is highly interesting, and being now fairly before the public, it will, we have little doubt, meet with the attention it merits, from such of our readers as are conversant or interested in the physical theory of the strength of materials.

II. *On the Gold Mines of North Carolina.* By DENISON OLMSTED, Professor of Chemistry and Mineralogy in the University of North Carolina.

THIS very interesting paper, which we are desirous of laying before our readers, has been published in America in Professor Silliman's *Journal.* The description of the mines themselves is too valuable to admit of any abridgement.

The gold mines of North Carolina, which have recently become an object of much inquiry both at home and abroad, are situated between the 35th and 36th degrees of N. latitude, and between the 80th and 81st degrees of W. longitude from London. They are on the southern side of the State, not far from the borders of South Carolina, and somewhat westward of the centre. Through the gold country flows the river Pedee, receiving, within the same district, the Uwharre from the north, and Rocky river from the south, both considerable streams. Above the junction with the Uwharre, the Pedee bears the name of Yadkin.

The gold country is spread over a space of not less than 1000 square miles. With a map of North Carolina one may easily trace its boundaries, so far as they have been hitherto observed. From a point taken eight miles west by south of the mouth of the Uwharre, with a radius of eighteen miles, describe a circle,—it will include the greatest part of the county of Montgomery, the northern part of Anson, the north-eastern corner of Mulenberg, Cabarrus, a little beyond Concord on the west, and a corner of Rowan and of Randolph. In almost any part of this region, gold may be found, in greater or less abundance, at or near the surface of the ground. Its true bed, however, is a thin stratum of gravel inclosed in a dense mud, usually of a pale blue, but sometimes of a yellow colour. On ground that is elevated and exposed to be washed by rains, this stratum frequently appears at the surface; and in low grounds, where the alluvial earth has been accumulated by the same agent, it is found to the depth of eight feet: where no cause operates to alter its original depth, it lies about three feet below the surface. Rocky river and its small tributaries which cut through this stratum, have hitherto proved the most fruitful localities of the precious metal.

The prevailing rock in the gold country is Argillite. This belongs to an extensive formation of the same, which crosses the State in numerous beds, forming a zone more than twenty miles in width, and embracing, among many less important varieties of slate, several extensive beds of novaculite, or whetstone slate, and also beds of petrosiliceous porphyry and of greenstone. These last lie over the argillite, either in detached blocks, or in strata that are inclined at a lower angle than that. This ample field of slate I had supposed to be the peculiar repository of the gold; but a personal examination discovered that the precious metal, embosomed in the same peculiar stratum of mud and gravel, extends beyond the slate on the west, spreading, in the vicinity of Concord, over a region of granite and gneiss.

A geographical description of the gold country, would present little that is interesting. The soil is generally barren, and the inhabitants are mostly poor and ignorant, The traveller passes the day without meeting with a single striking or beautiful object, either of nature or of art, to vary the tiresome monotony of forests and sandhills, and ridges of gravelly quartz. Here and there a log hut, or cabin, surrounded by a few acres of corn and cotton, marks the little improvement which has been made by man, in a region singularly endowed by nature. The road is generally conducted along the ridges which slope on either hand into vallies of moderate depth, consisting chiefly of fragments of quartz, either strewed coarsely over the ground, or so comminuted as to form gravel; these ridges have an appearance of great natural sterility, which, moreover, is greatly aggravated by the ruinous practice of frequently burning over the forests, so as to consume all the leaves and under-growth, giving to the forest the aspect of an artificial grove.

The principal mines are three—the Anson mine, Reed's mine, and Parker's mine.

The Anson Mine is situated in the county of the same name, on the waters of Richardson's creek, a branch of Rocky river. This locality was discovered only two years since by a "gold hunter,"—one of an order of people, that begin already to be accounted a distinct race. A rivulet winds from north to south between two gently sloping hills that emerge towards the south. The bed of the stream, entirely covered with gravel, is left almost naked during the dry season, which period is usually selected by the miners for their operations. On digging from three to six feet into this bed, the workman comes to that peculiar stratum of gravel and tenacious blue clay, which is at once recognized as the repository of the gold. The stream itself usually gives the first indication of the richness of the bed through which it passes, by disclosing large pieces of the precious metal shining among its pebbles and sands—such was the first hint afforded to the discoverer of the Anson mine. Unusually large pieces were found by those who first examined the place, and the highest hopes were inspired. On inquiry it was ascertained that part of the land was not held by a good title, and parcels of it were immediately *entered,** but it

* A piece of land is said not to be *entered* when it remains the property of the public, without taxation. Any one is at liberty to enter on the state books whatever land he can find in this situation, the land being secured to him on his becoming responsible for the taxes.

has since been a subject of constant litigation, which has retarded the working of the mine.

Reed's Mine in Cabarrus is the one which was first wrought; and, at this place, indeed, were obtained the first specimens of gold that were found in the formation. A large piece was found in the bed of a small creek, which attracted attention by its lustre and specific gravity, but it was retained, for a long time after its discovery, in the hands of the proprietor, through ignorance whether it were gold or not. This mine occupies the bed of Meadow creek, (a branch of Rocky river,) and exhibits a level between two hillocks, which rise on either side of the creek, affording a space between from fifty to one hundred yards in breadth. This space has been nearly all dug over, and exhibits at present numerous small pits for the distance of one-fourth of a mile on both sides of the stream. The surface of the ground and the bed of the creek are occupied by quartz and by sharp angular rocks of the greenstone family. The first glance is sufficient to convince the spectator that the business of searching for gold is conducted under numerous disadvantages, without the least regard to system, and with very little aid from mechanical contrivances. The process is as follows. During the dry season, when the greatest part of the level above described is left bare, and the creek shrinks to a small rivulet, the workman selects a spot at random and commences digging a pit with a spade and mattock. At first he penetrates through three or four feet of dark coloured mud, full of stones in angular fragments. At this depth he meets with that peculiar stratum of gravel and clay, which he recognizes as the matrix of the gold. If the mud be very dense and tenacious he accounts it a good sign; and if stains or streaks of yellow occasionally appear on the blue mud, it is a fortunate symptom. Sometimes he penetrates through a stratum of the ferruginous oxide of manganese, in a rotten friable state. This he denominates "cinders," and regards it also as a favourable omen. Having arrived at the proper stratum, which is only a few inches thick, he removes it with a spade into the "cradle." This is a semi-cylinder laid on its side, (like a barrel bisected longitudinally and laid flat-wise,) and made to rock like a cradle on two parallel poles of wood. The cradle being half filled with the rubbish, water is there laded in, so as nearly to fill the vessel. The cradle is now set to rocking, the gravel being occasionally stirred with an iron rake, until the coarse stones are entirely freed from the blue mud,—a part of the process which is the more difficult, on account of the dense adhesive quality of the mud. By rocking the cradle rapidly, the water is thrown over board, loaded with as much mud as it is capable of suspending. The coarser stones are then picked out by hand, more water is added, and the same process is repeated. On pouring out the water a second time, (which is done by inclining the cradle on one side,) a layer of coarse gravel appears on the top, which is scraped off by hand. At the close of each washing, a similar layer of gravel appears on the top, which appears more and more comminuted until it graduates into fine sand, covering the bottom of the cradle. At length this residuum is transferred to an iron dish, which is dipped horizontally into a pool of water, and subjected to a rotatory motion. All the remaining earthy matter goes overboard, and nothing remains but a fine sand, chiefly ferruginous, and the particles of gold for which the whole labour has been performed. These are frequently no larger than a pin's head, but vary in size from mere dust to pieces weighing one or two pennyweights. Large pieces, when they occur, are usually picked out at a previous stage of the process.

Large pieces of gold are found in this region, although their occurrence is somewhat rare. Masses weighing four, five, and six hundred pennyweights, are occasionally met with, and one mass was found that weighed, *in its crude state*, 28 lbs. avoirdupoise. This was dug up by a negro at Reed's mine, within a few inches of the surface of the ground. Marvellous stories are told respecting this rich mass; as that it had been seen by gold hunters at night, reflecting so brilliant a light, when they drew near to it, with torches, as to make them believe it was some supernatural appearance, and to deter them from farther examination. But all stories of this kind, as I was assured by Mr Reed, the old proprietor, are mere fables. No unusual circumstances were connected with the discovery of this mass, except its being nearer the surface than common. It was melted down and cast into bars soon after its discovery. The spot where it was found has been since subjected to the severest scrutiny, but without any similar harvest. Another mass weighing 600 pwts. was found on the surface of a ploughed field in the vicinity of the Yadkin, twenty miles or more north of Reed's mine. Specimens of great elegance, as I should infer from the descriptions of the miners, are occasionally found, but for want of mineralogists to reserve them for cabinets, they have always been thrown into the common stock and melted into bars. Mr Reed found a mass of quartz, having a projecting point of gold, of the size of a large pin's head. On breaking it open, a brilliant display of green and yellow colours was presented, which he described as exceedingly beautiful. The gold weighed 12 pwts. The mineralogist may perhaps recognize in this description, a congeries of fine crystals, but on that point the proprietor could not inform me. Although fragments of greenstone and of several argillaceous minerals, occur among the gravel of the gold-stratum, yet, in the opinion of the miners, the precious metal is never found attached to any other mineral than quartz. Indeed it is rarely attached to any substance, but is commonly scattered promiscuously among the gravel. Its colour is generally yellow with a reddish tinge, though the surface is not unfrequently obscured by a partial incrustation of iron or manganese, or by adhering particles of sand. The masses are flattened and vesicular, having angles rounded with evident marks of attrition. The rounded angles and vesicular structure lead to the opinion, which is very general, that the metal has undergone *fusion;* but any one who inspects the specimens narrowly, will be convinced that their worn and rounded appearance is owing to attrition, and that the cavities are produced by the indentation of sand and gravel, the exact impress of which may be observed, and particles of them may still frequently be seen imbedded. The gravel, moreover, which is separated by washing, bears evident marks of attrition, of *a limited duration*, sufficient to round its edges and angles, but not sufficient to destroy them: the fragments are not ovoidal like the pebbles of rivers, but are still flat, retaining their original form, except that their edges are dull, and their angles blunted. In short, the whole appearance is such, as would naturally result from so soft a substance as virgin-gold, being knocked about among such stern associates as quartz and greenstone.

