THE

EDINBURGH NEW
PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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NEW PUBLICATIONS.

THE

EDINBURGH NEW

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On certain Newer Deposits in Sicily, and the Phenomena accompanying their Elevation. By Dr ALEXANDER TURNBULL CHRISTIE, M. W. S., F. G. S., &c. &c. Communicated to the Society by RODERICK IMPEY MURCHISON, Esq. President of the Geological Society, and read November 2d 1831 *.

THE following observations on the geology of Sicily, being the result of a very rapid excursion through that island, are necessarily very imperfect; but as they may probably tend to throw some light upon disputed points regarding the age of the Sicilian formations, and upon some of the theories which at present excite the interest of the geological world, I hope I may solicit for them the attention, as well as the indulgence, of the Society.

After having spent a few days at Palermo, I travelled along the northern coast as far as the Castello de Tusa, crossed the central chain of mountains, by way of Mistretta, and the Monte di Castelli, to Nicosia, Leonforte, and Castro Giovanni; turned eastward by way of Santo Filippo d'Argire to Catania, and proceeded along the east coast by Lentini, Syracuse and Noto, to Cape Passero, where I embarked for Malta.

* This interesting memoir of our friend and pupil Dr Christie, at present engaged in examining the geological structure of Palestine, was transmitted by him from Malta to Mr President Murchison, to be read before the Geological Society, and afterwards published in the Edinburgh New Philosophical Journal. A Geological map of Sicily, by Dr Daubeny, will be found in vol. xiii. of Edinburgh Philosophical Journal.—EDIT.

During this excursion, I have had an opportunity of examining the greater number of the extensive and interesting formations which enter into the structure of this island, and have been enabled, I hope, to determine clearly the exact place in the geological series to which many of them must be referred. The formations which I shall have to describe, will be, 1*st*, A sandstone, with a few subordinate beds of marl and limestone, occupying a great part of the central chain, and extending along part of the northern coast, which is inferior to the Jura or Apennine limestone, but whose exact age it was not in my power to ascertain during my rapid tour; 2*d*, The limestone and dolomite, of which the north-western part of the island consists, and which is probably the equivalent of the Jura or Apennine limestone; 3*d*, Marls and limestones containing nummulites and hippurites, and which must probably be referred to the chalk and green sands of other parts of Europe; 4*th*, Cretaceous limestones and marls belonging to the older tertiary epoch; 5*th*, The extensive newer tertiary deposit, containing shells of existing Mediterranean species; 6*th*, A conglomerate, also containing recent shells, but of a still newer date than the tertiary rocks; 7*th*, Bone-breccias, and cave-bones, of the same age as the recent conglomerate; and, *lastly*, Diluvium.

I did not visit the north-eastern angle of the island, and have therefore nothing to say of the primitive and transition rocks which are found only there; nor will I attempt any description of the volcanic rocks, excepting only such as are found in connection with the tertiary. My limited time will scarcely admit of my doing more than to transcribe my notes, which plan, although inconvenient in some respects, will possess the advantage of enabling me to bring forward my observations in the order in which they occurred to myself. I shall confine myself, in the first place, to mere geological descriptions of the districts I visited, and will leave all theoretical conclusions till the end.

Neighbourhood of Palermo.—The fine Bay of Palermo is flanked on both sides by rugged precipitous hills of limestone, from behind which other hills extend, having the appearance, when seen from the sea, of gradually contracting inwards, and thus forming an amphitheatre, bending at the distance of one or two miles from the shore, the fertile plain which stretches from it to their base. The geologist who had already seen the dolomite mountains of the Tyrol, or of the Tessino, could scarcely fail to recognise at once their characteristic features in some of the mountains of Palermo. In them he would see a bold rugged outline, no traces of stratification, but an appearance of highly inclined rents and fissures extending down their naked sides, many of them with pointed or conical summits, and all of them thinly clothed with verdure, or presenting a perfectly bare surface, of a white or grey colour. They are finely contrasted with the rich plain stretched out at their feet, which is composed of tertiary rocks and conglomerate. These different formations, with the bone-caves which are found in the limestone and dolomite hills, I shall now proceed to describe.

I had no opportunity, when at Palermo, of ascertaining the heights of the neighbouring mountains, but that of some of them must be very considerable, probably from 2000 to 3000 feet. The highest is the Monte Cuccio, which, as seen from the east, has a perfectly conical form, but exhibits an even summit when seen from the south. As far as my observations extended, they are composed of a grey limestone, which frequently contains magnesia, and of a white dolomite. The limestone only differs in colour from light to dark grey; it has a splintery fracture, and generally contains a number of very small fissures, many of which are lined with microscopic crystals, probably of dolomite. Many of these hills have their escarped sides perforated by numerous, irregular, somewhat rounded cavities, which have probably arisen from the little fissures already mentioned having been enlarged by the action of the weather; and it is not unlikely that the same fissured structure may have given rise to the formation of the caverns, which are so common in this limestone, by affording a ready passage to running water.

The small conical hill of La Giazia, near Parco, which has an elevation of about 1370 feet above the level of the sea, is entirely composed of a white dolomite, traversed in all directions by fissures, which cause it to break down easily into small angular fragments, many of which are covered with minute crystals; and the whole exactly resembles, in its structure, the upper part of the Monte Salvadore near Lugano. I could find no trace of organic remains in any of the hills of this formation near Palermo.

Throughout the whole plain of Palermo beds of coarse limestone and conglomerate, containing shells of existing Mediterranean species, are found in horizontal strata, which extend as far as the foot of the limestone and dolomite hills. They rise very gently from the shore towards the hills, and their greatest elevation, I should think, does not exceed 200 feet. They probably include two distinct formations, viz. the tertiary and the new conglomerate already mentioned; but this having been the first spot which I examined in Sicily, I was not yet aware of the distinction between the two, which subsequent observations in other parts enabled me to detect, and I therefore unfortunately overlooked their relations.

The tertiary rocks are well seen in many situations, where they are quarried for building-stones, and particularly on the west side of the Bay, under the Monte Pelegrino. They consist principally of a coarse yellowish or white limestone, separated occasionally by thin beds of a conglomerate. The former is composed of small grains of lime, generally adhering together without any cement, and having the appearance, at first sight, of an oolite; but the grains are not round, and many of them appear to be small rolled fragments of shells. Some of the beds have rather a firmer texture, contain clay or sand, and resemble very much the calcaire grossier of Paris. The conglomerate of the tertiary formation occurs in thin beds, in the limestone, and is composed of small rounded fragments of limestone and quartz, with a calcareous cement. Shells, belonging chiefly, I believe, to existing Mediterranean species, are abundant throughout the tertiary rocks, by far the most common being pectens and oysters, which are often seen arranged in thin beds. The genera Cardia, Pectunculus, Arca, with Echini, Serpulæ and Corals, are also very common. In no part of the plain of Palermo are the tertiary beds at all deranged; they everywhere retain a perfectly horizontal position; but on a short excursion which I made along the valley of the Oretus, I observed them to be inclined at a considerable angle, with a dip (speaking in general terms), towards the north-west, and they here attain an elevation of probably 100 feet higher than that which they have in the plain. The connection of these facts with Elie de Beaumont's theory shall be pointed out hereafter.

I have little to say in regard to the new conglomerate in this situation, owing to the circumstances already stated. It is found in horizontal strata along the shore to the east of Palermo, and probably in many other places in the neighbourhood, and is composed of large rounded fragments of limestone, none of which resemble the tertiary, and smaller fragments of quartz, united by a base of lime.

Bone Caves.—Three bone-caves have been already discovered in the neighbourhood, one, the Grotto di Santo Ciro, about two miles south-east, and two in the mountain of Beliemi, about four miles to the west of the town of Palermo. A description of them was lately published by Professor Scina of Palermo; but as it may not be generally known, and, moreover, is imperfect upon some points which are of great interest to the geologist, I do not hesitate to offer a brief account of them from my own observations, and beg leave, at the same time, to present a copy of the Professor's memoir to the Society.

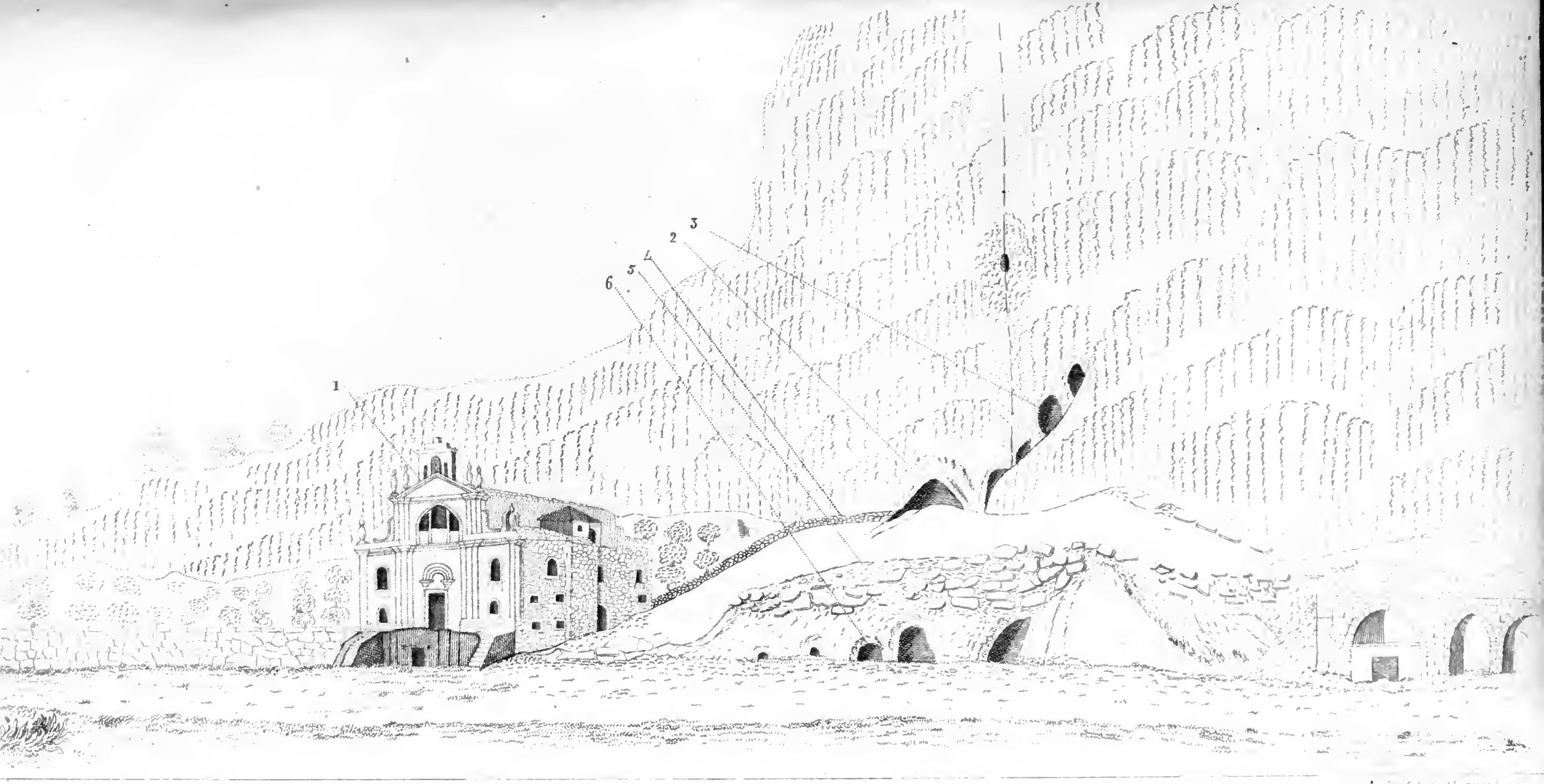
The cave of Santo Ciro is situated near the base of the magnesiferous limestone mountain of Grifone, close upon the plain of Palermo, about a mile and a quarter in a straight line from the sea, and close to the small church of Santo Ciro, from which it has received its name. Its external opening is about 200 feet above the level of the sea, and about 63 above the plain, to which it is connected by a steep talus, partially cut away at its base for the convenience of the high road which passes it; and some of its beds are thus fortunately exposed. The cavern slopes upwards from its entrance to its remotest part. Its length is about 131 feet, its width at the entrance about 10 feet, its height at the same place about 50, its width in the middle 30, which again contracts at its inner end to about 15 feet *.

Before proceeding farther, I must remark that this bone deposite has more analogy to the bone-breccias that occur in various parts along the shores of the Mediterranean, than to the cave-bones of the more northern parts of Europe, which will be made

* These dimensions are nearly the same as those given by Professor Scina, but which I did not adopt until I had verified them by actual measurement.

evident by the details that follow. The breccia is not merely confined to the cavern, but also forms a great part of the external talus, along which it extends (according to Professor Scina) for more than 266 feet, and is there associated with beds of diluvium, and rests upon the tertiary rocks with recent shells which have been already described. The interior of the cavern having been completely excavated, and the breccia removed, we can now only give an account of the arrangement met with in the external talus; but it is extremely probable that the beds composing the latter extended originally into the cavern; and in regard to most of them, indeed, we may say that this is certain, for we can still observe the stain left by them upon the walls. A deep trench has been cut from the entrance of the cave through the upper part of the talus, which, together with the excavations in the interior, and the exposed part on the road below, afford us a distinct and accurate section of the whole. Immediately under the vegetable soil of the talus, are numerous large blocks of limestone, imbedded in reddish clay, the whole having a thickness of about 6 feet. These blocks are seen all along the face of the talus, and are exposed on the road below, where they appear to rest on the tertiary beds, as indicated in accompanying section, Plate I. 1.

Similar blocks are met with in various situations in the neighbourhood of Palermo, the most considerable of which is one which extends along the western shore of the bay near the foot of the Monte Pelegrino for the space of about a mile, and having a thickness of 40 or 50 feet. The blocks, which are of great size, some of them being many yards in circumference, are all of limestone, and are united by a coarse calcareous conglomerate, which having rather a loose texture, numerous caverns have been hollowed out in it by the waves, and are known by the name of the Grotte dell' Arenella. This great deposit rests on beds of tertiary limestone, which here do not reach the level of the sea. (Pl. II. Fig. 1.) But to resume our description of the talus: Under the blocks we find a bed of reddish clay, mixed with a little lime, and containing small rounded fragments of limestone and quartz, with a few bones, (Pl. I. 3.); beneath which is the true bone-breccia, having altogethe a thickness of about 20 feet. (Pl. I. 4.) It has some ap-



Church of Santo Ciro & Bone Cave of the Monti Grifone near Palermo.

No. 1 Church of Santo Ciro. 2 Bone Cave. 3 Small Caves without any bone breccia.

Fig. 1.

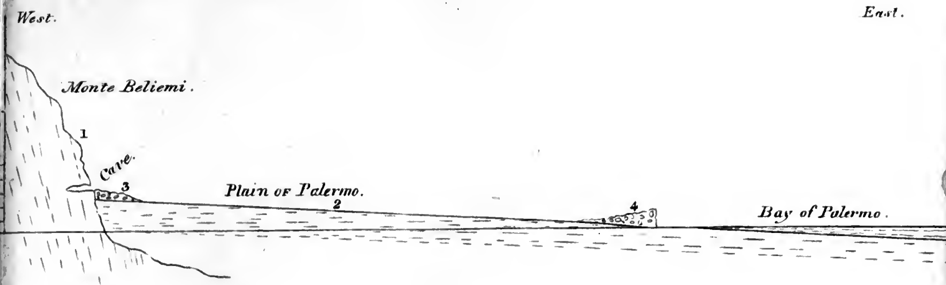
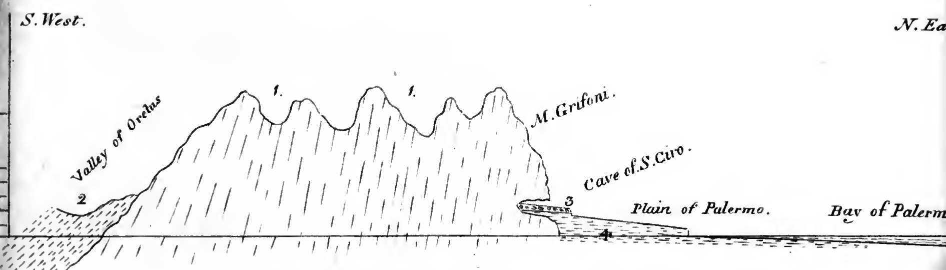


Fig. 2.