The appearance of fusion, supposed to be exhibited by the gold, has inspired the idea among the miners, that the small pieces which they obtain have been melted out from some *ore* that lies disguised somewhere in the vicinity. This idea has frequently made them the dupes of imposition. The Mineral Rod, charms, and other follies, have had their reign here, and the first is still held in some estimation. The common rocks and stones of the country have been tortured by a new race of alchymists, who have imagined them to be the ore of gold, veiling, under some disguise, the characters of the precious metal. A great degree of eagerness also pervades the country on the subject of the metals in general. The minerals, thrown out in excavating pits in search of gold, consist chiefly of quartz, greenstone, and hornblende mixed with chlorite, and afford little that is interesting to the collector of specimens. Almost the only substance which I met with, that was worth preserving merely as a specimen, was *Pyritous Copper*. Of this I saw some elegant fragments. It occurs in a gangue of quartz, and resembles that found at Lane's Mine at Huntington, Con. (*Amer. Journal of Science*, vol. i. p. 316.) A vein of it occurs in slaty clay, six miles east of Concord, in Cabarrus county. This ore had been subjected to numerous experiments, on account of the belief that it was the "ore of gold," above mentioned; and, although the experiments did not lead to the discovery of gold, yet a "German miner and mineralogist" had, it was said, detected PLATINA in it. On searching into the evidence of so unexpected a result, I was informed that a white metal was produced from this ore, which was not lead, nor tin, nor silver, but answered perfectly to the description of platina, although, as they acknowledged, it was easily fused, and burned with a blue flame. I suspected it to be *metallic antimony*, but still could perceive no signs of that metal in the ore. I requested a minute account of the process.—"The materials, namely, the ore, charcoal, borax, &c. were put into a crucible—Emetic tartar, in considerable quantity, was added to make the ore "spew out" the metal. Ipecacuanha was afterwards tried with the same view, but was not found to be strong enough "to make the ore vomit." After the account of the process, it was not difficult to account for the production of antimony, it being obviously derived from the Emetic tartar.

At Concord, near the western limit of the gold country, the metal is found in small grains in the streets and gullies, after every rain; and the gullies frequently disclose the stratum of gravel and mud, well known as the repository of the gold. Washings, on a more limited scale, are conducted here. The clay is not so dense at this place as at Reed's Mine, but more ferruginous and full of spangles of golden-coloured mica. This stratum rests on *gneiss:* those before described were over the slate formation.

Parker's Mine is situated on a small stream four miles south of the river Yadkin. As in the instances already mentioned, excavations were numerous in the low grounds adjacent to the stream; but, at the time of my visit, the earth for washing, (which was of a snuff colour,) was transported from a ploughed field in the neighbourhood, that was elevated about fifty or sixty feet above the stream. The earth, at this place which contained the gold, was of a deeper red than that at either of the other mines. The gold found here is chiefly in flakes and grains. Occasionally, however, pieces are met with which weigh 100 pwts. and upwards; and very recently a mass has been discovered that weighed four pounds and eleven ounces. This is said to have been found at the depth of ten feet, which is a lower level than any I had heard of before. The idea of an aqueous deposit, which is apt to be impressed upon us whenever we either inspect the formation or reflect upon its origin, would lead us to expect, on account of the great specific gravity of gold, that the largest masses would be found at the lowest depths. But I am not aware that any uniformity exists in this respect. The largest mass hitherto discovered was, as has been mentioned already, found within a few inches of the surface It is evident that the thin stratum which contains the metal, will be buried at different depths, by variable quantities of alluvial earth, that are accumulated over it by causes still in operation; and, consequently, that the depth at which the stratum happens to be met with, in any given place, is no criterion of its richness. Nor does the fact, that this fortunate discovery was made at a lower level than ordinary, afford any encouragement to work lower than the usual depth. It might interest geological curiosity, however, to learn the nature of the strata below the gold deposit, although I do not know that the existence of this furnishes any reasonable grounds for supposing that there are other similar deposits below it. I could not find that any search had been made with such an expectation except in a single instance. Near the spot where the largest mass was found, the earth was penetrated a few feet below the gold bed. Immediately beneath this was a thin layer of green sand, and next a similar layer of a bright yellow sand. These had a very handsome appearance, but neither of them seemed to contain any thing more precious than mica.

The *terms* on which the proprietors of the mines permit them to be worked, vary with the productiveness of the earth which is worked. Some of the miners rent for a *fourth* of the gold found; some for a third, and others claim half, which is the highest premium hitherto paid. The average product at Reed's mine was not more than sixty cents a day to each labourer; but the undertakers are buoyed up with the hope of some splendid discovery, like those which have occasionally been made.

The mines have given some peculiarities to the state of society in the neighbouring country. The precious metal is a most favourite acquisition, and constitutes the common currency. Almost every man carries about with him a goose quill or two of it, and a small pair of scales in a box like a spectacle case. The value, as in patriarchal times, is ascertained by weight, which, from the dexterity acquired by practice, is a less troublesome mode of counting money than one would imagine. I saw a pint of whisky paid for by weighing off three and a half grains of gold.

The greatest part of the gold collected at these mines is bought up by the country merchants at 90 or 91 cents a pennyweight. They carry it to the market towns, as Fayetteville, Cheraw, Charleston, and New York. Much of this is bought up by jewellers; some remains in the banks; and a considerable quantity has been received at the mint of the United States. Hence it is not easy to ascertain the precise amount which the mines have afforded. The value of that portion received at the mint before the year 1820, was 43,689 dollars. It is alloyed with a small portion of silver and copper, but is still purer than standard gold, being 23 carats fine. (Bruce, *Mineral. Jour.* I—125.)

It will probably appear evident to geologists, from the foregoing statements, that the gold of North Carolina occurs in a *diluvial* formation. Such, indeed, seems to be its usual bed; and, in this respect, it resembles the gold countries of South America, of England, of Scotland, of Ireland, and of Africa. (Buckland, *Rel. Diluv.* 218—20.)

Our author next proceeds to the discussion of two questions connected with this subject:

1*st*, Is the gold brought down from the sources of the rivers? And,

2*d*, Did the present lumps and grains ever form parts of large masses in a continued bed or vein?

The first of these questions Professor Olmsted answers in the negative; but he considers it as evident that the rivers cut through a stratum containing the gold, which covers like a mantle an extensive part of the country through which they flow, and that they bring the precious metal to view by separating it from its stony matrix.

On the subject of the second question, Professor Olmsted concludes that this gold existed originally, that is, before its removal to its present position, in pieces somewhat larger than those found at present, but still of a moderate size; but he considers it is impossible to decide whether those pieces lay contiguous to one another in a large vein, or whether they were scattered abroad in individual masses.

Art. XXIX.—NOTICES OF RECENTLY PUBLISHED BOTANICAL WORKS.

We have already mentioned the "*Flora Edinensis*, or Description of Plants growing near Edinburgh," of Dr Greville, which appeared last year. Shortly after was also published, by James Woodforde, Esq. "*A Catalogue of the Indigenous Phenogamic Plants growing in the neighbourhood of Edinburgh; and of certain Species of the Class*

Cryptogamia; with reference to their localities." 12mo. This little work is intended for the pocket, and may advantageously be taken into the field by the students who object to carrying an 8vo book in their hand; and, in this point of view, will be found an useful companion to those who are interested in collecting the vegetable productions of the environs of Edinburgh. The stations mentioned, too, are generally more full than in Dr Greville's work. We rejoice at the appearance of every new botanical work in this part of our island, however humble its pretensions; for we are satisfied that each one is a means (to use our author's own words) of "facilitating the acquisition of a science which is everywhere loved, and valued, and cultivated,—which, while it informs the understanding, improves also the heart, and enlarges the boundary of harmless and rational enjoyment."

Transactions of the Linnæan Society of London.

The 2d Part of the 14th volume of this valuable work has lately appeared, and it contains the following botanical articles:—"A Commentary on the Second Part of the *Hortus Malabaricus*, by Dr Francis Hamilton."—"Descriptions of Nine New Species of the Genus Carex, Natives of the Himalaya Alps, in Upper Nepal, by Mr David Don."—"Descriptions of Two New Species of Erythrina, by Felix de Avellar Brotero;"—and some Account of a Collection of Arctic Plants formed by Edward Sabine, Esq. F.R.S. and L.S. &c. during a Voyage in the Polar Seas in the year 1823, by W. J. Hooker, LL.D. Communicated by the Council of the Horticultural Society.

Prodromus Floræ Nepalensis.

Mr David Don has recently published, in one volume duodecimo, a "Prodromus Floræ Nepalensis, sive Enumeratio Vegetabilium quæ in itinere per Nepaliam proprie dictam et regiones conterminas, Ann. 1802, 1803, detexit atque legit D. D. Franciscus Hamilton, &c.; accedunt Plantæ à D. Wallich nuperius missæ." The arrangement is according to the Natural Orders, and the greater number of species, as may be supposed, are entirely new.

Botanical Magazine, No. 456, January 1825.

Tab. 2537. *Zephyranthes rosea* of Bot. Reg. t. 2538. *Pancratium zeylanicum*, Linn. t. 2539. *Gloriosa virescens*, n. sp. (Lindley mss.) "foliis cirrhiferis, pedunculis pendulis, petalis unguiculatis apice undulatis:" introduced by the Horticultural Society from Mosambique. t. 2540. *Goodyera pubescens*, Br. *β.* minor. t. 2541. *Lavatera hispida*, Desfont. t. 2542. *Phlomis lunariifolia*, *β. Russelliana*. t. 2543. *Caladium bicolor*, Willd. t. 2544. *Malva abutiloides*, Linn.

The 458th Number of this work, for March 1825, contains, t. 2551, *Centaurea sphærocephala*, L. t. 2552, *Petunia nyctaginiflora* of Jussieu, the *Nicotiana axillaris* of Lam. Ill. (*N. nyctaginiflora*, Lehm. Hist.

Nicot.); a genus separated from *Nicotiana* principally on account of the inequality of the corolla, by Jussieu. *Petun* is the Brazilian name for *Tobacco,* whence the appellation of the genus. t. 2553, *Campanula latifolia v. macrantha.* t. 2554, *Boltonia asteroides,* Hort. Kew. t. 2255, *Nicotiana Langsdorfii,* Roem. et Sch. t. 2556, *Chrysanthemum sinense,* Sab. (var. 17.) t. 2557, *Herpestis monnieria β,* Kunth, (*Gratiola monnieria,* L.) t. 2558, *Zanthoxylum nitidum,* De Cand. (*Fagara nitida,* Roxb.)

No 459. April.

Tab. 2559, *Catasetum tridentatum,* Hook. t. 2560, *Elsholtzia cristata,* Willd. t. 2561, *Crotalaria retusa,* L. t. 2562. *Cactus truncatus* of Hooker's *Exotic Flora,* t. 20, where the plant was figured and described under that name, for the first time, although not referred to by Dr Sims. It was previously described by Mr Haworth, under the name of *Epiphyllum truncatum.* t. 2563, *Lobelia longiflora,* L. t. 2564, *Primula sinensis,* of Sabine.

Botanical Register for December, No. 118.

Tab. 847. *Fuchsia gracilis,* Lindl. (*F. decussata,* Bot. Mag. not of Ruiz and Pavon.) t. 848. *Passiflora alato-cærulea,* a hybrid, produced by *P. alata,* and *P. cærulea.* t. 849. *Amaryllis alvena,* Bot. Mag. t. 850. *Leonotis intermedia,* n. sp. from Delagoa Bay in S. Africa, "caule suffruticoso, foliis petiolatis ovato-cordatis acuminatus inciso-dentatis, bracteis mollibus ovato-lanceolatis, internodiis terminalibus longissimis." t. 851. *Polystachia puberula,* n. sp. from Sierra Leone, introduced by Hort. Society; "spica paniculata thyrsiformi, foliis lanceolatis 7, nervibus scapo longioribus floribus ovariisque pubescentibus, bulbis ovatis:" Mr Lindley enumerates four species of the genus. t. 852. *Cuphea Melvilla*; *Melvilla speciosa* of Anderson in Journ. of Sciences and the Arts; and also, we think the same with *Grislea secunda* of Smith in Rees' Cycl. Introduced by Mr James M'Crae from St Vincent's, whence we have also received fine dried specimens from the Rev L. Guilding. t. 853 represents a very remarkable new plant, belonging to that family of *Compositæ,* denominated *Labiatiflora* by De Candolle; *Triptilium* (Ruiz and Pavon) *cordifolium,* received from Chili at the Hort. Society's garden. Three other species are mentioned by Lagasca, all natives of the same country.

No. 119, January 1825.

Tab. 854. *Rubus pauciflorus* of Wallich. t. 855. *Gerberia crenata,* (*Arnica crenata,* Thunb.) t. 856. *Cassia purpurea,* Hort. Bengal. t. 857. *Fuchsia excorticata,* Linn. from New Zealand. t. 858. *Catesboa latifolia,* n. sp. from W. Indies, "corollis tubo longissimo, spinis foliis lucidis convexes longioribus." t. 859. *Templetonia glauca,* Bot. Mag. t. 860. *Hibiscus strigosus,* n. sp. from S. America, "Caule suffrutico strigoso foliis trilobis angulatis cordatis dentatis tomentosis pedunculo petiolo longiore, involucelli foliolis 12 hispidis linearibus apice appendiculatis."

Hooker's Exotic Flora. *Part* 19. *February* 1825.

TAB. 142. *Dendrobium album*, n. sp. from Jamaica, "bulbis ellipticis compressis apice uni-trifoliis, pedunculis unifloris erectis, petalis sublanceolatis, labello oblongo obscure trilobo, medio tuberculo oblongo carnoso." t. 143, *Bromelia nudicaulis*, L. t. 144, *Roscoea purpurea*, Sm. t. 145, *Habenaria orbiculata*, (*Orchis*, Ph.) t. 146, *Impatiens fimbriata*, Colebr. MSS. "racemo terminali capitato, foliis ovali-lanceolatis acuminatis longe ciliatis, nectario corniculato florem excedente; bracteis pulcherrime ciliatis."

Part 20. *March.*

TAB. 147. *Parkeria pteridoides*, a new genus of plants, allied to the true *Ferns*. It has the habit of *Pteris*, or rather *Teleozoma* of Brown, but has the capsules quite destitute of annulus. It was gathered in Guiana, by Charles Parker, Esq. after whom the genus is named. t. 148, *Pachysandra? coriacea*, a remarkable plant of the family of *Euphorbiaceæ*. t. 149, *Anisopetalon Careyanum*, a singular new genus of Orchideous plants, sent from Nepal by Dr Carey to the Liverpool Botanic Garden. t. 150, *Cuscuta reflexa*, Roxb. *var. β. verrucosa.*

ART. XXX.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Comet of July and August* 1824 *discovered at Paramatta.* This comet was discovered at Paramatta by our countryman Mr Dunlop, and the following elements have been computed from Mr Dunlop's observations, (as communicated to us by Sir Thomas Brisbane,) by Mr George Innes and Mr Gordon of Aberdeen. The observations themselves will appear in the *Edinburgh Transactions*, vol. x. part ii., now in the Press.

		Mr Innes.	Mr Gordon.
Time of Perihelion Passage, Mean Time at Paramatta,	July 10th	10^h 17′ 30″	10^h 17′ 41″
Long. of Perihelion,	-	259° 45′ 32″	259° 45′ 31″
Long. of Ascending Node	-	330 29 8	330 29 8
Inclination of Orbit	-	57 0 36	57 0 36
Perihelion Distance	-	0.5956114	0.5956147
Motion retrograde.			

2. *Comet of September* 1824 *discovered at Paramatta.* In our last Number, p. 177, we gave the elements of the comet which was discovered by Mr Rumker, as computed from his observations by a Correspondent.

The following elements, differing very little from those previously given, have been computed from Mr Rumker's observations, (as communicated to us by Sir Thomas Brisbane,) by Mr George Innes and Mr Gordon of Aberdeen :

	Mr Innes.	Mr Gordon.
Time of Perihelion Passage, 1824, Sept. 29th Mean Time at Paramatta,	7h 23′ 26″	7h 25′ 10″
Long. of Perihelion - -	4° 23′ 12″	4° 22′ 11″
Long. of Ascending Node - -	279° 17′ 56″	279° 19′ 13″
Inclination of Orbit - -	54 22 14	54 22 22
Perihelion Distance - -	1.048553	1.048739
Motion direct.		

3. *New Comet of* 1825. M. Gambart of Marseilles discovered, on the 19th May 1825, a small comet in the head of Cassiopeia, about 0^h 20′ of right ascension, and 48° 22′ of north declination. On the 1st of June at 12^h 31′ its right ascension was 1^h 51′, and its declination 73° 39′ north. This comet appeared as a small nebulosity of about two minutes in diameter. It is round and well defined. Its light is evidently condensed at its centre; but M. Gambart could not see distinctly its nucleus, or the part which is separated from the nebulosity.

4. *Longitude and Latitude of Paramatta.* The position of the Observatory at Paramatta, as corrected by numerous and recent observations, is East longitude from Greenwich, 10^h 4′ 5″, and South latitude 33° 48′ 45″.

5. *Action of the Moon on the Earth's Atmosphere.* From a series of 4752 observations made on the barometer, between the 1st October 1815, and the 1st October 1823, M. Laplace has concluded, that the magnitude of the lunar atmospherical tide is about the 18th part of a millimeter, or about the $\frac{1}{457}$th part of an English inch.

6. *Lunar Eclipse of* 31*st May, observed at Bushy Heath.* Colonel Beaufoy observed the beginning of the eclipse, at 11^h 52′ 43″, mean time, and the end at 12^h 15′ 58″. The shadow was ill defined. The longitude of his observatory is 1′ 20″.93 west, mean time, and 51° 37′ 44″.3.—*Ann. of Phil.* July 1825, p. 44.

OPTICS.

7. *Light produced during the Crystallization of Benzoic Acid.* M. Buchner of Magonza having mixed impure, but perfectly dry, benzoic acid with the sixth part of its weight of pulverized charcoal, left it exposed, for several days, to a moderate heat, the mixture being covered with a cylinder well luted with a paste of almonds, but having a small aperture left on purpose to see the crystallization within. Having been exposed, for several days, to a moderate heat, the crystals had already begun to form, but being desirous of hurrying the operation, M. Buchner placed the apparatus in a stove of a high temperature. In the space of half an hour he was surprised to see a brilliant flash of light within the cylinder, the brightness of which was augmented by the darkness of the room. A number of similar flashes immediately succeeded, and continued for half an hour. M. Buchner now found that a great quantity of crystals of ben-

zoic acid were formed similar to those obtained in the usual way, but only less regular. As the flash did not continue after each crystal was deposited, M. Buchner thought that the light was produced by a neutralization of electricity. M. Buchner observed similar phenomena in the crystallization of acetate of potash, and M. Dobereiner observed the same in the preparation of oxygen by means of a mixture of oxygenated chlorate, potash and manganese in powder. The last of these chemists is of opinion, that those salts which contain no water of crystallization, are particularly powerful in producing light during crystallization. See *Neue Journ. fur Chem. und Phys.* 1824, vol. ii. p. 222, and *Giorn. de Fisica*, vii. 470.

8. *Iridescence of Clouds.* M. de Humboldt mentions this phenomenon as having been seen by him in South America, but I have not met with any notice of its having been seen in this country, though it has most likely been witnessed by some of our meteorologists who are accustomed to observe the nepheological phenomena. On the morning of the 13th of December last, we had a hard gale from the N. W., with black and dense cumulostrati driving rapidly in the direction of the wind. At 9½ A. M., when examining the appearance of the heavens through an opening in the cumulostrati, I observed an extensive cirrostratus resting motionless in a higher region of the atmosphere, stretching from S. E. to E., and rising about 5° above the horizon, the sun at that time being about 7° or 8° high. This cirrostratus exhibited all the prismatic colours in broad alternate stripes. There were four alternations, and the tints being very brilliant, it formed a most beautiful spectacle. It lasted till 11 A. M., when the colours gradually faded, and at last blended into a uniform yellowish brown. Since that time I have frequently seen the same phenomenon shortly after sunrise, when the rays of the sun are incident at small angles, upon a thin and shallow cirrostratus.