1. Limestone & Dolomite. 2 Tertiary. 3 Diluvium & Bone breccia. 4 Diluvium.

Fig. 3. 0 1 2 3 4 5 Miles

1 Dolomite. 2 Diluvium. 3 Tertiary 4 Limestone. 5 Sandstone & Marls.

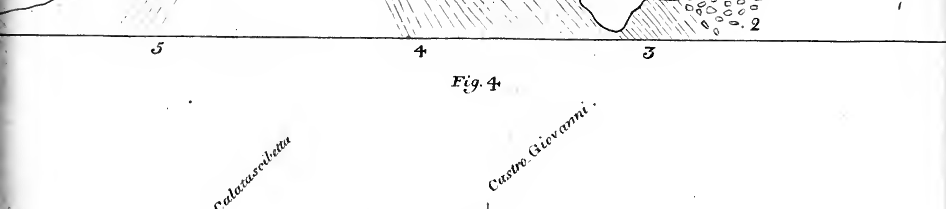
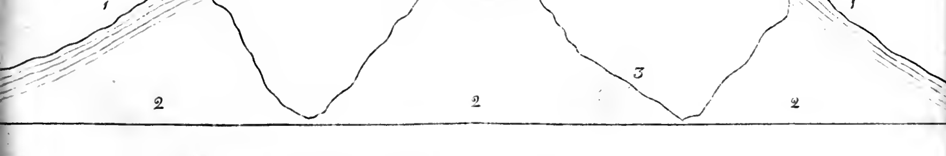


Fig. 4.



1.1.1. Recent Tertiary. 2.2.2. Older Tertiary. 3 Gypsum.

E. Mitchell sculpt.

pearance of being divided into strata, as if it had been deposited under water, has a grey colour, and consists of a prodigious number of fragments of bones, with some rolled pieces and blocks of limestone, cemented together by a little lime or clay. Many of the bones have a calcined appearance, and stick to the tongue; some are light and fragile, others are completely petrified with lime. In some places they are tolerably loose, and can be easily detached; in others the breccia is so hard that it can be employed as a building stone. A collection of the bones was sent to Paris to Baron Cuvier, and, according to the list in Professor Scina's memoir, they include bones of elephant, hippopotamus, and deer, with a few of a carnivorous animal of the genus Canis *.

The whole of the bone-breccia having been removed from the interior of the cavern, the substratum has thus been exposed, which consists of a thin bed of loose sand, shells, and corals, extending into the cavern about 30 or 40 feet beyond the entrance. (Pl. I. 5.) The shells and corals are in great abundance, forming the principal part of the bed, and are generally broken or rounded. This is probably the highest, and consequently the last formed bed of the tertiary deposits; and some of the inferior beds on which it rests may be seen at the exposed part of the talus on the side of the high road. (Pl. I. 6.)

There is very little stalactite in this cavern. Its sides are smooth and polished, as if by the waves; and on the left side, on entering, it is perforated by numerous small holes, the work of lithodomi, and which I observed to extend under the thin bed of shells already described. These holes are confined to the left side, which has been probably owing to the slanting form of the cave from left to right, which causes the right side to hang over the other, and which would thus expose it to the dash of the waves, a situation little favourable for the piercing animals alluded to. Traces of lithodomi and oyster-shells are also seen on the outside at the base of the cliff.

* I am sorry to have none of these bones to present to the Society and to the University of Edinburgh. Having been promised a collection of them by a person at Palermo, who ultimately disappointed me, I unfortunately neglected to collect any myself from the cave.

The bone-breccias of the mountain of Beliemi do not possess quite so much interest as those of Santo Ciro, nor had I time to examine them with the same care that I bestowed upon the latter. There are some circumstances connected with them, however, which deserve attention, as being capable of throwing light upon the manner in which these breccias were formed. Both of the caves of the Monte Beliemi have a higher situation than that of Santo Ciro, the most easterly, which Signor Seina calls the Grotta del Feudo, being 332 feet; the other, named Grotta dei ben Fratelli, 320 feet above the level of the sea. At the former, the bones are only found at the outside of the cavern; at the latter, they occur both within the cave and in the talus which slopes from it to the plain below. The breccia differs considerably from that of St Ciro, but is of much less extent, has not been so much excavated, and therefore cannot be studied with the same facility. It contains large masses of limestone; the bones have a brown or black colour, and in some cases a resinous lustre, are cemented together by a dark brown clay, or by a whitish or grey lime, which occurs in spots or streaks. In the Grotta dei ben Fratelli, it forms a very hard mass, which I found very difficult to detach even with a pick-axe. These caves appear to be situated much above the highest point attained by the tertiary deposits in this neighbourhood, and the relation of the bone-breccia with the tertiary beds, therefore, cannot be seen as at St Ciro; nor is there the slightest appearance in the caves themselves of the sea having been there; no sea-shells, no traces of lithodomi are to be seen, and their sides have not that smooth polished surface which is produced by the action of the waves. They contain scarcely any stalactites.

I shall now give an account of the different formations which I observed on the northern coast, between Palermo and the Castello di Tusa.

From Palermo the tertiary rocks continue in horizontal strata the whole way to Cape Melicia, forming a narrow belt between the shore and the magnesiferous limestone hills which rise behind, but which is separated from the sea at one spot, viz. by the high limestone hills of the promontory of the Bay of Palermo. They are extensively quarried for building-stones at Santa Flavia, where they consist of a coarse yellow limestone, principally made up of shells, containing pectens, oysters, and cardia in abundance, besides other fossils, and exactly resembling the beds at the foot of the Monte Pelegrino.

Immediately beyond the cape of Melicia, these beds present a different arrangement, for we there find them very considerably inclined to the horizon, and they will therefore deserve some attention. The small valley between the capes of Melicia and Delle Mandre, has a general direction of about S. 25° W., and its surface rises rapidly from the sea, excepting in a deep ravine, which runs through the midst of it, and intersects the tertiary beds which compose it. The small ridge on the western side of the valley (Pl. II. Fig. 3.), and terminated by Cape Melicia, consists of dolomite; that on the east, terminated by the Cape Delle Mandre, of limestone. In the dolomite, as usual, no stratification is to be observed; but the limestone presents most distinct strata, which are very highly inclined. Their direction is nearly that of the ridge itself, viz. S. 25° W., and they dip at an angle of about 40° towards the valley. Upon crossing the ridge to the eastward, I found, at a few hundred yards, that they are interspersed with marls, and dip towards the east, preserving, however, the same direction, which would indicate this as the situation of an anticlinal line, having a direction parallel to the ridge, and consequently to the valley.

The only exception to this general bearing of the strata, is at the extremity of the cape towards the sea, where some of the limestone-beds have a direction of W. 35° S., and dip towards N. 35° W., but this may have been produced by some local disturbing cause.

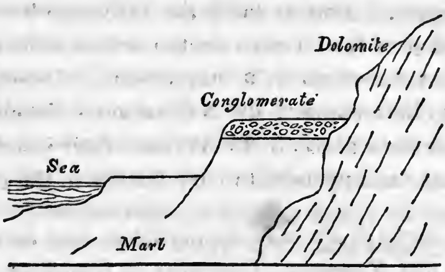
The valley itself is composed of coarse tertiary limestone and conglomerate, the strata of which have the same dip and direction as of the eastern ridge, against which they rest, but which becomes less as they recede from it; and it is worthy of remark, that the above direction is nearly the same as that of the valley of the Oretus, where the tertiary beds, as we have already remarked, are also deranged. The highest point which the tertiary rocks attain is 311 feet above the level of the sea*. To-

* By barometer.

wards the western side of the valley, they are concealed by diluvium, and I could not therefore observe their relation with the dolomite ridge.

A few words will suffice in regard to the mineralogical characters of these rocks. The dolomite has a light grey or white colour, contains a number of small irregular cavities, some of which are lined with crystals. I observed a cave on one part of the hill, which I had not time to examine. The limestone of the eastern ridge, which I suppose to belong to a newer formation than the dolomite, has a grey colour, is compact, divided generally into strata not exceeding two or three feet in thickness, and containing, in some places, thin beds or veins of a black silex, not unlike flint. The tertiary rocks consist of a coarse limestone, and of a calcareous conglomerate, containing small rounded fragments of lime and silex, both of which contain casts of shells, and resemble some of the beds in the neighbourhood of Palermo.

I observed no tertiary rocks beyond the Cape delle Mandre, the limestone of which, associated with light grey-coloured marls, continues along the coast to the east. The strata are generally much inclined or bent. They consist there of numerous beds of a soft marl, interstratified with thin beds of limestone, some of which contain nummulites, the only organic remains which I could find. They rise to a considerable height at some distance from the shore, and in the valley of the river Termini, having been cut down by the stream, or by diluvial action, they stand out in bold high cliffs. The country all around Termini is composed of this formation, with the exception of the hill on which the castle stands, which I could not examine, but which, as seen from a distance, would appear to be composed of magnesiferous limestone or dolomite. Immediately to the east of Termini, the marls are associated with some thick beds of a siliceous sandstone, and they continue with the same characters as far as the Fiume Grande. They are easily recognised along the coast, even at a distance, by their rounded outlines, and fertile soils, which are strongly contrasted with the bold, rugged, sterile aspect presented by the dolomite hills, which rise to great heights immediately behind them. To the east of the Fiume Grande, these grey marls and limestones are succeeded by a white marl or cretaceous limestone, very closely resembling some varieties of chalk. It contains no beds either of compact limestone or sandstone, and exhibits scarcely any traces of stratification; and with these characters it appears at intervals, where not covered by debris, for several miles along the coast. It is here overlaid by horizontal strata of a coarse conglomerate and sandstone. The former consists of large rolled fragments of limestone and sandstone, with some pebbles of quartz, cemented together by a hard calcareous base. I found some shells in it, of the genera Cardium and Pecten, and in one part of it, in which there were scarcely any rolled pebbles, and which therefore consisted chiefly of the calcareous matter which forms the base, there were numerous holes of lithodomi. These formations present a steep face towards the sea, from which they are distant about a quarter of a mile. They have an elevation of nearly 300 feet, and as soon as we attain their summit, we find them o have a table form, which arises from the horizontal position of the conglomerate, and to extend to a greater or less distance inland, until they meet the higher hills of limestone or dolomite.



Continuing our journey along the coast, we first met with the great formation of sandstone near the river Pilato, a few miles to the west of Cefalu, and which now occupies the whole country to the eastward, with some exceptions in the neighbourhood of that place, which I shall first notice. The Castle-hill of Cefalu is composed of limestone, which rises abruptly from the sea, in bare precipices to the height of 1233 feet *. The limestone has a grey colour, and exactly resembles that of the Palermo hills, to which formation it evidently belongs; it con-

* By the barometer.

tains a few nodules and veins of calcareous spar, and in many places numerous casts of shells, which have been converted into spar, and whose general outlines only can now be discerned. Belemnites, however, are distinguishable. There are several other high hills to the south of Cefalu, which also consist of limestone.

To the eastward of Cefalu we find nothing but sandstone and its accompanying shales, and the scenery consequently now acquires a new character, for, instead of a fertile, undulating, cultivated tract along the shore, backed by a lofty range of peaked mountains, with bare sides and rugged summits, the land rises at once boldly from the sea, and steep rounded hills overtop each other in succession, until the loftiest reach an altitude of several thousand feet, the whole being covered with trees, or with a coarse shrubby vegetation.

The sandstone is composed of large grains of quartz, generally of a white colour on its fresh fracture, with little or no cement. The shale is of a grey or bluish colour, sometimes contains a little mica or sand, and breaks naturally into rhomboidal fragments. The strata of the sandstone have nearly the same dip as that of the limestone in the neighbourhood of Cefalu, by which they are overlaid, at least as far as I could ascertain, by observing their exposed strata from some distance. I made their direction to be about S. 20° W. near their junction with the limestone, but this appeared to vary farther to the east.

From the Castello di Tusa on the northern coast across the Central Range of Mountains to Leonforte.

My route from the Castello di Tusa was up the great valley of Petinnea to Mistretta, across the Monte di Castelli to Nicosia, and thence nearly in a straight line to Leonforte. The valley of Petinneo runs nearly due north among hills of the great sandstone formation, which here consist of sandstone and shale, with a few beds of limestone. The general direction of the strata is towards same point between S. and W., and their dip varies. This valley contains an immense accumulation of diluvium, which is also seen on the summits of many hills, having an elevation of several hundred feet above the river, which has cut its way through it, and has thus produced precipitous banks of 50 or 60 feet in height. It consists of light coloured clay, containing numerous large blocks of sandstone with occasionally some of limestone.

The whole of the great central chain, which forms one of the most prominent and important features in the geology of Sicily, is composed in this part entirely of the sandstone formation, which here rises to very great heights. The mountain of St Diana, which is the highest in the neighbourhood of Mistretta, I found to have an elevation of 3875 feet above the level of the sea *; but it is situated a little to the north of the principal crest of the chain, and is overtopped by many others within sight, the loftiest of which is the Madonia, whose summit, even on the 8th of June, was still white with numerous large patches of snow †.

The direction of the strata at Mistretta appears to be nearly parallel to the general direction of the chain itself, viz. about W. 18 S., and they are seen distinctly to dip away from an anticlinal line, which passes across the mountain of S. Diana, extends between the hill on which the castle stands and the small hill of St Catarina on its north, and thence across the valley to the east of Mistretta. The highest part of the chain here is the Monte di Castelli, which is considerably higher than the St Diana, has an even summit and a direction nearly the same as that of the chain; but it is worthy of remark, that two distinct bearings may be observed in the strata, one being nearly W. 15 S. ‡, the other apparently north and south; the former having a southerly, the other an easterly dip. In the valley which runs down from the east part of the Monte Castelli towards Nicosia, the strata have a direction of S. 15. W. and dip towards the east. Two distinct directions are also observable in the sandstone at Nicosia, where certain vertical strata bear W. 18 S., and others less inclined, and not quite so distinct,

* From a barometrical observation at the Castello di Tusa, at half-past 2 P. M., on the 7th of June, and one on the summit of the mountain, at the same hour of the following day.

† Ferrara makes this mountain only 3660 feet above the level of the sea which it is needless to say must be too low by some thousand feet.

‡ About east and west by the compass.

bear to the west of south. These appear to indicate that the mountains of the central chain have undergone at least two distinct elevations, the connection of which, with the views of Elie de Beaumont, will be noticed hereafter.

A great formation of clay is first met with a short way to the north of Nicosia. It extends up the valleys, reaching high up the sides of the sandstone hills, and, owing to its soft nature, it is worn down into a number of deep ravines. Its general colours are grey, greenish-grey and red; it has a talcky lustre on its fresh fracture, is friable, and breaks into irregular-shaped fragments, and it contains a few very thin beds of indurated marl. In many places a white efflorescence is seen on its surface. Every year great masses slip down, and are washed away by the rains. Its strata are variously inclined, bent or contorted. The salt-mines between Castro Giovanni and Alimena are situated in this formation.

To the south of Nicosia the clay is succeeded by gypsum, of a white or grey colour, and in very thick beds. A great part of the Monte St Giovanni appears to be composed of it, and it has there two directions, being in one place nearly W. 18 S.*, in another it is nearly south. It is associated with beds of marl and thin beds of limestone, but from not having been able to detect any fossils in them, I am unable to say to what formation they ought to be referred. They continue as far as the Monte Nissuria, where they are succeeded by the old and new tertiary rocks, which now alone occupy the whole country.