The cause of the iridescence is not easily explained, but it seems to be connected with the magnitude of the aqueous globules of which the cloud is composed.

I may give another instance, which took place on the 21st of January. Wind brisk, from the W. by N., Hygrom. 3.5; an extensive black cloud veiled the heavens, extending from N. E. and W. to within 10° of the southern horizon. The sun's place was completely obscured; but a small portion of the south edge of the cloud had a dazzling yellow colour. At this time a chain of *scud*, flying from S. to S. E., crossed in succession the illuminated part, each, as it passed, suddenly displaying a splendid show of prismatic tints, and then returning to its original sombre hue. I watched this interesting sight for ten minutes, when a nimbus approached, and effectually darkened all that part of the heavens.

J. Foggo.

ELECTRICITY.

9. *Remarkable Electricity of Oxalate of Lime.*—Having obtained, by precipitation, some oxalate of lime, and dried it when well worked in a

Wedgewood's basin, at a temperature of about 300° of Fahrenheit, until it was so dry as not to dim a cold plate of glass held over it, Mr Faraday remarked, that when it was stirred with a platina spatula, it became in a few moments so strongly electrical, that it could not be collected together, but flew about the dish whenever it was moved from its sides into the sand-bath. This took place either in porcelain, glass, or metallic basins, and with porcelain, glass, or metallic stirrers. When the particles were well excited and shaken on the top of a gold leaf electrometer, the leaves diverged two or three inches. When cooled out of the contact of air, the same phenomena took place. When excited in a silver capsule, and left out of contact with the air, the powder continued electrical for a great length of time, proving its very bad conducting power, in which it probably surpasses all other bodies. Mr Faraday remarks, that oxalate of lime stands at the head of all substances, yet tried, as to its power of becoming positively electrical by heat. *Quart. Journ.* No. 38, p. 338.

10. *Electricity developed in Capillary Attraction.*—M. Becquerel is said to have demonstrated, that there is a sensible developement of electricity during the ascent of liquids in capillary tubes. He first obtained this result by increasing the sensibility of Schweigger's galvanometer. He placed three of these instruments together, so that the magnetic needle of the middle one deviates from its ordinary direction, by the lateral effects produced upon each of its poles by the contrary poles of the two other needles. From this arrangement it follows, that, when an electric current passes into the apparatus, tending to bring the needle into the plane of the magnetic meridian, the middle needle will be as much less retarded in its progress as the poles, opposite to its own, of the other two needles are more remote from it, consequently, the oscillations will have a wider extent than if there were only one galvanometer.

In order to observe the electricity of capillary action, M. Becquerel could not employ glass, as it is not a conductor of electricity; but he employed sponge of platinum, and small pieces of charcoal. Pure hydrochloric acid, much diluted with water, is poured out into the platinum dish, which communicates with one of the ends of the wire of the galvanometer; and into the dish is plunged sponge of platinum, which is fixed at the other end of the wire. At this contact there is produced an electric current, which goes from the sponge to the acid, and the direction of which is contrary to that of the current which would have been obtained if the acid had been attacked by the metal. As the interstices of the sponge are filled with the fluid, the current diminishes, and it ceases when the sponge has absorbed all the liquid which it can contain. Sometimes the current takes another direction, but the cause of that is not known. The same effect is produced with nitric acid, but it is less marked. The same result was obtained with a small piece of charcoal, prevented from touching the platinum by a band of *papier Joseph.*

11. *Electricity developed in Solutions and Mixtures.*—By means of the

same apparatus, M. Becquerel has discovered that an electrical current goes from the acid to the water, when sponge of platinum, that has imbibed distilled water, is plunged into the dish of platinum containing hydrochloric acid.

In order to observe the electricity of solutions of alkalis in water, he fixed in the platina pincers a fragment of hydrate of potash or soda, enveloped in *papier Joseph*, and then plunged it into distilled water in the platina cup. A current was thus produced from the water to the alkali.

M. Becquerel also found that electricity was developed during the mixture of sulphuric and nitric acids. *Bull. des Sc. Phys.* &c. Fev. 1824, p. 99.

12. *Electrical Gale.*—On the 6th December 1823, about 100 miles to the west of the Fiord of Drontheim, the Griper, commanded by Captain Clavering, experienced a severe gale which lasted three days, and during which period there was no intermission of its violence. This gale was remarkable for the small amount of the effect produced on the barometer, either on its approach, during its continuance, or on its cessation; and by the indications which were afforded of its having *originated in a disturbed state of electricity in the atmosphere.* It was accompanied by very vivid lightning, which is particularly unusual in high latitudes in winter, and by the frequent appearance, and continuance for several minutes at a time, of balls of fire at the yard-arms and mast-heads. Of these, not less than *eight* were counted at one time. Sabine's *Pendulum Experiments.* p. 181.

MAGNETISM.

13. *Mr Babbage and Mr Herschel on the Magnetism developed during Rotation.* In our last number, we gave a notice of the experiments made in France on the effect of copper in motion or at rest, on magnetic needles. Mr Babbage and Mr Herschel have pursued the subject with much success, and have communicated an account of their experiments to the Royal Society. In order to reverse the experiment, they put in rotation a powerful horse shoe magnet, and suspended over it various metals and other substances. In this way they developed signs of magnetism in copper, zinc, silver, tin, lead, antimony, mercury, gold, bismuth, and carbon, in that metalloidal state in which it is precipitated from carburetted hydrogen gas works. In sulphuric acid, rosin, glass, and other non-conductors, or imperfect conductors of electricity, no positive evidence of magnetism was obtained.

In order to determine the comparative intensities of these bodies, Messrs Babbage and Herschel used two methods, 1st, By observing the deviation produced in the needle by plates of great size cast to one pattern; and, 2dly, By observing the times of rotation of a neutralized system of magnets suspended over them. These two methods assigned the same order to all the bodies but copper and zinc; and it is a very curious fact, which the authors have no doubt thoroughly investigated, that the two methods *gave opposite results in the cases of zinc and copper, placing them constantly above and below each other, according to the mode of observation employed.*

Messrs Babbage and Herschel next investigated the effect of solution of continuity on the various metals, and they ascertained the curious fact, that the re-establishment of the metallic contact in other metals, restores the force either wholly or in a great measure, even when the metal used for soldering has in itself but a weak magnetic power. Hence is obtained a power of magnifying weak degrees of magnetism. They found also that the force varied inversely between the square and the cube of the distance.

From these valuable experiments, Messrs Babbage and Herschel conclude, that the phenomena may all be explained, by supposing time to be requisite, both for the developement and the loss of magnetism, and that different metals differ, in respect not only of the time they require, but of the intensity of the force ultimately producible in them. See *Quart. Jour.* vol. xxxviii. p. 276.

14. *On the Magnetism imparted to Iron bodies by Rotation.* This is the title of a paper read before the Royal Society by Mr Barlow. Having fixed a 13 inch mortar shell to the mandril of a powerful turning lathe wrought by a steam-engine, and caused it to perform 640 revolutions in a minute, the magnetic needle deviated several degrees from the magnetic meridian, and remained stationary during the motion of the shell. When the rotation ceased, it immediately resumed its original position. When the motion of the shell was inverted, an equal but opposite deviation of the needle took place.

When the earth's action on the needle was neutralized, and the needle made a tangent to the ball, the *north* end of the needle was *attracted,* when the motion of the ball was made towards the needle, and repelled when the motion was in the contrary direction, and this happened whatever was the direction of the axis of rotation. In the two extremities of the axis, there was observed no effect, but in two opposite points, at right angles to the axis, the effect was a maximum, and the deviation of the needle was to the centre of the ball. In speculating on these facts, Mr Barlow is disposed to think, that the earth's magnetism is of the induced kind, and he considers this opinion as supported by the fact of the non-coincidence of the magnetic axis with the axis of the earth's daily motion.

15. *Mr Christie's New Experiments on the Magnetism produced by Rotation.*—In a letter to J. F. W. Herschel, Esq., which was read to the Royal Society on the 16th June, Mr Christie has communicated the following facts: After confirming the results obtained by Mr Babbage and Mr Herschel, as given above, Mr Christie found, that when a thick copper plate is made to revolve under a small magnet, the force tending to make the needle deviate is directly as the velocity, and inversely as the fourth power of the distance; but that when magnets of considerable size are made to revolve beneath copper discs, the force diminishes more nearly as

the inverse ratio of the square of the distance, or between the square and the cube, though not in any constant ratio of an exact power.

When copper discs of different weights are set in rotation, the force at small distances seems to increase as the weights of the discs; but at smaller distances it varied in some higher ratio. See our last Number, p. 135.

METEOROLOGY.

16. *Remarkable Hailstones with pyritic Nuclei.* The following very curious account of these hailstones is given in a letter from Professor John of Berlin, to Baron Ferrussac. It forms also part of a letter from Dr Eversmann, known by his travels in Asia, dated 16th September, from Orenburg, where he has landed property.

" Some days before our arrival at Sterlitamak, (more than 100 versts from Orenburg,) there arose a storm in which very remarkable hail fell. *The hailstones, which were tolerably large, contained a stony and crystallized nucleus.* Thirty of them have been sent to our Governor, and I have received two specimens." They are of a brown colour like the auriferous pyrites of Beresowsky, in Siberia. Their surface is shrivelled and shining. The crystal forms a flattened octohedron, whose edges are salient. The two diagonals of the base are five lines by four, and the distance of the summits is two lines. Sometimes the four angles of the base are truncated. *It seems that the constituent parts of these crystals are sulphur and metals.* No analysis of them has yet been made, but I shall perhaps have occasion to do this. See *Bull. des. Sc. Phys.* Feb. 1825, p. 117.