From Castro Giovanni by way of Leonforte, St Phillippo d'Argire and Paterno, to Catania.

The country for many miles round Castro Giovanni, and in all probability a very large part of the island, is composed of blue marls and a white cretaceous limestone, the higher hills being capped with calcareous sandstone and more indurated marls, which form bold precipices round their summits. From the soft and perishable nature of the marls, causing them to be always every where covered with debris, from the imperfect state of their fossils, the indistinctness of their stratification, and the

* East and west by compass.

few instances in which we can obtain a view of their actual junction with the superincumbent beds, it is difficult to determine whether they belong to a distinct formation, or must be all referred to the same.

The hill of Castro Giovanni is about two or three miles long, and varies a little in breadth, has a table form, and a direction sensibly parallel to that of the great chain, which runs across the island to the north of it. Its eastern extremity, which is its highest part, is about 2950 feet above the level of the sea *, and appeared to me to be the highest point attained by the tertiary rocks in this part of the country. Its upper part is composed of horizontal beds of tertiary calcareous sandstone, conglomerate and coarse marl, exposing bold perpendicular cliffs all round, and from the base of which there is a very rapid slope to the valleys below. To the south it is separated by a deep valley from another ridge having exactly the same structure, but in which the beds of the summit have a very considerable dip towards the south. To the north, also, we observe a similar arrangement; for there the hill of Calatascibetta, which is separated from that of Castro Giovanni, has the same structure, and the tertiary beds which form its summit dip away in an opposite direction from those on the opposite side, viz. to the north. Since then, the tertiary beds on the hills both to the north and south of Castro Giovanni dip away from it as from an anticlinal line; and, since this hill is the highest point to which the tertiary rocks have been elevated, I think we cannot avoid the conclusion, that it was in the exact line of elevation, and it ought to be kept in view, that this line is parallel to the principal line of elevation in the island, viz. that of the great central chain. It is also an interesting fact in connexion with these views, that beds of gypsum are met with near the base of the hill of Castro Giovanni on its south side, and dipping under it at a very considerable angle. These different circumstances will be more easily understood with the assistance of the accompanying hypothetical section (*Vide* Pl. II. Fig. 4), where No. 1.

* This must be taken only as a very rough approximation, for it was calculated from two barometrical observations taken on different days, and at different hours.

represents the tertiary beds, with numerous shells of existing species, No. 2. the marls, and No. 3. the bed of gypsum.

I have already stated that the recent tertiary rocks on the upper parts of the hills, consist of different kinds of limestone and conglomerate. Some of the limestones have a yellow colour, a coarse texture containing some fragments of shells, and exactly resembling some of the tertiary limestones of Palermo. There are two other varieties, one of which has a straw, the other a blue colour, and both of them are finer grained, and much more compact than that already described. They differ also materially from the other beds with which they are associated, in the appearance presented by their organic remains; for they appear to have exerted a solvent property upon the shells, which in most instances are removed, and casts only are left; oysters, pectens, and balani being the only fossils which I found entire. In many places they are so hard, that it is nearly impossible to separate the shells which they contain; in others, they are so soft, that the fossils may be removed by the hand.

The beds of gypsum on the south side of the hill are a good deal contorted and fractured. They have a grey colour, a large scaly fracture; but in a few places are white and granular, and contain seams of transparent, white, foliated selenite.

The oysters, pectens, and balani are so perfectly preserved, that in many instances they retain their original colours. Besides these, I found casts of a large *Panopœa P.?* of a large *cardium*, *venus*, *voluta*, *natica*, an *echinus*, &c.

The hills on which Leonforte, Asaro, and St Filippo d'Argire are situated, are all of them composed of recent tertiary rocks, similar to those of Castro Giovanni, and all present high perpendicular cliffs towards the south, the strata dipping in the opposite direction; and it is farther of importance to observe, that a line drawn from Castro Giovanni through the highest points of these hills, which are invariably at the very edge of their southern escarpments, will be found parallel to the principal chain, and if prolonged to the east and west, will also correspond to other lines of escarpments in the elevated tertiary rocks.

In almost all the valleys on this side of the chain, great accumulations of diluvium are seen, which have exactly the same characters everywhere as far as the plain of Catania. They always occupy the bottom of the valleys, have frequently a depth of from fifty to sixty feet, or even more, and, having been cut through by the rivers, form steep escarpments along their sides. They consist of rolled pebbles of the old sandstone, of the tertiary conglomerate and limestone, and of a great deposit of grey clay, which not only connects the pebbles, but rises above them to a great thickness, containing sometimes great numbers of helices and cyclostomæ, asssociated in one instance, near Castro Giovanni, with lymneæ. In some places, a diluvium of a different and older date from this may be observed, rising to very considerable heights, on the sides or summits of the hills. It consists of larger rolled fragments of sandstone, with a few fragments of the tertiary rocks, connected by a sandy clay, and nowhere accompanied with the great deposit of grey clay which forms the principal feature of the other.

The two diluvia *(terrains de transport,* Fr.) may be well seen in the valley of the Simethus. There, the new diluvium forms a perfectly level plain, with a height of probably twenty or thirty feet above the river, and has exactly the same characters which I have already described, with the exception, that it contains a few fragments of granite, and numerous rolled masses of at least two kinds of cellular lava.

This plain is bordered on its eastern side by a steep bank of about forty or fifty feet in height, which also supports a plain extending as far as the surrounding hills. At a distance I supposed that this horizontal deposite, with its bare rocky front, might be a recurrence of the tertiary beds; but upon approaching it, I found it to consist of a coarse conglomerate, containing large and small rounded masses of the older and of the tertiary rocks, firmly united by a calcareous cement. The most common fragments were of the old sandstone, of the tertiary conglomerate and limestone, in one of which I found tertiary shells, with a few of granite, gneiss, red porphyry, and basaltic lava containing olivine. This diluvium also covers the sides and summits of most of the rounded undulating hills between Palermo and Catania, where I observed it at the height of about 800 feet above the sea. It contains the same fragments as those already mentioned, but it is only its highest part which has a cement of lime, like that of the valley of the Simetus, the greater mass of it having only a basis of loose sand.

From Catania by way of Lentini, Syracuse, and Noto, to Cape Passèro.

The plain of Catania, at the part where I crossed it, at no great distance from the sea, consists of diluvial clay, similar to that of the valleys of the interior, but without any pebbles or rolled masses of rock. It is well seen along the River Simetus, which has cut its way through it, and has thus exposed it to a great depth in the form of precipitous banks.

Bounding the south side of the plain, is a small range of low hills, with even summits, which I found to be composed of horizontal strata of a coarse shelly straw-coloured limestone, resembling that on the west side of the Bay of Palermo, and containing the same organic remains, viz. pectens, oysters, corals, echini, &c. &c. Among these beds were also found some of rather a different nature, but containing the same fossils. They consist of a conglomerate, having a basis of a white marl, with small rounded pieces of a greenish clay.

The hills immediately behind, and to the south of Lentini, consist of the same coarse shelly limestone; in one part of which I observed a few rolled fragments of cellular lava, which shew that a volcano must have existed in the neighbourhood, at the time of their deposite, and which would lead us to conclude that the igneous rocks, interstratified with the tertiary, are all of volcanic origin, and do not belong to the trap series, as supposed by some geologists who have visited this place.

The tertiary rocks continue the whole way from Lentini to Syracuse, interstratified near the former place with volcanic rocks, consisting of basalt and volcanic tufa.

The north side of the small harbour of Syracuse, and the continuation of the coast to the north of it, present low cliffs of tertiary rocks, abounding with shells of existing species, and from the top of which the ground rises with a gentle slope to an inland range of cliffs, nearly parallel to the former, and which were at some former period washed by the sea, for they still exhibit in many places a smooth surface, and numerous holes left by marine mollusca. Here was situated the ancient Acradina*, some of whose remains, nearly crumbled to dust, are seen forming a thick bed along the tops of the lower cliffs, which are gradually yielding to the attacks of the sea. It is here also that the catacombs, latomiæ†, and other ancient excavations, are met with; and, besides these, which are either wholly or in part artificial, there are several other caverns, which were undoubtedly formed by Nature, and which I shall now endeavour to describe. They are all situated in the inland cliff, and are at once distinguished from those which were the work of man by their irregular forms, by their sides being pierced by lithodomi, and by some of them containing the bones of extinct quadrupeds. The latter interesting fact was first discovered only about eight months ago. One of these caves, the Grotta di Gesu e Maria, had been built up in front, and converted into a chapel some centuries ago. It is situated beyond the Capuchin Convent, about two miles north of Syracuse, about a quarter of a mile in a straight line from the present shore, and 70 feet above the level of the sea. In its present state (for it has probably been altered by its having been converted into a chapel) it is about 100 feet long, its greatest breadth is nearly 80 feet, and its greatest height about 30 feet. In November last year, excavations were first made in its floor, for the burial of the dead, and the important discovery was then made of a great deposit there of antediluvian elephants, hippopotami, and other extinct quadrupeds. Some of these bones were sent to the museum of Palermo, others were deposited in that of Syracuse. The excavations have been discontinued for some time, the floor has been restored to its former state, and it was therefore only in my power to procure a few fragments of the bones which had been collected by a person in Syracuse. The deposit in which they are found is a loose calcareous sand, with a little clay, which also contains, especially near the top (according to the information I received from the man who had worked there), large fragments of the tertiary limestone.

A few months ago, bones were discovered in another of these

* Acradina, the citadel of Syracuse, taken by Marcellus, the Roman consul.

† Latomiæ are prisons cut out of the solid rock by Dionysius.

caverns, but in a very different state from those just described. They form a true bone-breccia, having a very hard basis of a blue or grey limestone, with irregular patches in various places of an equally hard rock, made up of fragments of sea shells and corals*. This cavern has a long narrow entrance from the base of the inland cliff, its length being about 130 feet, and its breadth only 20, terminating in a circular cave, whose diameters, in different directions, vary from 60 to 80 feet. The bone-breccia is only found in the entrance, and appears to have been much worn down since its first formation, for it is higher at its sides than middle, and the smooth water-worn appearance of its surface, and the fact of its having been pierced by lithodomi, throughout nearly its whole length, shew that it had not been worn down by artificial means. No excavations appeared to have been made in this cave before I was there, and the above appearances having excited my most lively interest, I immediately procured the assistance of a labourer, who could only detach with his pick-axe the few, but I hope satisfactory, fragments which I send with my other specimens to the Society. I next examined the outside of the caves, and was delighted to find that the analogy between this and the caves at Palermo was still kept up, by the breccia extending for a great distance along the ground, at the base of the cliff. My time would not permit me to trace its extent, which must, I should suppose, be considerable, for I observed it at several points at a great distance from each other. I entered several other caves, but it was only in one of them that I could detect any thing like a deposit of a more recent date than the tertiary rocks, in which they are situated. That to which I allude is a long irregular-shaped cavern, the entrance of which contains on its floor, and extending some way up its sides, a calcareous yellow breccia, principally made up of broken shells and small fragments of limestone, but containing no bones, although there can be no doubt that it belongs to the same formation, and the absence of bones in this cave, or, perhaps, to speak more correctly, their presence in the other, must be considered accidental.

* M. Brongniart, in his "Tableau des Terrains," says, "Autres les os on y trouve des coquilles qui sont toujours terrestres, fluviatiles et lacustres."

On the south side of the valley of the Anapus, there is another example of the old conglomerate, with characters exactly similar to those presented by it in the valley of the Simetus, near Catania, and on the north coast. It consists of a deep deposit of rolled masses of tertiary limestone, with a few of lava connected together by a loose calcareous sand, having some appearance of stratification, and upon which rests beds containing similar rolled masses, but cemented by a hard base of lime, which contains a few marine shells, and forms the whole into a strong conglomerate. These beds terminate towards the plain of the Anapus, in a low irregular cliff, 40 or 50 feet high, and stretch many miles to the south and west; their surface forming a perfectly level and slightly elevated plain. I may mention that near the edge of this cliff was situated the temple of Olympic Jove, two only of the pillars of which, formed of tertiary shelly limestone, are now erect. It is scarcely necessary to point out the analogy between the different old conglomerates which I have described, and the diluvial deposits of the valleys of the Isere of the Rhone, and the Saone, described by Elie de Beaumont under the name of *Terrain de Transport Anciens.*

Beyond the deposit of conglomerate to the south, the country immediately along the coast gradually consists of a white cretaceous limestone, which rises towards the base of a range of hills running parallel to the shore, but which I had not time to examine. The same white chalky-looking limestone is found at Noto, associated with numerous beds of a straw-coloured limestone of which nearly the whole country appears to be composed. It is generally very soft, but some beds of it are so hard as to afford an excellent building stone, for which purpose its fine texture, its light straw colour, and the ease with which it is cut, render it well adapted. The only other rock I observed in this neighbourhood was a red calcareous breccia, conformable to, and interposed between the beds of the straw-coloured limestone. These beds contain a few casts of shells and echini, few of which were sufficiently perfect to enable us to determine their characters, and long smooth cylindrical bodies were every where very common, but in no case could I observe the least trace of organization in them. I am therefore rather inclined to think that they may have originated from some peculiar arrangement in the particles of limestone. I have seen these bodies more than a foot long; they are always smooth on their outer surface, of the same thickness throughout their whole length, seldom bent, and have never any branches or any other appearance of a vegetable structure.

The same formation extends the whole way to the village of Pachino, a few miles from Cape Passero, where I found a few shells, and among others a small terebratule, and one resembling a gryphæa, but which I suppose to be the Ostrea anomalis. Another formation is now met with, having different mineralogical characters, and containing different fossils from those already described, viz. the hippurite limestone, which extends from the village of Pachino to the sea, occupies the upper part of the island of Cape Passero, extends round the most southerly point of Sicily, and forms the base of the small island named the Isola delle Conenti. It consists of beds of different coloured hard compact limestones, containing great numbers of hippurites, nummulites, and casts of various other shells, the characters of which cannot be easily determined, on account of the hard nature of the rock. The most common colour of the limestone is white, with which grey is often intermixed in the same stratum, and red and white sometimes occur in the same mass, giving it a brecciated appearance. A yellowish limestone is also met with along the south coast, and in the Isola delle Conenti. These beds are all horizontal, are quite conformable in stratification to the white cretaceous and straw-coloured limestone which are above them, and rest upon beds of trap-tuff and basalt. The trap-rocks extend from the neighbourhood of Pachino along the valley to the south of that place, as far as the sea, and are only seen below the limestone beds, there being no appearance of alternations, at least as far as my observations extended. They are seen very distinctly in the island of Cape Passero, and on the neighbouring coast, with the hippurite limestone resting upon them in horizontal strata. They are lost near Porto Palo, and do not again make their appearance along the coast so far as the Isola delle Conenti, which was the extent of my excursion. They consist of a black compact basalt, containing grains of pyroxene and olivine, a grey basalt, without any disseminated minerals, and different kinds of trap-tuff containing a good deal of lime.

None of these beds have any resemblance to melaphyre, nor do they appear on the other hand to belong to true volcanic rocks. Fragments and grains of them are found in some of the superincumbent limestones *.

The base of the small island of Conenti is composed of beds of hard nummulite limestone having a yellow, brown, or white colour. It contains nummulites in some situations, but not in great abundance, and I thought I could distinguish some traces of hippurites. They extend the whole way round the island, rising only a few feet above the level of the sea. Resting upon them are beds of a loose yellow limestone, or marl of a grey colour, and of the white cretaceous limestone already so frequently mentioned. They are all perfectly horizontal, and are capped by a thin bed of a harder limestone, which has protected them against the attacks of the weather, and has prevented them from having been long ago completely washed away. The greatest height of the island is probably not more than 30 or 40 feet. I found a few microscopic shells in the white and grey marls, similar to those found in the same formation in other parts of Sicily.

Conclusions.