II. CHEMISTRY.

17. *On a compound of Carbon of Hydrogen, with remarkable properties.* A paper was read at the Royal Society on the 16th June, by Mr M. Faraday, containing an account of this curious substance which he calls a *Bi-carbonet of hydrogen,* from its consisting of two proportions of carbon, and one of hydrogen.

This substance is a fluid deposited in vessels in which oil gas has been compressed. It is colourless, has less specific gravity than water, is almost insoluble in water, but is soluble in alcohol, ether, oils, &c. It burns with a dense flame, and is not acted upon to any extent by solutions of the alkalies. If it is put into gas, burning with a blue flame, it makes the flame bright and white. It dissolves caoutchouc readily, and will answer all the purposes of essential oils as solvents.

Part of this fluid is very volatile, causing the appearance of ebullition at temperatures of 50° or 60°, other parts are more fixed, requiring even 250° or more for ebullition. By repeated distillations, a series of products were obtained from the most to the least volatile, the most abundant being such as occurred from 170° to 200°. On subjecting, these, after numerous rectifications, to a low temperature, it was found that some of them concreted into a crystalline mass, and ultimately a substance was obtained from them, principally by pressure at low temperatures, which, upon examination, proved to be a new compound of carbon and hydrogen. At common temperatures, it appears as a colourless transparent liquid, of specific gravity 0.85 at 60°, having the general colour of oil gas. Below 42°, it is a solid body, forming dendritical transparent crystals, and contracting much during its congelation. At 0° it appears as a white or transparent substance, brittle, pulverulent, and of the hardness nearly of loaf sugar. It evaporates entirely in the air. When raised to 186° it boils, furnishing a vapour which has a specific gravity of 40 nearly, compared to hydrogen as 1. At a higher temperature the vapour is decomposed, depositing carbon. The substance is combustible, liberating charcoal, if oxygen be not abundantly present. Potassium exerts no action upon it below 186°.

Experimenting with the most volatile portions of the liquid, a product was obtained, which, though gaseous at common temperatures, condensed into a liquid at 0°. This was found to be very constant in composition and properties. It was very combustible. It had a specific gravity of 27 or 28 as a gas; as a liquid that of 0.627, being the lightest substance, not a gas or vapour, known. When analyzed, it was found to consist of one proportion of carbon 6., and one of hydrogen 1., as is the case with olefiant gas; but these are so combined and condensed, as to occupy only one-half the volume they do in that substance. A volume therefore of the gas contains four proportionals of carbon 24, and four of hydrogen 4 = 28, which is its specific gravity.

Beside the remarkable difference thus established between this substance and olefiant gas, it is also distinguished by the action of chlorine, which forms with it a fluid body, having a sweet taste, and resembling hydro-chloride of carbon; but from which a chloride of carbon cannot be obtained by the further action of chlorine and light.

The other products from the original fluid do not present any characters so definite as the above substances; at the same time they appear to be very constant, boiling uniformly at one temperature. They cannot be separated by distillation into more and less volatile parts, so as to afford means of reducing their numbers to two or three particular bodies. They have the general properties of the original fluid, and, like the other products, are peculiarly acted upon by sulphuric acid, presenting phenomena in the investigation of which Mr Faraday is now engaged. See *Quart. Journn.* No. 38.

III. NATURAL HISTORY.

BOTANY.

18. *Overland Arctic Expedition.* We have received intelligence from the overland Arctic American Expedition, containing the welcome account of its safe arrival at Penetanguishene, at the eastern extremity of Lake Huron, upon the 22d of April. Our letter, which is from Dr Richardson, announces that the party had a prosperous voyage, of 26 days, to New York; at which place the naturalists visited Dr Hossack, who seems to be the liberal patron of botany, Mr Le Conte, well known as the author of some Botanical Memoirs in the Lyceum of Natural History of New York, Mr Halsey, a successful student of the Lichens of America, Mr Cooper,

and Dr de Kay, the latter one of the most zealous cultivators of Natural History at New York, but who now devotes himself almost entirely to zoology. A day was devoted to an excursion to the Military Academy at West Point, on the river Hudson, in order to see Dr Torry, who has been recently appointed Professor of Chemistry and Mineralogy to that institution, and who is working, besides his Flora of the midland counties of the United States, at a compendium of the same, and is, moreover, collecting materials for a complete North American Flora.

Dr Richardson and Mr Drummond (who is especially charged with the collecting of plants) had already, notwithstanding the early season of the year, been very successful in their botanical pursuits.

Of the Orchideous plants, indeed, the flowering season was already past, but they found many species, and the beautiful *Calypso borealis* (*Americana, Br.*) in great abundance. The *Violets*, the *Raspberries*, and the *Currants* occupied much of their attention, and seemed to have been very imperfectly described by authors. The *Ranunculus rhomboideus*, first detected and described by Goldie, and the *Primula pusilla* of the same author, which certainly comes very near to Michaux's *Primula mistassinica*, were in flower. Mr Drummond was much pleased at finding the *Juncus arcticus* and the *Orthotrichum Ludwigii*, two plants of which he had been, a short time previously, the discoverer in Scotland.

As to mosses, they were, as may be supposed, in a high state of perfection. *Bryum roseum, Neckera pennata, Dicranum glaucum, Fontinalis capillacea*, and several other fine species, have been collected with abundant fructification, together with very many individuals of the genus *Leskea*, several of which appeared to have been hitherto unnoticed by botanists.

At Penetanguishene, Dr Richardson found a gentleman who was much occupied with botany, Mr Tod, assistant-surgeon to a small naval establishment at that place. Encouraged by the well known zeal and enthusiasm of our valued friend and correspondent, it is to be hoped that he will be led to investigate thoroughly the botany of that interesting part of North America.

On the 24th of April the whole of the officers of the expedition were to be assembled, and they were to proceed, on the following day, in the prosecution of their voyage.

19. *Plantes rares du Jardin de Genève, par Aug. Pyramus De Candolle, &c.* This beautiful work, of which we have just received the first Livraison from the hands of its estimable author, merits the attention of every lover of botany, no less as coming from the pen of one of the most profound botanists that exist, than on account of the circumstances which gave rise to it.

Driven by religious persecution from the Botanical Garden at Montpellier, and from the chair of that university, which he had filled with so much honour to himself and to his adopted country, Professor De Candolle returned to his native city, Geneva, when a professorship of Natural History was constituted for him in 1817, and the formation of a garden contemplated. The establishment of the Botanic Garden was facilitated by a circumstance, unfortunate, indeed, in itself, namely, the distressed condition of the lower classes of the people, which induced the sovereign council of Geneva to devote a sum of money for their maintenance, expressing a wish, at the same time, that they should be employed in preparing the ground for the garden.

Soon after a private subscription was entered into, which, being aided by almost all the inhabitants of the city, speedily furnished the government with the necessary funds for constructing the inclosures, hot-houses, and green-houses, &c ; and the government likewise undertook to contribute to its future support. The buildings were erected in 1818, and such was the zeal shown in the promotion of this institution, and in fulfilling the wishes of the learned Professor, and such the number of seeds and plants that it received from various quarters, that, from the following year, its advantages began to be perceived, and already a number of useful and ornamental plants were thence distributed through the country. Every year the garden has increased in value; and, at this moment, the directors of it are constructing a museum therein, for the purpose of depositing a herbarium, and collections of fruits and seeds. This building, too, is erected at the expence of a private individual, a citizen of Geneva, who has withheld his name from the public.

The taste for painting flowers being very general at Geneva, and M. De Candolle, principal director of the garden, having already had occasion to witness * the anxiety with which the private artists sought the means of rendering their talents useful, invited them to draw, upon a uniform scale, the plants which flowered in the garden, with the view of preserving the recollection of them, and of forming a collection which might be valuable to botany, and as specimens of the art. This request was granted with pleasure, and already upwards of 300 coloured drawings, either made from nature by private artists, or given by the benefactors to the garden, compose the collection, " Eh qui pourra, as M. De Candolle himself well observes, " nous l' esperons, servir un jour d'exemple de la manière dont l'espirit public peut, dans les petites républiques, compenser quelques-uns des avantages des grands Etats."

It is from the portfolio of drawings thus formed, that M. De Candolle will select those plants which are either entirely new, or which are not well figured in any work, in order to publish them by livraisons, accompanied by such scientific descriptions and observations as are necessary for their complete history.

The present Livraison contains, 1. 2. the *Pinus canariensis, Buch.* of which two plates are given, and which seems never to have been well described or understood. Some had taken it for the *Pinus Larix,* others for the *Pinus Tæda,* whilst others had confounded it with the *Pinus ma-*

* M. Mocino, one of the authors of the *Flora of Mexico*, having given all the original Drawings of that work to M. de Candolle, that he might publish them in his name, and having afterwards, on his return to Spain, desired to possess them again, M. De Candolle expressed a wish to have copies made of the most interesting of them. In the short space of a week, with one accord, as it were, all the artists came forward, copied for him nearly a thousand drawings, and have thus been the means of preserving the most valuable part of the collection.

ritima. Von Buch and the late Christian Smith named it, in their catalogue of the Vegetation of Teneriff, *Pinus canariensis,* and they state, that it inhabits that island from the edge of the sea to an elevation of 6700 Parisian feet above the level of the sea; but that the region where it is most abundant may be reckoned at from 4080 to 5900 feet, where snow falls for about a month. The temperature of this zone M. De Candolle estimates to be similar to that of Scotland, or to the north of France, or of Germany. The wood is resinous, highly flammeable, and is excellent for constructing buildings, being known to continue sound for ages. 3. *Nemopanthes canadensis.* (the *Ilex canadensis* of Michaux.) 4. *Jussiœa longifolia,* DC. 5. *Sesamum indicum,* Linn. 6. *Silene picta,* Desf.

There are thus six plates, and twenty-one pages of letter-press. The size is a large quarto, and the execution of the plates is such as to reflect great credit both upon those who have made the drawings and those who have engraved them.

IV. GENERAL SCIENCE.

20. *Lieut. Kotzebue's recent Voyage of Discovery.*—Dispatches have been received from this active navigator, from the harbour of St Peter and St Paul in Kamschatka, where he had arrived on his return home. He has discovered *three* Islands, one of which, called after his ship Predpriætige Island, is situated in west Long. 140° 2′ 38″ and south Lat. 15° 58′ 18″. The second, called Bellinghausen, after the eminent Russian navigator, is situated in west Long. 154° 30′ and in south Lat. 15° 48′ 7″. The third called Kordaken, after his first Lieutenant, is in west Long. 168° 6′ and in south Lat. 14° 32′ 39″. This Island, however, had been previously discovered by M. Freycinet.

Lieut. Kotzebue has examined Navigation Island, and has corrected the positions of several places in the Pacific Ocean. He visited Otaheite and Owyhee, and he saw the Island of Karishof, seen by Roggewens in 1722, and situated in west Long. 145° 24′ 22″ and south Lat. 14° 27′.

21. *Steam-Boat Enterprise for India.*—This Steam-Boat, which sailed on the 2d August, is the first which has ventured to cross the Indian seas, and is one of 500 tons burden. It has two steam-engines, each of 60 horse power. The boilers, which are made of copper, extend across the ship, and are heated by seven furnaces, each seven feet in depth. The whole of the machinery is executed by that able engineer Mr H. Maudslay, who has contrived an ingenious method of changing the water in the boilers, in order to prevent the deposition of a crust of a salt on the bottom of the boilers. He has also fixed up an ingenious pump to answer various purposes on board a ship, and he has constructed a moveable railway to conduct the coals to the furnace when they are wanted. The coals which the Enterprise carries along with her, amounting to about 300 tons, are partly contained in chambers within the sides of the vessel, covered with sheet iron, and partly in tanks beneath, which, as the coals are used, will be filled with water, to keep the vessel properly ballasted. There are twenty cabins in the ship, furnished elegantly, and supplied with every convenience.

Art. XXXI.—LIST OF PATENTS FOR NEW INVENTIONS. SEALED IN ENGLAND FROM JANUARY 1*st*, to MAY 14*th* 1825.

Jan. 1. For *Machinery to Make Wove and Laid Paper.* To S. Denison and J. Harris, Leeds.

Jan. 1. For *Lace and Net Machinery.* To J. Heathcoat, Tiverton.

Jan. 5. For *Improved Piano Fortes.* To P. Erard, London.

Jan. 11. For an Improved *Steam-Engine.* To Dr Tilloch, London.

Jan. 11. For Improvements in the *Manufacture of Slivers, &c.* To J. F. Smith, Esq. of Dunston-Hall.

Jan. 11. For *Lace and Net Machinery.* To W. Henson and W. Jackson, Worcester.

Jan. 11. For a *New Musical Instrument.* To G. Gurney, London.

Jan. 11. For Improvements in *Weaving.* To F. G. Spilsbury, Leek.

Jan. 11. For Improved *Spinning Machines, &c.* To W. Hirst, Leeds.

Jan. 11. For Improvements in *Finishing Woollen Cloth.* To J. F. Smith, Esq.

Jan. 11. For Improvements in *Calico Printing.* To J. Locket, Manchester.

Jan. 11. For *Condensed Wood.* To J. Falconer Atlee.

Jan. 11. For Improved *Sawing Machinery.* To G. Sayner, Leeds.

Jan. 11. For a Composition to *Preserve Animal and Vegetable Substances.* To T. Magrath, Dublin.

Jan. 11. For an Apparatus for *Conducting and Preserving Water.* To T. Magrath.

Jan. 11. For *Paper Machinery.* To J. Phipps, London.

Jan. 11. For Improvements on *Ships.* To W. S. Burnett, London.

Jan. 11. For Improvements in *Cotton-Spinning.* To J. Andrew, G. Tarlton, and J. Shepley, Crumpside.

Jan. 13. For *Spinning Machinery.* To W. Booth and M. Bailey, Congleton.

Jan. 18. For Improved *Cocks.* To E. W. Rudder, Edgbaston.

Jan. 18. For Improvements in *Casting Cylinders, Tubes, &c.* To W. Church, Birmingham.

Jan. 18. For Improved *Piano Fortes.* To F. Melville, Glasgow.

Feb. 1. For Improved *Bricks, Tiles, &c.* To E. Lees and G. Harrison.

Feb. 1. For an Improved *Roasting-Jack.* To J. Thin, Edinburgh.

Feb. 1. For an Apparatus for *Registering the Quantity of Liquids passing from one Place to another.* To S. Crosley, London.

Feb. 1. For Improved *Gas Regulators or Governors.* To S. Crosley.

Feb. 3. For a *Steam-Carriage.* To T. Burstall and J. Hill.

Feb. 10. For a New Composition of *Malt and Hops.* To Dr G. A. Lamb, Rye.

Feb. 10 For Improved *Spinning Machinery.* To R. Bagnall, Leek.

Feb. 11. For Improved Methods of *Manufacturing Silk.* To J. Heathcoat, Tiverton.

Feb. 19. For Improved *Water-Works.* To E. Lees, Essex.

Feb. 19. For an Apparatus to *Bottle Liquids.* To T. Masterman.

Feb. 19. For a *Fuel-Feeding Apparatus.* To E. Lloyd, Middlesex.

Feb. 19. For *Fire-Proof Buildings.* To B. Farrow, London.

Feb. 19. For an Apparatus for *Combing Wool.* To Jesse Rosse, Leicester.

Feb. 19. For Improved *Fire Arms.* To J. Mould, Middlesex.

Feb. 19. For a *Rotatory or Endless Lever Action.* To H. Burnett, Middlesex.

Feb. 19. For Improved *Water-Closets.* To J. Beacham, Middlesex.

Feb. 19. For an Improvement in *Bolting Mills.* To J. Ayton, Norfolk Company.

Feb. 26. For a *New Inkstand.* To D. Edwards, Middlesex.

Feb. 26. For Improved *Fire Arms.* To Jos. Manton, Middlesex.

Feb. 26. For Improvements in *Propelling Vessels.* To W. H. Hill, Woolwich.

Feb. 26. For Improved *Piano Fortes.* To G. A. Kollman, Middlesex.

Feb. 26. For a Method of Producing *Figures on Silk or Goods.* To J. Heathcoat.

Feb. 26. For a *Portable Life-Boat.* To J. Bateman, Middlesex.

Feb. 26. For Improved *Gas-Tubes.* To C. Whitehouse, Wednesbury.

Feb. 26. For Improvements in *Printing Cottons, &c.* To T. Atwood, Birmingham.

Feb. 26. For Improvements in *Cooling Iron with Copper.* To D. Gordon, Esq. and W. Bowser, London.

Art. XXXII.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE JUNE 16, 1825.

March 14. For a *Locomotive or Steam Carriage.* To Timothy Burstall, Leith, and John Hill, Bath. (Omitted in last Number.)

27. June 16. For the Preparation of *Certain Substances for making Candles.* To Moses Poole, Middlesex.

28. June 24. For *Improvements in Machinery.* To Henry Burnett, Middlesex.

29. June 23. For Improvements in *Fire Extinguishing Machinery.* To George Dodd, Middlesex.

30. June 24. For Improvements in *Axletrees.* To William Mason, Middlesex.

31. July 2. For Improvements in *Spinning-Machines, &c.* To Maurice De Taigh, Warrington.

32. July 2. For an Improvement in the making of *Dies, Moulds, or Matrixes.* To Philip Brookes, Stafford.

33. July 2. For Improvements in *Looms.* To John Martin Hanchelt, London, and Joseph Delvalle, Middlesex.

34. July 2. For Improvements on *Steam-Engines.* To John Charles Christopher Raddatz, London.

35. July 8. For Improvements in the Process of, and Apparatus for *Distilling*. To JEAN JACQUES SAINTMARC, Surrey.

36. July 29. For Improved Machinery for Preparing and *Spinning Flax Hemp, &c.* To JAMES KAY, Lancaster.

37. Aug. 3. For an Improved *Machine or Press for Printing*. To JOHN RUTHVEN, Edinburgh.

38. Aug. 5. For an Improvement in *Lamps*. To JOSEPH FAREY, Middlesex.

39. Aug. 8. For Improvements in the Construction of a Machine used for *Throstle* and *Water-Spinning* of Thread or Yarn, To JONATHAN ANDREW, GILBERT TARLTON, and JOSEPH SHEPLEY, Manchester.

40. Aug. 11. For Improvements in the Machinery to be employed for *Sawing and Grooving Marble, &c.* To JAMES TULLOCH, London.

41. Aug. 7. For Improvements in *Pipes or Tubes* for the Passage or Conveyance of Fluids. To WALTER HANCOCK, Middlesex.

42. Aug. 11. For a New mode of obtaining *Power* applicable to *Machinery*. To EDWARD JORDAN, Norwich.

43. Aug. 19. For an Improvement in the Construction of *Lamps or Lanthorns*. To JOHN CROSSLEY, Middlesex.

44. Aug. 19. For Certain Mechanical Arrangements for Obtaining Powers from certain Fluids. To MARC ISAMBARD BRUNEL, London.

45. Aug. 19. For Improvements in the Manufacture of *Silks*. To RICHARD BADNAL Younger, Stafford.

ART. XXXIII.—CELESTIAL PHENOMENA,

From Oct. 1, 1825, *to Jan.* 1, 1826, *calculated for the Meridian of Edinburgh*. By Mr GEORGE INNES, Aberdeen. Communicated by the Author. These calculations are made for Astronomical time, the day beginning at noon. The Conjunctions of the Moon and Stars are given in Right Ascension.

OCTOBER.