Notwithstanding the very limited and imperfect nature of the preceding observations, I believe that they will nevertheless enable us to arrive at some very important theoretical conclusions, which I shall now proceed to consider; and first in regard to the bone-breccias. From the situation of these breccias, both at Palermo and Syracuse, there can be no doubt that the extinct quadrupeds existed at a period long posterior to that in which the Mediterranean began to be inhabited by its present species of mollusca, radiata, and zoophytes, and before the last great convulsion, which raised a great part of Sicily above the level of the sea. The smooth water-worn surface of the cave of Santo Ciro, and of some of those at Syracuse, and the numerous holes left by perforating marine mollusca, force upon us the conclusion, that these caves were long under the surface of the sea, and this at a period long posterior to the formation of

* Dr Davy has been so kind as to examine some specimens of the white hippurite limestones, in order to determine whether they contain magnesia. No trace of this earth could be detected.

the limestone beds containing shells of existing species, for we find these beds at Santo Ciro below the bone-breccia, and at Syracuse they actually form the cliffs in which the caves are situated. Not only, however, were these caves long under the sea, but they continued so for a great length of time after the bone-breccia had been deposited in them, of which we have ample evidence, both in the cave of Santo Ciro and in those of Syracuse. In the former we find distinct traces of stratification in the breccia; and above it is a thick bed of clay, containing a few bones (Pl. I. 3.), which could only have been deposited in tranquil water; in the breccia of the latter we have still more positive proof, for in it we find sea-shells, and its surface has been worn down by the waves, and has been perforated by marine animals, and, since that period, these caverns have all been raised up above the level of the sea, into their present position. Thus we may divide their history into six distinct epochs; first, That of their formation, which probably took place from the enlargement of fissures in the limestone rocks by the action of the sea; 2d, That in which they were occupied only by the sea, and which is evinced by the holes of lithodomi left in the walls, far below that part occupied by the deposit of bones; 3d, That of the great catastrophe by which the fractured bones and fragments of rocks were washed into the caves, or accumulated at their entrance; 4th, That more tranquil period during which the bed of clay (No. 3), at the cave of Santo Ciro, was deposited, and the breccia at Syracuse was perforated by marine animals; 5th, That of the great convulsion which heaved them up above the level of the sea, at which time the great blocks at the cave of Santo Ciro and other similar deposits were formed; 6th, The present period extending from the last great convulsion, which gave to this part of the world its actual form.

I have hitherto intentionally omitted to say any thing of the caves of Beliemi, which, it was formerly remarked, had no appearance of ever having been under the surface of the waves. They therefore differ very materially from the others; but they are not without considerable interest, for, in connexion with that of Santo Ciro, they may afford us data for determining the height attained by the former ocean, or to speak more correctly, the number of feet the present coast has been elevated above its surface. Now, independent of the caves of Beliemi, we know that the cave of Santo Ciro must have been very near the surface of the sea, for the holes of lithodomi which are seen on its walls, and on the rocks below it, do not extend above it. But the caves of Beliemi are more than 100 feet above that of Santo Ciro, are considerably above the highest level of the tertiary rocks, which must have been elevated at the same time with the caves; and as they have always been above the waves, it follows that the surface of the former sea must have reached some point between the cave of Santo Ciro and that of Beliemi, and therefore that this part of the country has been elevated between 200 and 300 feet.

I consider one of the most interesting and important results of the preceding observations to be the complete confirmation they afford of M. Elie de Beaumont's views regarding the epochs of elevation of the Sicilian mountains. The principal chain extending across the island to the north of Castro Novo, and Nicosia, towards Messina, is sensibly parallel to the principal chain of the Alps, whence alone M. de Beaumont infers that the date of its elevation must be the same, which, I think, is completely confirmed by the small part of the chain which I had an opportunity of examining. Many of the separate parts, of which the whole is made up, are sensibly parallel to the direction of the chain; thus, I have already noticed the parallelism of the bearings in the strata at Mistretta, in the Monte di Castelli, at Nicosia, and of many of the tertiary hills between Castro Giovanni and Santo Filippo d'Argire. Never was I more forcibly impressed with the truth of this theory than when viewing Sicily from the top of Ætna, for there I looked down upon the great chain of hills which I had already toiled over, and saw it stretching away in a distinct line to the west, and the lower hills to the south of it, with their scarped cappings of recent tertiary rocks following the same direction, which could be easily traced from the declining sun having thrown all into shade except the prominent parts, except those elevated points and lines which had been heaved highest up by the great convulsion, to which they owed their origin. Other lines could also be perceived crossing them, but their true direction could not be so easily determined, and their magnitude was not equal to those which formed the most marked features of the scene.

On the north side of the chain we have scarcely any means of coming to a positive conclusion regarding the epoch of its elevation; but when we get to its south side, we see the recent tertiary rocks heaved up to several thousand feet above the level of the sea, and in lines parallel to the general direction of the chain. Thus we have a proof of the elevation of these mountains after the formation of the tertiary rocks; but this is not sufficient to make it correspond with the epoch of elevation along the principal chain of the Alps, which took place at a still later period, viz. after the formation of the great deposit of pebbles and clay which occupies the valley of the Isere, and the plain of L'Abresse, (the terrain de transport ancien of Elie de Beaumont). At first, therefore, I was inclined to suppose that the recent tertiary beds containing shells of existing Mediterranean species, might be the equivalent of the deposit of the plain of L'Abresse, and be entitled to the term of a quaternary formation; but the discovery of a deposit newer than these beds, and most distinctly corresponding to that of L'Abresse, made me abandon this hasty opinion. The deposit to which I allude, is that which I have described under the name of old conglomerate. It has somewhat different characters in different situations, according to the nature of the rocks from which it has been derived; but the following are the general results which will be obtained from studying it in a variety of situations, viz. on the north coast, in the valleys to the south of the great chain, particularly in that of the Simethus, between Palermo and Catania, and to the south of Syracuse, it is composed of rolled pieces of a great variety of rocks, some of which have been derived from a great distance, and it was therefore produced by some great general disturbing cause. Since it contains fragments of tertiary rocks it was of posterior formation to these. In some places it has a cement of lime which contains sea shells, shewing that in such situations it was formed under the sea, and being sometimes found perforated by lithodomi it must have continued long under the waves before its elevation. We may therefore fairly conclude that it is of the same age as the deposit in the plains of L'Abresse, and it is also clearly contemporaneous with the bone-breccias, which I have shewn to have been formed after the tertiary period, but before that of the last great convulsion, by which a large part of Sicily was elevated.

It now only remains for us to shew, that the principal chain of Sicily was elevated after the deposit of this conglomerate, in order to make the analogy between it and the principal chain of the Alps complete. For this purpose we have only to study the relations of the diluvium with the conglomerate, and we everywhere find that the former occupies the bottom of the valleys which cut through the latter; and since the diluvium on both sides of the chain can be traced up to its highest parts, and consists of fragments of all its rocks, we must conclude, that the conglomerate was elevated either before, or at the same time with the diluvium, and not after it, in which case, the latter would have been found elevated in the same way. We may also refer the great blocks of limestone which cover the bone deposit of Santo Ciro, and those also on the west side of the bay of Palermo, to the same conclusion, and they must therefore have been formed exactly at the same time that that coast was raised up above the sea.

In the plain of Palermo, and along a great part of the north coast, the tertiary strata are perfectly horizontal, as far as the base of the dolomite hills; but in the valley of the Oretus, and in that between the capes of Melicia and Delle Mandre, they are considerably inclined to the horizon, and have a direction nearly parallel to that of the western Alps, which Elie de Beaumont has shewn to have been elevated immediately after the deposit of the tertiary formation. Nearly the same direction may be observed in many of the beds near Mistretta and Nicosia, intersecting the more general direction, which is that of the chain itself; but as no tertiary beds occur there, the influence of these disturbances upon them cannot be observed.

I shall now add a few words in regard to the age of the older formations. Considering, for the reasons already mentioned, that the coarse limestone beds with recent shells belong to the upper part of the tertiary series, the extensive formation of cretaceous limestones which immediately succeeds, will belong to the lower part of the same series. It probably contains some shells of existing species, but which are certainly not nearly so abundant as in the upper beds.

It is the opinion of Mr Hoffmann, that the nummulite and hippurite limestone belongs to the period of the chalk and green sand, and the marls and limestone beds to the east of the Cape delle Mandre, may perhaps belong to the same formation; but I will not venture to give a decided opinion in regard to either, nor in regard to the beds of clay containing salt, on the south side of the principal chain.

The limestone and dolomite mountains of the neighbourhood of Palermo, and extending along part of the northern coast, are certainly older than all the preceding, and therefore cannot be referred to a newer period than that of the Apennine or Jura limestone; and their resemblance to this formation in the north of Italy, would incline us to refer it to this, and not to any older part of the series.

Having no positive data whereby to determine the exact age of the old sandstone formation, all that can be said regarding it is, that it is inferior to the Apennine limestone.

Malta.

Since writing the above, I have visited several parts of the islands of Malta and Gozzo, and have made myself acquainted with their general structure. They consist entirely of tertiary rocks, closely resembling those of the south-eastern part of Sicily. The most common is a fine-grained straw-coloured limestone, which is often so soft as to be worn down rapidly by the weather; but, in other instances, is sufficiently hard to form an excellent building stone, to which circumstance these islands have been in a great measure indebted for the elegance of the numerous churches and palaces which are seen in every town and village. Harder and more crystalline limestones are also met with, and all of them with nearly the same colour. A grey marl occurs abundantly in Gozzo, and in some parts of Malta, but bearing a small proportion to the limestone. The strata are everywhere horizontal, or only very slightly inclined, the whole appearing to have been raised up above the sea without having been materially deranged. The south coasts are bold and precipitous; the north coasts rise more gradually from the sea, and have a direction nearly parallel to the south coast of Sicily. They will also be found to be nearly parallel to the chain of the Pyrenees; from which circumstance, and from its having been asserted that belemnites had been found in these islands, M. Elie de Beaumont supposed them to be of the age of the chalk, and to have been elevated between the periods of the chalk and tertiary formations. I have seen no fossils here that could be referred to the secondary class, and the belemnites which are said to have been found, are probably nothing more than those cylindrical shaped bodies, of which I have already made mention, when describing the rocks of Noto, and which are also found in great abundance in the fine soft limestone of Malta and Gozzo.

In almost all parts of the islands, the beds of limestone are found to be traversed by great cracks and fissures, filled with a breccia of red clay, and fragments of limestone. On digging a drain near the new Naval Hospital, on the south-east side of the harbour, and about 40 or 50 feet above the sea, one of those fissures, of small dimensions, was cut across, and was found at one spot to contain bones, some fragments of which were preserved by the workmen, but so much broken, and so imperfect, that their characters could not be determined. At Mafra, on the west coast of Malta, and opposite the island of Gozzo, I observed a bed of a similar breccia, resting on the tertiary rocks, and above it a bed of a loose calcareous sandstone, containing fragments of shells, both dipping at a moderate angle under the sea, and towards the north, and not reaching higher than 50 or 60 feet up the sides of the hills. This, as well as the breccia of the fissures, corresponds, I should think, to the conglomerate which I have described as occurring in various parts of Sicily: My reasons for supposing so are, 1*st*, Because it is superior to the tertiary rocks; 2*d*, Because it contains fossil bones; and, 3*d*, Because it has been elevated above the sea since its formation.

Both of these islands are of trifling elevation, the highest point in Malta, which is in one of the hills to the west of Citta Vecchia, being only 590 feet above the level of the sea. Some of the hills of Gozzo are probably a little higher. Upon looking over a large manuscript map of the island, from a survey by the officers of the Royal Engineers, I observed that all the hills of any magnitude were in parallel ridges, having a direction of nearly north-east and south-west, and which also corresponds to that of the numerous deep narrow bays of the north coast, two of the largest and most beautiful of which form the fine secure harbours of La Valletta. To what this direction has been owing, it would, I conceive, be rather difficult to determine, for it does not correspond to any great fractures in the strata, all of which have very nearly retained their horizontal position; but, at the same time, it is worthy of remark, that all the hills having this direction appear to have been elevated above the sea before the deposit of the conglomerate mentioned above, for I have been assured by some intelligent persons here, that it is never seen on their summits, but only in the bottom of the valleys which separate them.

On the Proximate Causes of certain Winds and Storms. By Professor E. Mitchell, University of North Carolina. (Continued from page 296 of preceding volume.)

On the Causes of the Trade-Winds.

With the above facts and arguments before us, we are prepared for an investigation of the proximate causes of the trade-winds. Two theories have, as is well known, been advanced upon this subject. The earliest is contained in a paper of Dr Halley's, read before the Royal Society in 1686. The other, that of Hadley, was brought forward in 1735, and as it is that which is generally adopted by the oldest philosophers of the present age, it may be regarded as presenting the strongest claim to our particular and continued attention. It may be stated in the words of Laplace.

"The sun, which we will suppose, for the sake of simplicity, in the plane of the equator, there rarefies by its heat the columns of air, and elevates them above their natural level; they should then re-descend by their weight, and be carried towards the poles in the superior part of the atmosphere; but at the same time a current of cool air should arrive from the climates near the poles, to replace that which has been rarefied at the equator. Thus two opposite currents of air are established, one in the inferior, the other in the superior, part of the atmosphere. But the real velocity of the air, due to the rotation of the earth, is so much the less as it is nearer the pole; it ought therefore, in advancing towards the equator, to turn slower than the corresponding part of the earth, and bodies placed at the terestrial surface should strike against it with the excess of their velocity, and experience by its reaction a resistance contrary to their motion of rotation: thus, to an observer who thinks himself immovable, the wind seems to blow in a direction opposite to the rotation of the earth, that is, from west to east, which in fact is the direction of the trade-winds *."

As Laplace speaks doubtingly of this theory, remarking merely respecting it, that it " seems to be most probable," we may, without subjecting ourselves to the charge of overweening and unreasonable presumption, proceed to discuss its claims to accuracy, and state our objections to it—our objections to it as a full, complete, and satisfactory theory. The cause assigned by Laplace, has unquestionably a concurrent influence in the production of these winds. The trade-winds are here represented as a secondary result of the movement of the air overhanging the higher latitudes towards the equator, that movement being caused by the more elevated temperature of the tract towards which the current is directed. We are led to inquire why it is, that this current and the resulting wind are confined within the limits of thirty degrees on each side of the line. Why does the air not rush with as great velocity from the parallel of 60° towards that of 30°, as from the parallel of 30° towards the equator, and produce a trade-wind within the former, as well as within the latter limits, especially as both of the causes upon which the trade winds are made by Hadley to depend, operate with greater energy in the higher than in the lower latitudes.

(*a.*) The first of these causes is the excess of the temperature of the equatorial region over that of the countries lying nearer to the poles—of the tract under the equator, above that under

* Pond's Translation of the System of the World.

the parallel of 30°. But the heat at the parallel of 30° exceeds that of the parallel of 60° more than it is itself exceeded by the heat of the equator. Both theory and observation lead us to this conclusion. See Halley's paper in the Philosophical Transactions, and Emerson's Miscellanies, for a mathematical determination of the amount of heat communicated by the sun's rays in different latitudes. Supposing the sun to remain on the equator, it varies as the cosine of the latitude. But the cosine diminishing more rapidly for a given number of degrees in the high than in the low latitudes, so must also the heat; or the mean temperature at 60° must differ more from that of 30° than this last does from that of the equator. With this agrees the remark of one who had ample opportunity of observation. "Notwithstanding our advanced latitude, and its being the winter season, we had only begun for a few days past to feel a sensation of cold in the mornings and evenings. *This is a sign of the equal and lasting influence of the sun's heat at all seasons to thirty degrees on each side of the line; the disproportion is known to become very great after that.* This must be attributed almost entirely to the direction of the rays of the sun, independent of the bare distance, which is by no means equal to the effect *."