D.	H.	M.	S.	
1	11	25	42	☌ ☽ A ♉
1	20	58	48	☌ ☽ 2 ♓ ♉
1				☿ Greatest Elong.
2	14	4	50	☌ ☽ *ι* ♉
2	16	1	42	Im. 1. Sat. ♃
3	4	40	—	☌ ☽ ♄
3	21	55	50	☌ ☽ ♄ II.
4	1	28	8	☌ ☽ *μ* II.
4	6	37	—	☌ near ♃
4	17	57	40	☾ Last Quarter.
4	19	37	12	☌ ☽ ζ II.
4	22	22	—	☌ ☿ β ♍
6	21	5	56	☌ ☽ 1 *α* ♋
6	22	13	28	☌ ☽ 2 *a* ♋
7	17	9	34	☌ ☽ *c* ♌
8	1	36	40	☌ ☽ *π* ♌
8	12	3	37	☌ ☽ ♂
8	14	42	35	☌ ☽ ♃
8	22	41	5	☌ ☽ ♀
10	10	50	36	☌ ☽ ☿
11	11	3	34	● New Moon.
12	8	45	—	☌ ♂ ♃
14	0	55	—	☌ ♀ ♋ ♌
14	5	33	14	☌ ☽ δ ♏
16	10	13	12	☌ ☽ 1 *μ* ♐
16	10	47	45	☌ ☽ 2 *μ* ♐
17	9	56	37	☌ ☽ *π* ♐
17	13	27	50	☌ ☽ *d* ♐
17	14	2	44	☌ ☽ H
18	6	39	1	☽ First Quarter.
18	18	37	6	☌ ☽ β ♑
20	23	8	—	☌ ♀ β ♍

D	H.	M.	S.	
23	4	23	1	☉ enters ♏
25	16	11	27	Im. I. Sat. ♃
26	9	33	4	○ Full Moon.
27	7	5	—	☌ ☽ ♀ ♄ ♍
27	16	19	40	☌ ☽ δ ♈
28	17	10	4	☌ ☽ A ♉
29	2	40	48	☌ ☽ 2 K ♉
29	8	35	—	♂ near ♋ ♌
29	19	47	10	☌ ☽ ι ♉
30	9	7	1	☌ ☽ ♄ Occult.
	3	50	47	☌ ☽ ♄ II.
31	7	25	38	☌ ☽ μ II.
31	10	11	36	☌ ☽ ν II.
31	17	0	—	Sup. ☌ ☽ ☿

NOVEMBER.

D.	H.	M.	S.	
1	1	51	55	☌ ☽ ζ
1	15	6	57	Em. III. Sat ♃
1	18	5	4	Im. I. Sat. ♃
3	4	30	17	☌ ☽ 1 *a* ♋
3	5	50	0	☌ ☽ 2 *a* ♋
3	5	52	17	☾ Last Quarter.
4	1	26	0	☌ ☽ *o* ♌
4	10	12	30	☌ ☽ π ♌
4	14	43	58	Im. II. Sat. ♃
5	8	8	9	☌ ☽ ♃
6	1	41	3	☌ ☽ ♂
7	4	30	—	♀ near υ ♍
7	19	1	45	☌ ☽ ♀
8	4	46	35	☌ ☽ ι ♍
8	15	37	2	Im. III. Sat. ♃
9	20	44	50	● New Moon.
10	6	29	37	☌ ☽ ☿
10	14	27	2	Im. I. Sat. ♃
10	16	26	36	☌ ☽ δ ♏
11	17	17	20	Im. II. Sat. ♃
12	19	48	52	☌ ☽ 1 μ ♐
12	20	24	25	☌ ☽ 2 μ ♐
13	22	15	17	☌ ☽ *d* ♐
14	0	45	—	♀ near *m* ♍
14	4	9	0	☌ ☽ ♅
15	2	36	50	☌ ☽ β ♑
15	14	4	56	Im. IV. Sat. ♃
16	23	7	0	☽ First Quarter.
17	16	20	29	Im. I. Sat. ♃
20	7	14	—	☌ ♀ K ♍
22	0	49	38	☉ enters ♐
22	6	35	—	☌ ♀ λ ♍
23	22	49	5	☌ ☽ δ ♈
24	18	13	54	Im. I. Sat. ♃
24	23	29	35	☌ ☽ A ♉
25	3	46	10	○ Full Moon, Eclipse.
25	8	53	24	☌ ☽ 2 K ♉
25	20	37	—	☌ ♂ ♄ ♍
26	1	49	36	☌ ☽ ι ♉
26	11	57	14	☌ ☽ ♄
26	12	42	13	Im. I. Sat. ♃
27	9	23	30	☌ ☽ ♄ II.
27	13	6	25	☌ ☽ μ II.
27	15	31	40	☌ ☽ ν II.
28	7	25	12	☌ ☽ ζ II.
29	11	41	2	Im. II. Sat. ♃
30	20	22	0	☌ ☽ 1 *a* ♋
30	11	32	27	☌ ☽ 2 *a* ♋

DECEMBER.

D.	H.	M.	S.	
1	7	27	12	☌ ☽ *o* ♌
1	16	24	0	☌ ☽ π ♌
2	12	34	45	Em. IV. Sat. ♃
2	15	44	55	☾ Last Quarter.
2	20	6	50	☌ ☽ ♃
3	14	35	35	Im. I. Sat. ♃
4	12	32	49	☌ ☽ ♂
5	13	59	40	☌ ☽ ι ♍
6	4	8	—	☌ ♂ γ ♍
6	14	14	41	Im. II. Sat. ♃
6	22	56	—	☌ ☿ λ ♐
7	17	1	36	☌ ☽ ♀
8	3	7	8	☌ ☽ δ ♏
8	21	28	—	☌ ♀ K ♎
19	8	14	28	● New Moon.
10	5	40	—	☍ ☉ ♄
10	6	29	40	☌ ☽ 1 μ ♐
10	7	4	50	☌ ☽ 2 μ ♐
10	16	28	54	Im. I. Sat. ♃
10	20	28	52	☌ ☽ ☿
11	2	34	—	☌ ♀ λ ♎
11	8	30	50	☌ ☽ *d* ♐
11	12	45	35	☌ ☽ ♅
11	18	6	—	☌ ☿ ♋ ♐
12	12	14	40	☌ ☽ β ♑
13	5	17	—	☌ ♀ β ♏
13				☿ Greatest Elong.
13	16	48	30	Im. II. Sat. ♃

D.	H.	M.	S.	
14	10	27	—	☌ ♀ ν ♏
14	14	50	49	Em. III. Sat. ♃
16	2	19	—	☌ ☿ ψ ♐
16	18	49	28	☽ First Quarter.
17	18	22	12	Im. I. Sat. ♃
19	12	50	34	Im. I. Sat. ♃
19	17	56	—	♂ near ν ♍
21	6	28	27	☌ ☽ δ ♈
21	13	31	52	☉ enters ♑
21	15	23	4	Im. III. Sat. ♃
21	18	48	2	Em. III. Sat. ♃
22	7	6	52	☌ ☽ A ♉
22	16	29	20	☌ ☽ 2 K ♉
23	9	17	0	☌ ☽ ι ♉
23	14	35	24	☌ ☽ ♄
24	16	31	53	☌ ☽ ♄ II.
24	20	17	30	☌ ☽ μ II.
24	21	0	32	○ Full Moon.
24	22	49	23	☌ ☽ ν II.
25	14	7	20	☌ ☽ ζ II.
26	14	43	51	Im. I. Sat. ♃
27	16	9	48	☌ ☽ 1 α ♎
27	17	9	10	☌ ☽ 2 α ♎
28	12	57	12	☌ ☽ ο ♌
28	21	49	0	☌ ☽ π ♌
30	3	30	0	☌ ☽ ♃
31	11	23	32	Im. II. Sat. ♃
31	16	50	—	Inf. ☌ ☉ ☿

Times of the Planets passing the Meridian.

OCTOBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1.	22	46	21	32	21	25	21	42	16	42	6	29
5.	22	49	21	35	21	19	21	29	16	27	6	13
10.	22	58	21	39	21	14	21	13	16	8	5	54
15.	23	9	21	42	21	5	20	57	15	47	5	35
20.	23	20	21	45	20	56	20	41	15	27	5	16
25.	23	31	21	47	20	47	20	24	15	7	4	57
30.	23	42	21	50	20	37	20	8	14	45	4	39

NOVEMBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1.	23	47	21	52	20	34	20	1	14	38	4	30
5.	23	57	21	54	20	37	19	48	14	21	3	15
10.	0	6	21	57	20	19	19	30	14	0	3	55
15.	0	18	22	0	20	10	19	13	13	39	9	37
20.	0	30	22	4	20	1	18	55	13	18	3	17
25.	0	43	22	9	19	52	18	38	12	57	3	0
30.	0	57	22	12	19	42	18	20	12	39	2	43

DECEMBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1.	0	59	22	14	19	41	18	17	12	21	2	36
5.	1	9	22	18	19	33	18	2	12	14	2	22
10.	1	19	22	24	19	24	17	45	11	54	2	3
15.	1	24	22	30	19	14	17	25	11	31	1	45
20.	1	19	22	37	19	4	17	6	11	13	1	27
25.	0	57	22	43	18	55	16	47	10	49	1	8
30.	0	16	22	50	18	46	16	27	10	37	0	50

Occultation of Saturn, by the Moon

On the 30th of October there will be an Occultation of the planet *Saturn,* by the Moon. The following are the Elements, and principal results of a calculation for Edinburgh; using the Decimal Tables of Saturn by *Bouvard,* the Solar Tables of *Delambre,* and Lunar Tables of *Burckhardt.*

	D.	H.	M.	S.
Geocentric ☌ of the ☽ and ♄ at Edinburgh, *Mean Time.*				
October,	30	9	7	1,08
———————— apparent time,		9	23	12,81
Geocentric Conjunction in Longitude, - - -		81°	18	50,20
Sun's Right Ascension, - - - -		214	50	23,34
——horary motion in Right Ascension, - -			2	26,23
Apparent Obliquity of the Ecliptic, - - -		23	27	40,94
Moon's Latitude, South increasing, - - -			49	57,53
——— equatorial horizontal parallax, - - -			55	19,21
———horary motion in Longitude, - - - -			30	52,04
——————in Latitude, - - - -			2	47,08
Saturn's Geocentric Latitude, South, - - - - -		1	34	4,37