Professor Mayer, of Gottingen, undertook to deduce from a comparison of the meteorological observations, made in different latitudes, an empirical law for determining the mean temperature of different points in the earth's surface. He found this temperature to change very slowly in the neighbourhood of both the equator and the pole, and rapidly in the intervening space. Thus the mean temperature under the equator he makes 84° 2′; at the parallel of thirty, 71° 1′; at sixty, 45°; the differences of which are 13° 1′ and 26° 1′. If his numbers are correct, it is apparent that the causes tending to create a movement of the air towards the equator, operate at the parallel of 60° with just about double the force they do at 30°.

(*b.*) When the air has once been set in motion by the more elevated temperature of the lower latitudes, the creation of a trade-wind is determined by the increasing magnitude of the pa-

* Cook's Voyage to the Pacific, 4to. vol. iii. p. 255.

rallels over which it passes in its progress towards the equator, and the rapidity of the current flowing westward, will be greater in proportion as the differences in the circumferences of the successive parallels is greater. But these differences depending upon the differences of the cosines of the latitudes, must be greatest in the high latitudes; and supposing the movement of the air towards the equator to be the same as within the parallel of 30°, the trade-winds should not only exist, but blow more violently there.

It appears, therefore, that both of the causes on which the trade-winds are made by Hadley's theory to depend, operate with greater energy between the parallels of 30° and 60°, than within the actual limits of the trades, and yet fail of producing any wind. Not only is there no trade-wind there, but there is in both the northern and southern hemispheres, a decided predominance of winds from the west. It is generally regarded as a sound maxim in philosophy, that when a particular effect is attributed to the action of a certain cause, if, on the reproduction of the cause, the effect fails to follow, we are to conclude there was an error in the first instance, and the original effect is to be traced to some other source.

An attempt is however made by some of the philosophers who reject altogether the theory of Halley, and embrace the views of Hadley, to account for the fact that the trade-winds are limited by the 30th parallel, and that the westerly winds prevail in the regions lying beyond it. It is said that the air which is rarefied and ascends about the equator, flows off towards the poles, that being cooled and condensed, it at length descends to the earth, and retaining its original velocity, moves eastward faster than the parallel over which it is incumbent, producing a wind from the west *. He (Mr Daniell) remarks that the restriction of the trade-winds within the 30th degree of latitude, can be accounted for on no other hypothesis. Not upon his principles. It, however, may be accounted for on different grounds. Now, according to this hypothesis, the westerly winds of the temperate zones are a secondary result of a current flowing from the equator towards the poles. They prevail *at the surface of the earth, and can therefore be generated only by a ground current, directed*

* See Daniell's Meteorological Essays, p. 104.

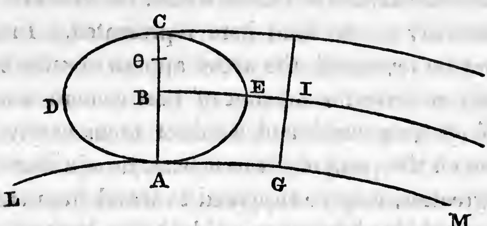
from the lower towards the higher latitudes. For it will hardly be contended, that the air rushing towards the poles, might occupy the higher regions of the atmosphere, and communicate to the strata below its motion eastward, without at the same time communicating its motion northward or southward. Is the existence of such a current probable? We have already seen that the causes by which the trade-winds are produced (according to the theory whose merits we are now endeavouring to estimate), act with less energy within the parallel of 30° than without it. Are we to embrace the opinion, nevertheless, that these causes produce the trade-winds within the parallel, and also counteract the operation of stronger causes, and determine the movements of the atmosphere to the distance of 30° beyond, forcing back the air of the temperate zone, notwithstanding its tendency to approach the equator, into the neighbourhood of the pole? This doctrine is very improbable, and has no evidence to support it. If there be an under current from the equator towards the poles, between the latitudes of 30° and 60°, the air that is transferred by it must be returned from the poles through the upper regions of the atmosphere, and the circulation be carried on in a curve, returning twice into itself, or resembling a figure 8, placed horizontally, and bent so as to apply itself to the arc of a circle. But we are not left to argument and conjecture in the case. It has been already shown that within the limits specified, there is no predominance of wind directed from the equator towards the poles; the current is in the opposite direction. Of course, the westerly winds of the temperate zones cannot be produced by winds blowing from the equator; and the objection to Hadley's theory, drawn from the predominance of westerly winds, between the latitude of 30° and 60°, remains unanswered, and it is believed unanswerable. Other objections may be found in the writings of Kirwan *, but it seems unnecessary to notice them.

The account of the origin and cause of the trade-winds, given by Dr Halley, was characterized by D'Alembert as obscure. Kirwan undertook to illustrate it, but does not appear to have been altogether successful. It seems to have been misunderstood by Playfair, by whom it is stated in the following terms:—" The cause usually assigned for the trade-wind, is the constant motion

* See Philosophical Magazine, vol. xv.

towards the west of the spot to which the sun is vertical, and where of course the rarefaction is greatest. This, it is supposed, draws along with it the air from the east. This, however, is by no means a satisfactory explanation," &c.*

Halley's theory, as here represented, verges so closely on the absurd and ridiculous, that we cannot, without doing injustice to its very acute and able author, accept of it as a correct exhibition of his views, which receive illustration from that part of his paper where he treats of the monsoons, and in the accurate conception of which we may derive aid from a diagram.



Let L A M be a part of the equator, or of an adjacent parallel of latitude, the spectator being on the north side of it. Let B I G A be the lower stratum of the atmosphere, three or four miles in thickness. Let the sun be vertical at A. The lower part of the column A C will be heated and expanded, and the portion B θ lifted into the position θ C, undergoing at the same time a slight condensation †. The portion θ C will therefore have a tendency to flow over into the columns on each side of it. But it cannot flow in the direction C E, because the sun, moving in the direction A C, at the rate of a thousand miles an hour, and carrying the point of the greatest heat forward with the same velocity: before the part θ C has time to yield to the impulse of elasticity and gravity, and flow into the columns west of it, they will themselves have been heated and expanded, and brought into the same condition with the column A C. It cannot flow either north or south, or at least its tendency to escape in those directions will be feeble, because all parts of the same meridian will be heated at the same time. There remains therefore only the direction C D. But the sun having already passed over the columns on the eastern side of A C, and they being cooled

* Outlines, vol. i. p. 307. † See remarks connected with Fig. 1.

by radiation, and condensed, and θ C being pressed on that side by a force less than its own elasticity, will expand itself, and create a current in that direction. The weight of A C being in this way diminished; and that of the columns on the east side of it increased, A C will rise, the air at the base of the columns east of it will flow in to supply its place, and a vortex be generated, moving westward below, and eastward above. A new impulse being given during each successive passage of the sun over the meridian, a permanent east wind will be created *.

Arguments will presently be adduced tending to render it probable that the motion of the air within the limits of the trade-winds is actually of the kind here represented. In the mean time, it may be remarked, the above applies to such parallels of latitude only as have the amount of heat communicated to the portions of air lying north and south of them nearly the same, or along which the point of greatest heat, or of a heat very little below the greatest, may be supposed to travel from east to west. If the excess of the heat on one side be moderately increased, the plane of the vortex will be inclined in that direction; but if the excess become considerable as through the greatest part of the temperate zone, the equilibrium will be established in a totally different way. Thus, with regard to the United States, the point of the greatest heat first passes south of us, and an impulse is given to the under strata of the atmosphere in that direction, and when some time afterwards the columns in the meridians west of us come to be expanded, the air that should have supplied the eastern or trade-wind having passed off towards the equator, the upper or western current descends to the earth creating a westerly wind, or rather by the composition of mo-

* The Abbe Mann notices this expansion of the lower strata of the atmosphere, which he denominates a heat tide, in a paper copied into the Philosophical Magazine for November 1799, but does not trace its effects in the generation of winds. It has this in common with the tide, that it accompanies the sun in his journey westward; but, in regard to its cause, effects, and the manner in which the equilibrium that has been disturbed by it is restored, it differs entirely. I have to regret that it has not been in my power to consult D'Alembert's "Researches sur les Causes general des Vents," of which, however, Playfair observes, that it is more remarkable for the resource and ingenuity it displays in the management of the calculus, than for the physical conclusions to which it leads.

tions in consequence of its mingling with the current that is proceeding southward, a northwest wind, which may be regarded as the natural wind of the parts of the globe lying on the north side of the equator beyond the 30th parallel. The same reasoning applies to the other hemisphere. As, however, the natural and gentle flow of the air in this direction is interrupted by evaporation, condensation, and other causes, the result is simply a predominance in those latitudes of winds from the west, and the direction of the pole over those from the opposite quarters.

Two different causes, therefore, must exert an influence in the production of the trade-winds. One is the permanent elevation of the temperature of the parallels lying near the equator over those more remote from it. Its action is indirect and most energetic in the northern parts of the temperate zone. The other is the diurnal increase of the temperature of the earth in all latitudes, in consequence of the passage of the sun over the meridian. Its action is direct within the limits of the trades. That it is adequate to the creation of a considerable wind is proved by the fact, that it is upon this that the other or permanent temperature depends, and that it is what determines the existence of two winds; the land and sea breezes blowing in opposite directions every twenty-four hours. By attending to the phenomena of the trade-winds in different parts of the globe, we may form a tolerable conjecture respecting the one of the two causes which must be supposed to exert a predominant influence in the production of the total effect. In the immediate neighbourhood of the equator, or at a small distance on the north side of it, the cause assigned by Halley, acts almost by itself, and the wind prevailing there appears to be from the east, but much less constant and violent than at some distance on either side. At those greater distances the two causes conspire, and a commensurate effect is observed. It is there that the trade-winds rush onwards with the greatest velocity. Between the latitudes of 30° and 60°, the two causes act in opposition; that assigned by Halley prevails, and there is a predominance of winds from the west.

That the trade-winds are in fact produced by a circulation within their own limits, carried on by vortices in which the motion is westward below, and eastward above, is rendered probable by a number of separate considerations.

(*a*) The definiteness of the boundary by which the trade-winds are limited and separated from currents flowing in an opposite direction, and that they commence at once in full vigour at that boundary, are circumstances of great weight. "Thus in the northern Atlantic, from the same limits whence the north-east trade blows towards the equator, a south-west (or rather west south-west) wind not uncommonly prevails in the contrary direction. So in the southern Atlantic, from the limits of the south-east trade, the prevalent winds are nearly converse, (west-north-west). Now adverting to these winds blowing contrariwise from the same limit, there is difficulty to conceive the origin of either trade, but as derived from upper strata of the atmosphere, and if that source of supply at the commencement be acknowledged, there is little reason for rejecting it in the wind's subsequent progress." This author, however, attributes the trade-winds to the diminution of the air's specific gravity by absorption of moisture.*

(*b*) In the Sandwich Islands, the trade-wind blows from the north-east. Upon the summit of Mouna Kea,† in Hawaii, estimated to be more than 18,000 feet in height, Mr Goodrich, in the month of April, found a wind from the south-west resembling the cold blustering winds of March, in New England‡. On the Peak of Teneriffe, Humboldt, Von Buch, and others, have encountered a raging west wind which scarcely allowed Humboldt to keep his feet. This was in summer. In the winter this west wind descends to the coast§. These facts show that the currents of the upper atmosphere are strictly counter currents, which carry eastward the air, the trade-winds have carried westward. They do not seem to be a mere result of motion

* Colebrooke's Meteorological observations in a voyage across the Atlantic in Brande's Journal, vol. xiv.

† The height of this mountain appears to be a matter of great uncertainty. It would be interesting to know whether the isothermal lines would strike it at the same height that they strike Chimborazo. Circumstances might be mentioned which would have a tendency to depress, and others having a tendency to elevate them. In calculating its height from the condition of the mercury in the barometer on its summit, it is probable that the coefficient employed in Europe would be found inapplicable.

‡ See Silliman's Journal, vol. ix. p. 4.

§ See Von Buch on the Climate of the Canary Islands, in Edinburgh Philosophical Journal for July 1826.

of the air of the equatorial regions towards the pole, but of a gyratory movement in a vertical plane.

(*c*) On Monday the 17th April 1812, the Souffrier mountain on the island of St Vincent, after having remained dormant for more than a century, suddenly emitted a column of smoke, which continued to increase in magnitude and density until Thursday the 30th, when it was accompanied with an appearance of flames and eruption of lava. On Friday the 1st of May, the atmosphere of Barbadoes was darkened by clouds of volcanic sand and ashes, which descended upon the island to the depth of nearly three quarters of an inch. Barbadoes lies at the distance of from 90 to 100 miles east of St Vincent, and the trade-winds blow so directly and violently from the former towards the latter island, that a passage from St Vincent to Barbadoes can be effected only by making a circuit of many hundred miles. Von Buch remarks, that "by this striking occurrence, the returning current in the upper regions was proved, and with it the theory of the trade-winds, for which we are indebted to Hadley, was become something more than conjecture.

It places the existence of the upper current beyond the reach of a doubt, but lends probability to the theory of Halley rather than to that of Hadley, which last supposes the upper current to be directed from the equator towards the poles. In the present instance its course was due east. It is well known that the under current is deflected from its course by islands and projecting shores, but it is not easy to see why Hadley's upper current should be similarly affected. I cannot help suspecting that a vortex had established itself with one extremity on Barbadoes, and the other on St Vincent, and that the ashes were whirled into the air at the latter or western extremity, and brought down to the surface at the eastern *.

(*d*) "On the western coasts of both continents, a wind from the west prevails." † This passage is quoted from a work which, along with much valuable matter, contains a share of inconclusive argument from facts incorrectly stated. These westerly winds are created by a cause, having a close resemblance to that to which the trade-winds are ascribed by Halley. They are un-

* See for the above facts Von Buch, in loc. cit. and Philosophical Magazine, vol. ix.

† Daniell's Meteorological Essays.

questionably movements of the air in vortices revolving eastward below, and westward above*. Their existence proves nothing absolutely, but lends a degree of probability to the accuracy of the views advanced in this paper. Why may not the eastern and western, or trade-winds, resemble each other in their causes, effects, and all the circumstances of their progress?

(e) The coolness and freshness of the air, within the limits of the trades, so much exceeding what might be expected from the latitude, is a proof that it is affected by currents flowing down from above, and altogether incompatible with the idea that they are ground currents, of which the cold returning upper current flows off towards the poles.

"Nothing equals the beauty and mildness of the equinoctial region on the ocean †." "In these winds there is something so exhilarating that one with difficulty believes so much vapour exists as the hygrometer indicates ‡." "The climate of these (the Sandwich islands) is far more cool than might be supposed, judging from their latitude§." He attributes the circumstance to the prevalence of the north-east trade-winds.

(f) The unfrequency of rain within the limits of the trades is another proof of the mixture of the upper and lower strata of the air, by ascending and descending currents. Rain is produced by the sudden mixture of the air of very different temperatures charged with moisture, effected, as there is good reason to believe, by the establishment of a vortex or horizontal whirlwind upon the spot where it falls; but the trade-winds, keeping up a constant circulation and intermixture of the upper and lower strata, there is no opportunity for those sudden changes which produce rain. In accordance with what is here stated, it is observed that such tracts of the intertropical ocean, as from any cause are not swept by the regular trade-winds, are subject to violent rain storms, accompanied by lightning and wind. So long as the monsoons blow regularly in either direction, the same effect is produced by them in the same way as by the trade-winds, but the period of their change is characterized by most violent storms.

* See an Account of the Land and Sea Breezes.

† Humboldt; see also his remarks on the temperature of the air, which are too long to be extracted.

‡ Caldcleugh's Observations in Brazil and on the Equator.

§ Stewart's Journal.

The causes assigned by Daniell for the unfrequency of rain within the limits of the trades, are strange and unsatisfactory. He remarks, first, that it being then only that the aqueous vapour attains its highest elasticity, and rises into the upper current of the atmosphere, it must flow off along with the equatorial wind into the temperate zones on either hand. Grant that it is so, we may answer; the language implies what is known to be a fact; that there is no deficiency of vapour within the limits of the trades; that the whole tract is in truth a great ocean of vapour; why is it not precipitated? why is there so little rain? Because, says the author, "the temperature being remarkably steady, seldom varying more than two or three degrees, precipitation can but seldom occur." But why this steadiness of temperature? Precipitation, evaporation, heat and cold, stand to each other in relation of cause and effect, which produce and reproduce each other in endless succession. Why are there not within the limits of the trades, the vicissitudes of the regions beyond? To say that precipitation seldom occurs there, because the temperature is remarkably steady, is very little more than reasoning in a circle.

(*g*) We seem to witness in the appearance described in the following extract from Humboldt's account of his voyage across the Atlantic in 1799, the effects of a succession of vortices moving westward over the ocean, creating a cloud by a mixture of the upper and lower strata of the atmosphere, and a breeze, by which the vessel was for a short time driven rapidly forward, and then subsiding into a calm.

"The wind fell gradually the farther we removed from the African coast; it was sometimes smooth water for several hours, and these short calms were regularly interrupted by electrical phenomena. Black thick clouds, with strong outlines, rose out in the east, and it seems as if a squall would have forced us to hand our top-sails; but the breeze freshened anew, there fell a few large drops of rain, and the storm was dispersed without our hearing any thunder."—It is by means of these squalls, which alternate with dead calms, that the passage from the Canary Islands to the Antilles or southern coasts of America, is made in the month of June and July*.

* Personal Narrative, vol. ii. p. 5.

Other arguments of less weight might be added to the above, but if these fail of producing conviction, I have no great hope that the others would be regarded as satisfactory, and shall therefore omit them. These vortices may be supposed to be either stationary or moveable, regular or irregular, few in number, and having their horizontal much greater than their vertical diameter, or numerous, and rolling in rapid succession across the ocean. The points where there is either a remission of the breeze, or a calm, will of course mark the separation of an individual from that which succeeds it.

The theory here advocated requires the prevalence in the latitude of the United States, of a westerly, or rather north westerly wind, proceeding from the higher regions of the atmosphere. That westerly winds predominate over the easterly in both hemispheres, between the 30th and 60th parallels, is shown in a preceding page. That the north-west winds of the United States descend from the higher regions of the atmosphere, is proved by President Dwight, with his usual ability, in a passage copied from his travels, into the 8th volume of this Journal, to which the reader is referred. The progress of scientific discovery, and especially the discovery of the immense power of radiation to cool the surface of the earth, has deprived some of his arguments of a part of their value, but the weight and force of the greater number remain unimpaired.

On the Navigation of the Maranon or Amazons. By Lieut. H. Lister Maw, R. N.* In a Letter to Professor Jameson.

Sir,

I have lately seen the short but very interesting account of improvements in the navigation of the Mississippi contained in the number of your Journal for June. The picture of that river in the year 1808 is so admirably drawn, and corresponds so much with what is at present the case on the lower part of the Maranon, that it made me feel somewhat uncomfortable

* Lieut. Maw is author of the interesting work entitled, "Journal of a Passage from the Pacific to the Atlantic, crossing the Andes in the Northern Provinces of Peru, and descending the Maranon or Amazons."

whilst reading, almost fancying myself embarked on board the river-craft between the Rio Negro and Para.

What is now the state of communications, &c. on the Mississippi might, in the course of a few years, be effected on the Maranon. I have visited professionally the East and West Indies, and the countries on the Pacific, and a strange sort of fortune, added to a sense of duty and desire of distinction, brought me down the Maranon from its sources to its mouth. From what I have seen, I do not hesitate to say that the countries through which the Maranon runs, especially the immense province or region of Para, are naturally the richest in the world in vegetable productions. In descending the river, and before reaching the Rio Negro, we landed daily to cook. Sufficient room could scarcely be got for making the fires, without clearing away plants, in general valuable in commerce, for instance cocoa, various dye plants, sarsaparilla, indigo, vanilla, spice plants, and many others, the properties of which are still unknown; and it is almost needless to say, that coffee, sugar, and other tropical productions, not excluding cotton, might be cultivated to any extent.

There is at present no steam-communication on the Maranon, and it appears extraordinary that a country naturally so rich, and affording such facilities for communication, should be the last to be made available. During the time that Brazil, like the Spanish provinces, was kept in a state of blockade, and prohibited from European communication, the British Government are said to have avoided pushing communications which the connection between Great Britain and Portugal might possibly have enabled them to form, up the Maranon, lest a road should also be opened for other nations. Now that the country is comparatively thrown open, it is neglected by England, whilst France and the United States reap the principal benefit. If, however, the West India islanders were to fulfil the threats they hold out, of separating from the British Government, it would soon be found that they would be undersold and superseded by produce from these regions, for it is undoubtedly the protection and advantages given to West India produce that at present enables them to compete; and, although the proprietors of West India estates would, in such a case, certainly suffer, it is perhaps a question whether the demand for and consumption of British manufactures would not be increased by the market that would be created, whilst what has hitherto been termed "Colonial produce" would be obtained at a cheaper rate in England, and West India slavery would cease.

There are, however, other productions in these regions than those the West India Islands can furnish, as was proved by the establishment of the British factory in Portugal, during the zenith of West India influence, and in the time of the slave-trade, and which was principally for the purpose of communicating with Brazil.

The most immediate point for the consideration of England in regard to these regions appears to be, whether she will endeavour to avail herself of a portion of the advantages which a communication may afford, or will leave them entirely to others.

I am aware that the failure of many speculations in South America, owing partly to false grounds of establishment, and partly to mismanagement and over expenditure, has given a check to the formation of companies; but I nevertheless believe that if a company were formed, to open a steam-communication up the Maranon, it would, with proper management, both pay the shareholders, and prove highly beneficial to the country, whilst it would tend to extend the commercial relations to Great Britain, by opening new markets for her manufactures.

Let it not be supposed that what I now state proceeds from interested motives. It would, I confess, be an object worthy of any man's ambition to lead the first steam-vessel up the Maranon, and thereby contribute to the development and improvement of such a country. It is a feat that will be related in history, and handed down to posterity. I am not without ambition, but I have already had more than enough of South America, having incurred risks, and expended health and property to meet but a sorry return. Still, I repeat, that the regions of the Maranon possess immense commercial resources, and should other persons choose to avail themselves of such advantages, I offer them the information I obtained in the country.

Should a company be formed for the purpose of opening a steam-communication up the Maranon, it would be necessary, in the first instance, to obtain the sanction of, and perhaps a charter from, the government of the country. The company should, I think, consist partly of natives. The spirit of monopolization that has hitherto marked the general proceedings of Europeans in and towards South America, and from which our own countrymen have not been altogether exempt, has, I conceive, been one very principal cause of the failures of many South American speculations. There are several persons resident in Para, who possess considerable property, and who, I think, would be far from objecting to become shareholders in such a company. By including them, it would not only be the most just and honourable mode of proceeding, but most likely to promote the interest of the company, as the natives would naturally apply the interest which they possess in the country, whilst they would derive the benefit of British or European capital and intelligence.

At first two vessels might be sent out, of about a hundred or a hundred and fifty tons burden, to ply the Rio Negro and Para, a distance that is estimated at about twelve hundred miles. There would, I think, be employment sufficient for two such vessels at present, and as they improved the commercial relations of the country, which in all probability they very soon would do, their places might be taken by vessels of a superior class, and these might be sent to feel their way up the higher Maranon or Rio Negro.

The fewer Europeans sent out in the vessels the better, as they are expensive and unaccustomed to the climate and country. Engineers would of course be required ; but there are persons who are masters of some of the river-craft at Para, and who being to a certain extent pilots for the river, would be the best as mates or pilots, or whatever else they might be called, perhaps letting the engineer have charge of the vessel. The river-craft at present working on the lower parts of the Maranon, have a sort of a house built above the deck, in which the men live, and in which part of the cargo being bulky but light, as for instance sarsaparilla, is stowed, and it would perhaps be well that something similar should be fitted to the steam-vessels, and taken out in frame, to be put up at Para.

There is a bed of coal high up the country through which the Maranon runs, but not fit for use, so that unless coals were sent out, wood must be depended on for fuel; it is superabundant on all parts of the river's banks, but as there is a certain acid which proceeds from wood in burning, and which is liable to affect the boilers, it would perhaps be necessary that those parts of the boilers exposed to the immediate action of the furnace should be stronger or thicker. Wood has been, however, and is still, used in different parts of the world as fuel for steam vessels.

There would not be difficulty as to depth of water. I sounded down to the Brazilian frontier, beyond which I should not have been permitted, and found that from St Joaquin de Omaguas, where there is a remarkable basin of still water, with 9 to 13 fathoms depths between two currents, and which would form a fine harbour. There is water for vessels of almost any class. It would of course be necessary to keep clear of the *sawyers*, &c.; but as they have been avoided on the Mississippi, so they might on the Maranon.

It has been objected, and it is true, that there is at present scarcely any population above the Rio Negro; districts are unoccupied that might be taken possession of by any one, provided the government of the country did not object, which they would scarcely be likely to do, as it is the evident advantage of all governments to bring their territory into cultivation. There is, however, sufficient population to employ two such vessels as I have mentioned below the Rio Negro, and was a steam communication once opened I think there would be above. My reasons for thinking so, are: by mismanagement and ill-treatment, the Indians have been driven from the banks of the Maranon, where, from the advantages that were afforded in obtaining food by catching fish, &c. they were formerly more numerous, into forests, where they have probably decreased in numbers, and become more savage.

Europeans or Brazilians who have been educated, and who can obtain the means of living in civilized countries, do not in the present state of these regions choose to be banished there. But let a steam communication once be opened, and the case will be altered; merchants, and a superior class of settlers, will then know that they can not only send their produce, and receive regular supplies, but if they please, can leave without difficulty;

order and a different mode of proceeding will be established; and the Indians, finding themselves differently treated, and obtaining superior advantages, will come from the forests as they did in the time of the Jesuits. Moreover, those now employed in the tedious and inefficient navigation may be employed in agriculture.

I have said that settlers might take possession of *districts*, provided the government which claims dominion did not object. No person will, I fancy, contradict this. Nevertheless, as particular facts are more satisfactory than general statements, I shall give an example.

On our way down the Maranon, and about 1500 miles above Para, we visited a lake called Prixelana, the fish-lake; its waters were clear and dark, and abounded with fish, whence it derived its name. It was about a league in length, and half a league across, communicating with the Maranon by a navigable channel, about three qnarters of a mile long, and 60 or 70 yards broad. The banks were high and healthy, and were not much troubled by musquitoes. This district had been taken possession of about theee years before, by a family who were living much in the style of the patriarchs. The father was a fine, stout, healthy looking person, of about fifty years of age; there were numerous children, of various ages and sizes, all of whom appeared healthy, and were remarkably handsome. The eldest daughter was married to a Portuguese, who had got up the river, and was settled on the opposite side of the lake, but who did not appear equal to his father-in-law. The old man gave a favourable account of his position during the time he and his family had been settled there; they had cleared away considerable spaces of ground, and had cultivated mandioca, a root used instead of bread, coffee, tobacco, cotton, and latterly indigo, which they intended to manufacture. Finding their circumstances improve, they were building a house on rather a large scale, having a store at one end, a platform for drying cotton, cocoa, and coffee at the other, and a thatched veranda in front. When not employed in their plantations, they went into the woods to collect wild cocoa, which is considered better than that raised by cultivation, sarsaparilla, &c.

It must not, however, be supposed, that this family had

had no difficulties to encounter. No country, however rich, is brought from a state of nature into cultivation without overcoming difficulties, a point that appears not to have been sufficiently considered by settlers in general, and especially by English settlers, the consequences of which have been disappointment, and sometimes destruction. His family had been fortunate in the choice of their position, and there are undoubtedly numerous positions in those regions, that might be brought into cultivation, with less difficulty than in most other countries, and, in a lucrative point of view, would repay exertions better. But still there are difficulties. Musquitoes, ants, and other insects, are in general troublesome; wild beasts, reptiles, and alligators, have to be destroyed, although, upon the whole, they are not so dangerous as they are generally supposed to be. The rains during a particular season are very heavy, and there are not the same conveniencies of communication as in old civilized countries, although the water communication of the Maranon and its tributaries affords great facility.

It is not impossible, and perhaps not improbable, that the provinces of Maranon and Para may separate from the rest of Brazil. Previous to the Royal family going over from Portugal, these provinces had a separate governor-general, owing to the distance and difficulty of communication between them and Rio Janeiro, which indeed amounts to a barrier. When we were in the country, one of the principal persons we met, remarked, that the province of Para was large enough to form an empire, or have a government of its own. In point of extent, such is certainly the case, but the province of Para is at present far behind in population and civilization. Was it not for the jealousy which unfortunately for both parties has sprung up between the Portuguese and Brazilians, Portugal and Para might still derive mutual advantages from communication. There is room enough in the immense unappropriated regions of Para for all the Portuguese in Europe to locate themselves, without injury or inconvenience to the present inhabitants. Europeans must, however, remember that the South Americans will no longer submit to the arbitrary domineering measures that have been exercised towards them. The title of "Mea branco" is indeed still considered too much an authority for exercising outrages on those who do not possess it, but a South American is now no longer ashamed of owning his country.

Perhaps, upon the whole, the animosity that exists between the Brazilians and Portuguese is not so vehement in the province of Para as in other parts of Brazil.

I cannot close this paper without remarking, that on my return from my expedition down the Maranon, I presented nearly fifty specimens of natural productions, &c. to the Adelphi Society of Arts, Manufactures and Commerce. They were, it is true, little more than rubbish, when viewed in any other light than that of specimens, but they were specimens, and as such had been collected by me with no small trouble. Whether the Adelphi Society have examined them, they can themselves best state; whether my specimens from the Maranon were beneath their notice, subsequent events will probably prove. They have been civil, and have bestowed upon me one of their silver medals, for what they are pleased to call a "pigment;" but when I last inquired, several of the specimens of natural productions were said to be still "unknown."—Your obedient servant,

H. LISTER MAW, *Lieutenant* R. N.

ATHENÆUM, LONDON,
September 24. 1831.

Remarks on Thermal Springs, and their Connexion with Volcanos. By CHARLES DAUBENY, M. D. F. R. S., Professor of Chemistry in the University of Oxford. Communicated by the Author.

DURING my residence at Geneva in 1830, I communicated to the Natural History Society of that city, which had done me the honour to enrol me amongst its members, a brief statement of some observations which I had at different times made, respecting the disengagement of azotic gas from various warm springs.

Although the memoir alluded to has since been inserted in the Bibliotheque Universelle, and has from thence found its way into Boué's Journal de Geologie, yet, as no notice has been taken of it in any British Periodical, and as the conclusions to which it leads seem intimately connected with some former inquiries of my own, which, though of a different description, had reference, nevertheless, to the subject here under consideration, I shall make no apology for embodying the substance of this communication, together with the results of the latter inquiry, in the following remarks on the general relation subsisting between the phenomena of thermal waters and those of volcanos.

In the treatise which I published on the latter subject in 1826 *, my attention was principally confined to phenomena attributed, as it were, by universal consent, to the agency of volcanos; so that, in attempting to account for their operations, I kept for the most part out of sight those effects, concerning the origin of which a difference of opinion might obtain.

I therefore excluded from my consideration the phenomena of warm springs, not having at that time collected sufficient data to satisfy myself, whether they ought, generally speaking, to be attributed to the same deep-seated cause, as that which was supposed to occasion the eruptions of a burning mountain.

Feeling, however, that my undertaking must be considered incomplete, until the question as to hot springs had been set at rest, I have at intervals employed myself, ever since the publication of the volume alluded to, in collecting facts, either from personal observation, or the researches of others, calculated to throw light upon the natural history of the latter. Of these inquiries, the results most connected with the question here alluded to may be divided into two heads; the former having reference to the physical and geological position of thermal waters; the latter to the gaseous products which accompany them. And whilst the former, by associating their exalted temperature with the general cause of subterranean movements, serves to give a degree of extension to volcanic operations throughout the globe, which we should otherwise be little disposed to admit, the latter lends, if I mistake not, an additional testimony in favour of that mode of accounting for their existence, which, in the treatise alluded to, I have attempted to confirm, by shew-

* Description of Active and Extinct Volcanos. London, 1826.

ing how completely all the phenomena that accompany the different stages of an eruption, or which are consequent upon it, may be explained on the principles of the theory which I have therein adopted.