	For the Immersion.						For the Emersion.					
	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.
Instants assumed, Appar. Time,	8	1	12,81	8	2	12,81	8	57	12,81	8	58	12,81
Right Ascension of the Meridian,	335°	5	15,64	335°	20	18,08	349°	7	32,12	349°	22	34,56
Moon's true Longitude, .	80	36	39,10	80	37	9,97	81	5	27,65	81	5	58,52
——— true Latitude, South,		46	9,19		46	11,97		48	45,13		48	47,90
Altitude of the Nonagesimal,	31	27	56,0	31	33	46,5	36	47	0,1	36	52	31,2
Longitude of the Nonagesimal,	12	22	13,7	12	32	12,5	22	47	43,8	22	58	25,2
Parallax in Longitude, .	+	6	51,19	+	26	53,93	+	28	16,41	+	28	16,99
Parallax in Latitude, . .		7	21,01		47	18,24		44	39,43		44	36,44
Appar. diff. Long. ☽ and ♄		15	19,91		14	46,30		14	53,86		15	25,31
Appar. diff. Lat. ☽ and ♄		0	34,17		0	34,16		0	41,81		0	40,02
Sun's Ap. mot. in 1 min. of time,						33,16						31,33
Errors from Instants assumed,		—	12,83		+	20,73		—	14,64		+	16,69
				h.	m.	s.				h.	m.	s.
Apparent Time of Immersion, - -				8	1	35,75	Emersion,			8	57	40,85

Hence the final results are as follows, *Mean time.*

	D.	H.	M.	S.		
Immersion,	October 30.	7	45	24,17	at 34″,17	South of the
Emersion,	——— —	8	41	20,17	—40, 93	☾'s centre.

The apparent semidiameter of Saturn being liable to some uncertainty, has not been used in the calculation.

Eclipse of the Moon.

On the 25th of November, there will be a small Eclipse of the Moon, *partly visible.*

		D.	H.	M.	S.
The Eclipse begins,	November	25	2	59	19
Moon rises Eclipsed,	- -	—	3	12'	56
Ecliptic opposition,	- -	—	3	46	10
Middle, - -	- -	—	3	56	24
End of the Eclipse,	- -	—	4	53	30

Digits Eclipsed, 2° 57′ 6″, by the north side of the Earth's shadow, or on the south part of the Moon's disc.

ART. XXXIV.—REGISTER OF THE BAROMETER, THERMOMETER, AND RAIN-GAGE, *kept at Canaan Cottage.* By ALEX. ADIE, Esq. F. R. S. Edin.

The Observations contained in the following Register were made at Canaan Cottage, the residence of Mr Adie, by means of very nice instruments, constructed by himself. Canaan Cottage is situated about 1½ mile to the south of Edinburgh Castle, about 3 miles from the sea at Leith, and about 1¼ of a mile N. of the west end of Blackford Hill. The ridge of Braid Hills is about 1 mile to the south, and the Pentland Hills about 4 miles to the west of south. The height of the thermometer is about 260 feet above the level of the sea. The morning and evening observations were made about 10 A.M. and 10 P.M.

JUNE 1825.

D. of Week.	Day of Month.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
W.	1	58	56	57	47	65	56	29.72	29.53	.17
T.	2	61	53	57	52	66	59	29.41	29.38	
F.	3	56	47	51.5	48	62	55	29.55	29.36	
S.	4	55	44	49.5	41	63	52	29.01	29.07	.53
S.	5	51	45	48	40	59	49.5	29.40	29.60	.07
M.	6	56	53	54.5	37	65	41	29.63	29.45	.03
T.	7	63	49	56	52	68	60	29.33	29.55	
W.	8	58	53	55.5	44	69	56.5	29.63	29.65	.09
T.	9	58	47	52.5	49	71	60	29.70	29.97	
F.	10	65	56	60.5	41	70	55.5	29.95	29.88	
S.	11	68	63	65.5	53	77	65	29.93	29.95	
S.	12	65	55	60	58	81	69.5	30.05	30.03	
M.	13	67	51	59	50	75	62.5	30.13	30.20	
T.	14	68	58	63	50	77	63.5	30.28	30.28	
W.	15	60	57	58.5	53	67	60	30.27	30.16	
T.	16	74	53	63·5	52	81	66.5	30.06	30.16	
F.	17	59	51	55	45	72	58.5	30.15	30.10	
S.	18	58	48	53	44	65	54.5	30.08	29.92	
S.	19	52	50	51	43	55	49	29.80	29.66	
M.	20	51	47	49	45	63	54	29.72	29.73	.05
T.	21	54	48	51	42	63	52.5	29.80	29.82	.04
W.	22	55	51	53	40	62	51	29.78	29.83	
T.	23	60	54	57	49	67	58	29.78	29.78	.08
F.	24	61	52	56.5	50	70	60	29.65	29.58	.03
S.	25	61	50	55.5	49	69	59	29.41	29.28	
S.	26	56	47	51.5	46	65	55.5	29.31	29.46	.48
M.	27	55	46	50.5	42	66	54	29.55	29.63	.28
T.	28	55	53	54	40	62	51	29.62	29.53	
W.	29	61	49	55	49	72	60.5	29.42	29.38	.05
T.	30	59	53	56	42	62	52	29.45	29.47	.15
	Sum,	1780	1539	1659.5	1373	2029	1791	891.35	891.39	2.05
	Mean.	59.33	51.3	55.32	45.77	67.63	56.7	29.742	29.713	

JULY 1825.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
F.	1	56	55	53.5	49	68	58.5	29.68	29.87	.05
S.	2	60	53	56.5	42	67	51.5	29.91	29.92	
S.	3	65	54	59.5	51	68	59.5	29.93	29.87	
M.	4	63	52	57.5	49	75	62	29.96	30.11	
T.	5	63	55	59	53	64	58.5	30.09	30.08	
W.	6	58	52	55	44	61	52.5	30.05	30.04	
T.	7	56	48	52	49	64	56.5	29.98	29.93	
F.	8	60	53	56.5	41	69	55	29.90	29.86	
S.	9	58	52	55	50	58	54	29.85	29.84	
S.	10	56	53	54.5	51	57	54	29.83	29.83	.07
M.	11	56	53	54.5	51	67	59	29.80	29.77	
T.	12	68	62	65	50	79	61.5	29.76	29.71	
W.	13	68	64	66	58	78	68	29.70	29.73	
T.	14	74	63	68.5	61	80	70.5	29.84	29.80	
F.	15	66	62	64	57	69	63	29.74	29.82	.03
S.	16	71	63	67	57	78	67.5	29.95	30.00	
S.	17	72	62	67	59	80	69.5	30.06	30.02	
M.	18	74	60	67	59	78	68.5	30.06	30.08	
T.	19	66	57	61.5	53	75	64	30.16	30.25	
W.	20	61	55	58	55	69	62	30.20	30.22	
T.	21	60	50	55	52	69	60.5	30.22	30.15	
F.	22	68	52	60	43	69	56	29.98	29.98	
S.	23	56	50	53	59	62	60.5	29.97	30.03	
S.	24	58	51	54.5	47	75	61	30.06	30.08	
M.	25	65	56	60.5	42	77	59.5	30.10	30.20	
T.	26	66	55	60.5	46	73	59.5	30.21	30.23	
W.	27	75	59	67	45	82	63.5	30.18	30.18	
T.	28	62	53	57.5	54	70	62	30.16	30.15	
F.	29	64	60	62	48	75	61.5	30.08	29.97	
S.	30	76	63	69.5	52	83	67.5	29·88	29.86	
S.	31	74	59	66.5	58	83	70.5	29.80	29.86	
		1995	1736	1865.5	1585	2222	1903.5	929.07	929.44	.15
		643.5	56	60.18	51.13	71.68	61.4	29.97	29.981	

AUGUST 1825.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
M.	1	62	66	64	55	70	62.5	29.76	29.68	.05
T.	2	65	55	60	58	73	65.5	29.52	29.59	.07
W.	3	62	55	58.5	51	73	62	29.53	29.33	.97
T.	4	62	54	58	52	67	59.5	29.17	29.10	.03
F.	5	60	54	57	49	65	57	29.08	29,16	.02
S.	6	63	55	59	51	66	58.5	29.18	29.26	.05
S.	7	62	55	58.5	53	68	60.5	29.39	29.36	.09
M.	8	64	55	59.5	47	68	57.5	29.32	29.40	
T.	9	62	54	58	48	70	59	29.37	29.42	
W.	10	61	54	57.5	46	67	56.5	29.59	29.78	.10
T.	11	62	50	56	48	69	58.5	29.85	29.83	
F.	12	60	57	58.5	44	65	54.5	29.60	29.28	.05
S.	13	61	56	58.5	45	66	55.5	28.90	28.80	.10
S.	14	59	53	56	51	65	58	28.92	29.07	.12
M.	15	57	54	55.5	51	64	57.5	29.32	29.55	.15
T.	16	59	55	57	47	66	56.5	29.61	29.60	
W.	17	61	55	58	51	66	60	29.66	29.71	
T.	18	62	53	57.5	53	72	62.5	29.93	30.03	
F.	19	62	64	62	49	72	60.5	30.03	30.08	
S.	20	70	57	63.5	60	76	68	30.11	30.23	
S.	21	67	59	63	56	74	65	30.18	30.21	
M.	22	59	62	60.5	55	71	63	30.15	30.04	
T.	23	72	56	61	54	75	64.5	29.97	30.04	
W.	24	58	51	54.5	53	64	58.5	30.08	30.02	
T.	25	62	52	57	52	68	60	30.03	30.03	
F.	26	59	55	57	47	65	56	30.07	30.03	
S.	27	62	52	57	49	64	56.5	30.00	29.90	
S.	28	62	61	61.5	48	68	58	29.87	29.78	.09
M.	29	65	62	63.5	56	63	59.5	29.71	29.80	
T.	30	72	63	67.5	56	73	64.5	29.83	29.85	
W.	31	66	67	66.5	59	74	66.5	29.88	29.90	
		1938	1751	1844.5	1597	2127	186.2	919.61	919.86	1.89
		62.52	56.48	59.48	51.52	68.61	60.06	29.665	29.673	

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DESCRIPTION OF PLATES IN VOL. III.