If we examine the geological position of the thermal springs most accurately known to us, they will be found situated, for the most part, in one of three positions; either in the vicinity of active or extinct volcanos; or, secondly, in the neighbourhood of some one of those chains of mountains, which, according to a prevailing theory *, have been uplifted by some violent action, which took place underneath them since their materials were originally deposited; or, thirdly, in some position, which, though remote from any of these leading systems of elevation, exhibits, either in its individual aspect, or in the general configuration of the surrounding country, marks of certain physical convulsions. Some, indeed, of these warm springs are so placed, as to combine all these three conditions, and many more unite in themselves both the second and third; but, without pausing to estimate the force of that accumulation of evidence which in these cases is afforded, I shall merely give some examples of springs met with in these different positions, and consider how far we shall be justified in assigning to each class a volcanic origin.

The first of these, indeed, need not detain us long, for it is well known, that every system of volcanos with which we are acquainted has its range of hot springs contiguous, and that not only Vesuvius and Hecla, which are in an active condition, evince in this manner an unceasing energy, even during the periods of their apparent intermittence, but that the volcanos of Hungary, or of Bohemia, which, from a time anterior to all history have appeared to be dormant, still retain these indications of continued vitality. Neither can it be doubted that the cause, which maintains the temperature of these springs at present, is the same as that which gave birth to their eruptions primarily; for there is not a more unbroken line of connexion between the active volcanos still existing in Sicily and in Campania, and the extinct ones recognised in France and Hungary, than that

* See Mons. Elie de Beaumont's Recherches sur les Revolutions, &c. Annales des Sciences Nat.

which may be traced from the Geysers of Iceland, to the nearly boiling waters connected with that dormant volcanic action, which we observe in some spots in the neighbourhood of Naples, and from thence, again, to those of somewhat more moderate temperature, which issue from the trachytic and other ignigenous rocks of Mont Dor in Auvergne, or of Glasshutte near Schemnitz. In such cases as these, the combined weight of evidence derived from their temperature, their geological position, and the nature of their gaseous products, appears almost irresistibly to establish a volcanic origin.

I proceed, then, to the second class of hot springs, those connected with ridges or chains of mountains, which are generally regarded as produced, in consequence of the strata composing them having been lifted up into their present highly inclined position, from one more nearly approaching to an horizontal one, by some cause acting from beneath.

Perhaps there is no chain which affords a fairer illustration of this class of springs, than the Pyrenees, these mountains being, along the whole extent of their northern declivity, accompanied by a succession of thermal waters, which from their supposed medicinal virtues have long attracted attention.

Now, if we assume the elevation-theory as applicable to this system of mountains, we might expect to trace a continuance of that volcanic action, which originally produced these effects, any where within the limits of the chain, where the valleys had been excavated to a depth sufficiently great to bring us nearly into contact with the central granite, or, more correctly speaking, the radius over which the force in question had been exerted in its greatest intensity. Hence we might reasonably look for hot springs even at a distance from the axis of the chain, in gorges cut to a great depth through the strata; whilst, near the axis, we should be prepared to meet with them bursting out occasionally even at a considerable elevation. Thus the distance of Bagneres di Bigorre from the axis of the chain does not prevent the occurrence of thermal waters in this locality, the valley from which they issue being at a low level; neither does the elevation of Barege occasion its springs to come out cold, because, from its situation near the centre of the chain, the source of the heat may be presumed to lie almost immediately underneath it.

Nevertheless the occurrence of hot springs is rendered more probable where both these conditions concur; and hence we shall generally find, that in mountainous tracts they are placed in gorges which lie at a comparatively low elevation. Thus M. Delarive has observed in the Alps, that the hot baths of St Gervois are situated exactly on the spot which, of all others, combines most completely the conditions, of approaching in the nearest degree to the centre of the chain, and being at the same time least elevated above the level of the ocean.

Another very probable position for a thermal spring is near the line, at which the elevation of a chain of mountains appears to have commenced. Thus the springs of Dax, in the Department des Landes, of Oleron near Pau, of Capvern near Bagneres, of Encausse near St Gaudens, &c. occur near the line at which the mountains of the Pyrenees begin to rise from the plain, the boundary, as it were, between the rocks that have been uplifted, and those that were subsequently deposited.

It is remarkable, that the hot spring of Aix, in Province, gushes out just about the point at which the line of elevation belonging to the Pyrenees would be intersected by another line that should represent the elevation of the Dauphiny Alps,—a position in which the chances of volcanic agency manifesting itself are of course doubled. The contiguity, also, of the baths of Aix to some remarkable dislocations of the strata has been already pointed out by Messrs Murchison and Lyell, in their memoir on the fresh-water formations of that district *, so that here the third condition laid down as favourable to the appearance of thermal waters concurs with the second.

The particular circumstances connected with the geological position of many thermal waters in Rousillon seemed also, so far as I could judge from the cursory attention I was able to bestow upon them last autumn, calculated to confirm that opinion of their volcanic origin, which their general position, near the base of an elevated chain of mountains, suggested. In several cases, as at Aleth, Rennes, and Campagne, a change of dip seemed to occur just where the springs burst out, coupled, in the case of Aleth, with the fact of the gorge, through which the river Aude passes just before it reaches the locality of the spring, being

* Edinburgh New Philosophical Journal, No. 21.

highly abrupt, and placed at right angles to the general direction of the valleys contiguous; circumstances which, taken together, suggest the idea of violent action having occurred in the vicinity of this spring.

At St Paul de Fenouilhedes, on the road from Carcassone to Perpignan, near the town of Caudies, a warm spring, having the temperature of 22° Reaumur, gushes out from the bottom of a vertical cleft or fissure in the range of hills which bound the valley to the west. It is evident, both from the extreme narrowness and depth of this cleft, that water has not occasioned it; and the appearance of the rocks on either side shews that they have been acted upon by violence. At a little distance both to the north and south of the spot at which the cleft occurs, the limestone rock capping the ridge pursues an almost horizontal direction, and a series of schistous strata, consisting of gritstones and marls, is seen underneath it, occupying nearly the same level for a considerable extent. But the calcareous rock just mentioned, when it approaches the cleft on either side, suddenly sinks downwards so far, that the subjacent schists in consequence altogether disappear, and the limestone is brought down to the lowest level of the valley; thus demonstrating, that the formation of the fissure was accompanied by a very considerable dislocation of the strata in which it occurs. (*Vide* Pl. III. Fig. 2.)

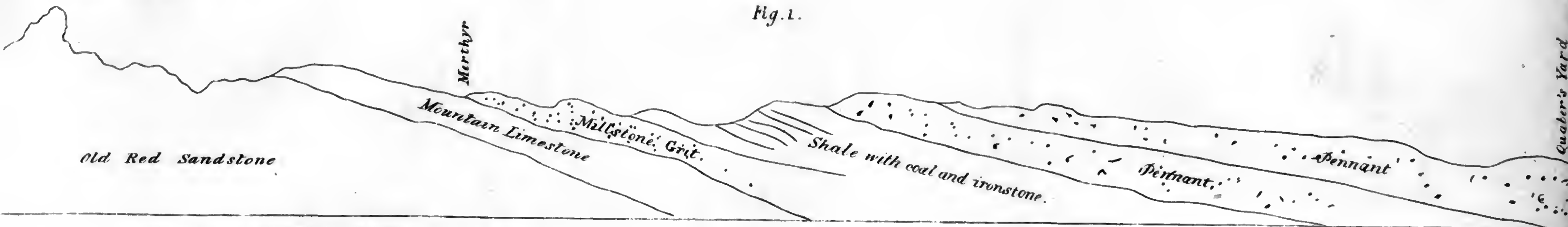
It may be asked, whether, besides that general suspicion of volcanic agency which many geologists are apt to entertain in the case of all uplifted chains of mountains, there are any phenomena observable in the Pyrenees which particularly point to the operation of the same cause? To this it may be replied, that on the Spanish side, the extinct volcanos of Ollot in Catalonia, and on the French, those that occur at Agde, near Montpellier, and in various parts of the Cevennes, seem connected with the same system of causes.

Earthquakes also, according to M. Palassou *, are frequent in all parts of this chain, though most destructive on the Spanish side, where, it is to be observed, hot springs are rare. Nevertheless, even at Bagneres de Bigorre, several houses were thrown down by an earthquake that occurred in 1660, at which

* Nouvelles Memoires pour servir à l'Histoire Naturelle des Pyrenees.

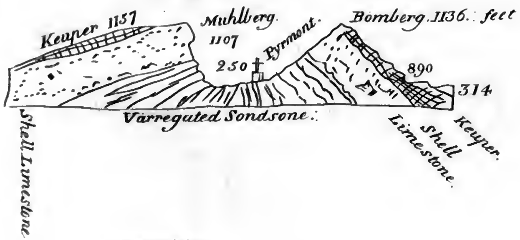
SECTION FROM CARDIFF TO THE BEACONS OF BRECON BY THE REV.D MR CONYBEARE.

Fig. 1.



Section of Circular Valley of Elevation at Pyrmont

Fig 3.



Section at St Paul de Fenouilhedes.

Fig. 2.

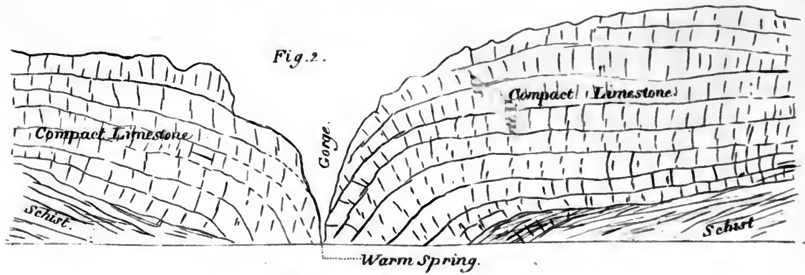
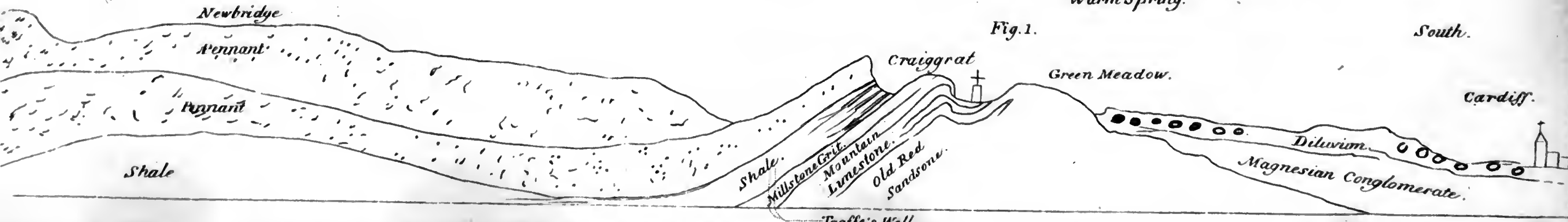


Fig. 1.



Section continued from Quaker's Yard.

time the hot springs became suddenly cold. It has been remarked, that the earthquake which was experienced on the 25th of May 1750, had for its central point the neighbourhood of the Pyrenees; for nowhere were its shocks so violent, or the damage occasioned by it so considerable, as in that chain, especially in the valley of Lavedar. The village, in which occurs the thermal spring called *Eaux chaudes*, seems particularly exposed to this visitation. In the case of the most recent of these earthquakes, that of the 22d of May 1814, it has been remarked that the direction of the shock was nearly parallel to that of the chain itself.

The constitution of the thermal waters of the Pyrenees is such as to confirm the idea of their being connected with volcanic operations. It will be seen by reference to my Description of Volcanos, page 376, that the gases resulting from the operations which occasion them, are muriatic acid, sulphurous acid, sulphuretted hydrogen, carbonic acid, and nitrogen; but that of these, muriatic acid and sulphurous acid are chiefly emitted during a period of vigorous action, whilst sulphuretted hydrogen, carbonic acid, and nitrogen, generally make their appearance when the process is in a more dormant condition. Now it is important to observe, that, according to Longchamp, a chemist expressly appointed by the late government of France to examine the mineral waters of that kingdom, azotic gas is disengaged, often very abundantly, from every thermal water found in or near the Pyrenees, and that sulphuretted hydrogen, though of rare occurrence at the foot of these mountains, is almost universally present in the hot springs that make their appearance near the axis of the chain.

The local position, therefore, no less than the gaseous contents, of most thermal waters in the Pyrenees, tend to confirm the opinion, which their occurring at the foot, and in the bosom, of an uplifted chain of mountains would of itself lead us to entertain; for although the cause of the elevation of extensive tracts of country partakes of the uncertainty, belonging more or less to all those effects, which have never been witnessed during the period of their accomplishment, yet when we perceive that the most analogous phenomena of which we have any experience are attributable to earthquakes—themselves volcanic phenomena,

—and that the forces seen in operation during a volcanic eruption are such as, if developed on a larger scale, would be fully adequate to produce such results, we cannot but regard it as most philosophical to look upon the elevation of these chains as the effects of those same forces, which give rise to volcanos in the present day.

The same kind of reasoning, which has been applied to the springs of the Pyrenees, might be extended to others similarly circumstanced, as to many at the foot of the Alps, those near the Riesengebirge in Silesia, and perhaps those described at the foot of the Caucasus.

There are, however, many hot springs in various parts of the globe, which lie too remote from any of these great systems of elevation, to be attributed with any degree of probability to such a cause.

Those of Bath, Clifton, and Buxton, are prominent instances of this kind, and the apparent absence of any indications of volcanic agency of a recent date in their neighbourhood, led me, in my work on Volcanos (p. 363), to conclude, that their heat must be accounted for by other causes of a more local nature.

A farther examination has since, however, convinced me, that in many of these instances also, the spots in which they are found exhibit proofs of violent convulsions having, at some period or other, taken place in their vicinity.

Now if such a conclusion can be borne out in a great majority of cases, it would seem hardly consistent with sound reasoning, to assign to this class of springs a different origin from that which we have been led to attribute to those found in the two former kinds of situation.

A good illustration of this is supplied us by the spot, whence issue the hot waters of Carlsbad in Bohemia. These are described by a very judicious observer, Von Hoff, as issuing from the bottom of a narrow glen, which several circumstances would incline us to attribute to the effects of some great natural convulsion, rather than to the operation of ordinary causes. Thus, although the direction of the defile in which the hot springs occur is from east to west, yet the valleys into which it opens at either extremity run from north to south; so that there seems an equal difficulty in referring it to the agency of any mighty mass of waters, such as that by which the contiguous rocks may have been affected, as to the more gradual working of the stream, which at present traverses it in its way from the upper to the lower longitudinal valley just mentioned. The extreme narrowness of the glen itself, which in some places does not exceed 150 feet, and the greater abruptness of the rocks by which it is flanked, than of those found elsewhere in the same neighbourhood, are facts, which tend to separate its origin from that which we should assign to the generality of the contiguous valleys, and which speak strongly in hehalf of our considering it as occasioned by some sudden violence.

The nature of the rocks themselves also favours the same conclusion. High up on either side of the valley, they are composed of granite, but towards its bottom, wherever the nature of the substratum is not concealed by the calc-sinter which the springs at the present time deposit, they are found to consist of breccia, made up of fragments of the granitic rock, cemented by infiltrations of siliceous or calcareous matter. As this breccia is not found elsewhere, we have strong reason for supposing the material of which it is made up, to have been torn from the granitic rocks adjacent, at the very time when this fissure was occasioned. The alteration observed in the nature of the cementing ingredients, is consistent with what we observe in hot springs of unquestionable volcanic origin, in which it is found, that silex is held in solution when the action is recent and energetic, but gradually gives place to calcareous impregnations as the latter becomes more languid.

Still more remarkable is the gorge out of which gushes the hot spring of Pfeffers in the Grisons, a fissure, says Ebel, from 400 to 664 feet in depth, so perpendicular, that the provisions required for the inmates of the bath are lowered from ropes attached to the summit of the cliff, and so narrow, that the rocks in some places touch overhead, and nowhere perhaps are more than thirty feet apart. M. Ebel remarks, with reason, that such a phenomenon cannot be attributed to the river which now flows through the glen, but accounts for it by the action of some larger body of water that once swept over the country,—a position in my judgment just as untenable. The only possible explanation of such a phenomenon is to be found in some convulsion of nature, such as that caused by an earthquake, or the sudden elevation of a large tract of the country.

Now, that a great change has taken place in the physical tructure of the country near Pfeffers, would seem from the fact, for which I may quote the authority of Ebel, that the Rhine, instead of flowing, as it now does, almost due north to the Lake of Constance, was at one time deflected to the east in the direction of the Lake of Wallenstadt, owing to the barrier that originally existed at the pass of St Lucia, where the mountains present the appearance of having been riven asunder by some subsequent violence. For the evidence in support of this I must refer to M. Ebel's work.

The other hot springs in Switzerland appear under circumstances for the most part similar. Those of Weissenburg, in the Canton of Berne, rise out of a gorge of the same kind as that of Pfeffers; those of Loueche appear at the foot of the mural precipice of the Gemmi, in the midst of indications of great confusion; whilst the spring of Baden, in the Canton of Argovie, from which that of Scinznach is not far removed, lie near the point where, in consequence of the two mountains of Staffelegg and Lagern having been severed asunder by some great convulsion, the waters of the Rhine and of the other rivers, which appear to have constituted a single lake, extending from Coire in the Grisons to this mountain ridge, including the Lakes of Zurich and Wallenstadt, with the intermediate country, in one continuous sheet of water, flowed off by the channel now taken by one of the rivers, the Limmat, alone. Thus the Rhine may be supposed to owe its original direction to the event which produced one hot spring, and its present course to that which occasioned another.

If we turn from the hot springs of the Continent to those of our own country, we shall find them, in the majority of instances, connected with proofs of similar convulsions.

Such appears to be the case with regard to that of St Vincent's rocks near Clifton. We have the authority of Messrs Buckland and Conybeare for considering the defile from which this hot spring issues, and which turns the river Avon aside from the valley leading through Long Ashton and Nailsea to the Bristol Channel, conducting it through the limestone chain of Leigh Down into the Severn, as the result of some internal derangement in the strata brought about by disturbing causes of great antiquity.

Every one who has been to Matlock, will have recognised the great similarity between the character of the gorge, out of which its tepid springs issue, and that of St Vincent's rocks near Bristol. But the researches of geologists have shewn, that this resemblance is not merely confined to the surface, and that more decisive evidence of disturbance may be collected from the structure of the rocks which form these precipices. Mr Whitehurst, many years ago, pointed out the existence of a great fault in the valley of Matlock, produced by the limestone and toadstone strata being tilted up in a westerly direction to that degree, as to occasion them to rise abruptly to the summit of Masson Low*. This elevation was productive of a fracture in the above rocks, near the place where the river Derwent now flows, the upper bed of limestone on the western side of the valley being brought down below the second bed on the east, and the first bed of toadstone on the one side being parallel to the second bed on the other. The connexion of this tepid spring with the cause of this dislocation will be further corroborated, if we may be permitted to give credence to the observations made subsequently by Mr Farey†, who professes to have traced this same fault from its commencement at Cromford, below Matlock, into Staffordshire, and from thence northwards as far as Buxton, where it was particularly examined during the building of the Crescent, and was found to pass through the spot from whence the thermal water isssue.

But if Mr Farey is to be believed, these are not the only warm springs that occur near this fault, for the latter, according to his statement, stretches from Buxton in a north-westerly direction to the village of North Bradwell, where is another spring having the temperature of 58°, and appears to terminate at Litton near Tideswell, about a mile from Stoney Middleton, where there is a third spring which raises the thermometer in the coldest weather to 64°.

* See Whitehurst's Theory of the Earth, Plate 2.

† See Farey's Derbyshire, vol. i. on the great limestone vault; and his map of the county, in which the line of faults is traced.

The only other springs in Derbyshire, which appear to be at all elevated above the medium temperature of the climate, are one in Stoke Park, which, being little more than a mile from Stoney Middleton, may possibly be influenced by the same cause as the former, and one in the town of Bakewell, which, though not actually upon a fault, is in a manner encircled by one, which, according to Mr Farey, sweeps round from Beely, on the south-west of Bakewell, to Alport, thence to Over Haddon, and terminates north-west of Bakewell, near to Baslow.

But the line of faults, and the country contiguous to them, seem in Derbyshire to be peculiarly favourable to the rise, not only of thermal springs, but also of carbonated or petrifying ones, as will be seen by the list given of the latter by Mr Farey, in page 458. Of these, it may be observed, by reference to his map, that nine out of twelve lie either upon the great limestone fault, or very near it, viz. that of Alport near Yolgrave, Brassington near Wirksworth, Cressbrook Dale near Litton, Matlock Bath, Monk's Dale west of Tideswell, Slaley in Bonsal Dale, Tideswell, and Wormhill. We must also not forget, that these springs occur in a country, which, at some remote period, has been the scene of decided volcanic action; and that, from what we know of the long continuance of such operations in other parts of the world, it would be rash to assign a limit to its duration in Derbyshire, or refuse to attribute the phenomena of its springs to such a cause, merely because it has not manifested itself in an energetic form since the period of the mountain-limestone-formation.

The connexion of carbonated springs with faults has likewise been observed in other parts of England. My friend Mr Phillips of York informs me, that he has noticed a series of petrifying springs, of which Knaresborough is the most noted, coinciding with the direction of a great fault which he has traced through a part of Yorkshire. The connexion of carbonated waters with dislocations of the strata has, however, been still more satisfactorily traced in Germany, where they have been found to issue from what have been termed *circular valleys of elevation*, that is to say, valleys, which are, or appear at one time to have been, enclosed by escarpments, the strata dipping away in all directions from the centre towards the circumference. Several valleys in Westphalia exhibit this remarkable structure, but none more strikingly than that in which the cold chalybeate of Pyrmont is situated. In this instance the rocks are composed of the variegated sandstone, the muschelkalk limestone, and the keuper, which are seen overlapping each other in the hills bounding the valley, but dipping in opposite directions on opposite sides of it, so as to present every where escarpments fronting each other. From the bottom of the valley, carbonic acid is constantly issuing in large quantities, impregnating the springs of water, and accumulating in dry pits and caverns. The valley of Dryburg, and other spots in the same country, noted for the occurrence of cold carbonated springs, exhibit a similar conformation of their strata. (*Vide* Pl. III. Fig. 3.)

Professor Buckland, in his Memoir on Valleys of Elevation, published in the Transactions of the Geological Society*, had previously pointed out the occurrence of such valleys in this country; and it is remarkable, that the most important of our chalybeates, that of Tunbridge, is found in this kind of situation. Now, the relative position of the strata in these valleys just as obviously suggests the idea of their having been affected by some convulsion of nature, as the highly inclined rocks of alpine countries; and it is impossible to conceive, either that they could have been deposited in the first instance at so high an angle, and with such a variety of dip, or that there should have been such a coincidence between the elevation of their escarpments on the opposite sides of the valley, if the beds had not been once in continuity. This inference is further corroborated by observing that carbonated springs are the common, and perhaps the almost universal, concomitant of volcanos, especially of those called extinct. Thus, they abound near Bonn and Coblentz among the extinct volcanos of the Rhenish provinces, and in the mountains of Nassau contiguous. The same country, too, it has been observed, which throws out hot springs at a low level, or at a point more contiguous to the supposed focus of the volcanic action, affords cold carbonated ones at a higher level, or at a point more remote. Thus the hot springs of Ems and

* Vol. ii. New Series.

Wiesbaden are found near the base of the Taunus Mountains, whilst the cold effervescing ones of Schwalbach and Fachingen occur higher up in the same chain; thus, too, the same district which gives rise to the thermal waters of Aix la Chapelle, furnishes the chalybeates of Spa near the summit of the hills above. This renders it probable, that such carbonated springs may in reality have acquired warmth from the focus of the same volcano, which served to heat the thermal waters of the low country, but that they have been robbed of this excess of temperature by passing through so much greater an extent of rock.

The only warm spring in England, which has been passed over in the preceding enumeration, is Bath, and this, though not immediately connected with any signs of disturbance, occurs, if I am rightly informed, in the vicinity of several large and extensive faults*. The warmth of this spring has indeed been attributed to the decomposition of pyrites, in which the lias clay, from whence it issues, abounds; but to this it may be objected, that the same stratum, though equally charged throughout with this mineral, nowhere else throws out springs possessing more than the medium temperature, and yet the sulphuretted hydrogen which the latter so frequently contains, shews a decomposition of pyrites to be going on in several other places. Neither do the Bath waters manifest any traces either of sulphur or of sulphate of iron, both which ought to be present, if their heat arose from the cause assigned.

The only thermal water known to exist in Wales is in the valley of the Taafe, about six miles north of Cardiff, Glamorganshire; and it will be seen by reference to the geological sketch (Pl. III. Fig. 1.) of this district*, with which I was some time ago favoured by Mr Conybeare, that its position is near the point, at which the beds of pennant, of shale, of millstone grit, and of mountain-limestone, begin to rise at a considerable angle towards the south. Thus, the occurrence of a fault, or a dislocation of the strata, at a spot where they appear to be inclined at so high

* I believe I may quote Mr Lonsdale, Secretary to the Geological Society, in support of this assertion, and it is well known that I could not appeal to any one more thoroughly acquainted with the stratification in the neighbourhood of Bath, than that gentleman.

an angle, if not established by observation, is at least not an improbable circumstance.

Should, then, the geological position of warm springs in general be such, as, in conjunction with other facts, lends countenance to the idea of their connexion with volcanic phenomena, the subject will acquire a much more universal interest than it had before, from the vast extension which it will give to the range of such operations manifested in different parts of the globe.

It will, then, be no longer considered necessary, to appeal exclusively to the effects observed in such spots as Etna or Vesuvius, when the hot springs met with in every country in Europe will afford us indications of a similar kind; neither shall we regard volcanic action as an exception to the other forces of nature, by imagining it to be exerted only in a few particular spots, and exclusively as an agent of terror and destruction.

The hurricane of the tropics, which roots up trees, and overwhelms houses, differs in degree only from the gales of more temperate regions; the earthquake, though really formidable in a few countries only, is experienced more or less in all parts of the globe; and the aurora borealis, which brightens up the long night of a polar winter, is experienced in a fainter degree even in more southern latitudes. Why, then, in defiance of all analogy, should we confine volcanic action purely to the neighbourhood of the sea, or regard it as manifesting itself solely in those mighty and terrific operations, which we witness during the eruption of a burning mountain? To me, at least, it seems more philosophical to imagine, that the same forces are at work in a greater or less degree throughout the globe, and that the evolution of carbonic acid, or the increased temperature of the springs that issue from the earth, may, with the same propriety, be looked upon in the light of volcanic phenomena, as eruptions of lava, or shocks of an earthquake.

Proceeding, then, upon this assumption, I shall next consider, whether any thing can be gathered from the phenomena of hot springs, capable of illustrating the real nature of the cause from whence they arise, and, consequently, of confirming, or otherwise, that theory of volcanic action which I adopted in my treatise on this latter subject.

From the solid contents of thermal waters little information of this kind can be expected to be derived, since it is probable, that these are merely obtained from the strata through which the water percolates. In the case of volcanos, indeed, the carbonate and muriate of soda so generally carried by sublimation into the different vents through which the vapours issue, may, with much reason, be referred to the seat of the igneous action itself, and the occurrence of these salts may thus be regarded as a presumption in favour of the theory, which assumes that sea-water has some share in the effects produced.

But, in the case of hot springs, we cannot be sure that the rocks themselves may not have furnished these ingredients, knowing as we do, that common salt is present every where, and that water, impregnated with carbonic acid gas, is a ready solvent of the alkali which felspathic rocks may contain. It is curious, indeed, that, in the Pyrenees, the warm springs appear to contain soda uncombined with carbonic acid, for I found that lime was not precipitated from its aqueous solution, when added to the water of Barege fresh drawn, and that even barytic water remained unaffected till some moments had elapsed after its addition. Nevertheless, it is possible that the water itself, at a high temperature, assisted by great pressure, may possess a solvent power over the materials of the felspar, and that the mineral alkali, as well as the silica, which such waters contain, may be derived from this source.

It is to the gases, therefore, accompanying hot springs, that we ought chiefly to look, as affording us a clew to the cause of their greater heat, and to those especially which are most abundantly and most generally present. Now, it has been already remarked, that the very same aëriform fluids which appear during the more languid states of volcanic action, are also evolved by hot springs; thus, as we have seen in the Pyrenees, sulphuretted hydrogen is a very common ingredient in them, and carbonic acid is even more generally present.

These two gases, however, will not assist us greatly towards the explanation of the primary cause of their heat; the former being too often absent to be regarded as essential; the latter being simply accounted for by the operation of the heat upon calcareous beds.

But there is a third description of air, the existence of which seems calculated to throw further light upon the nature of the process, being more generally met with than either of the two former, and being common alike to the springs belonging to each of the three kinds of situation to which they may for the most part be referred. The gas alluded to is nitrogen, which, as already stated, was found by Longchamp and others in every hot spring that had come under their examination within the compass of the Pyrenees. In those of volcanic districts it seems to be less common, nevertheless it has been found by a recent chemist, emitted in large quantities from a spring at Castellamare, in the Bay of Naples; and it has been detected by myself, mixed with a predominant portion of carbonic acid, in the hot springs of Mont Dor and Bourboule in Auvergne, and in those of Chaudesaigues in Cantal, whilst at Vichy Longchamp has ascertained its existence under the same circumstances.

The gas evolved from the thermal waters of the Alps seems to be the same in a state of nearly perfect purity; the carbonic acid, which probably accompanied it, being in these cases absorbed by the water through which it had to pass. Thus, on the Savoy side of that chain, I discovered it issuing in large quantities from the spring of St Gervais; and, on the Italian side, from those of Sainte Marguerite at Cormayeur, of St Didier in the same valley, and of Bonneval in the Tarantoise, half-way between the Bourg St Maurice and the Col de Bonhomme. In only one of these springs, that of Bonneval, did any carbonic acid appear to be present; and in this case it amounted to about 12 per cent. of the whole quantity emitted.

Dr Ure also mentions his having detected azote issuing in a state of purity from the baths of Louesche in Switzerland. Neither is this gas absent even from hot springs, which, like those met with in our own country, occur at a distance from great systems of elevation, such as those of which the Alps and Pyrenees afford us examples. It has long ago been detected in the Bath and Buxton springs; and I have myself, more lately, discovered it in two other tepid waters already noticed as belonging to the same country, and probably influenced by the same causes, as that of Buxton. The springs I allude to are those of

Bakewell and Stoney-Middleton, both, according to Farey, contiguous to that system of faults to which the heat of the Buxton springs may perhaps be referred. I have also found pure, or nearly pure, azote, issuing in great quantities from the tepid spring called Taafe's Well, near Cardiff, in South Wales.

I am disposed, therefore, on the strength of a large accumulation of facts, which might be still farther increased were the inquiry extended into other parts of the globe, to consider an evolution of the azotic gas, one of the most constant concomitants of thermal waters, and, as such, to regard it as a phenomenon, which must be kept in view, whenever we wish to offer a consistent explanation of volcanic action.

I shall, therefore, conclude the present memoir, by applying this test to the theories which appear at present to divide the scientific world on the subject of volcanos, leaving of course out of consideration, those attempts to explain them by the combustion of coal, of bitumen, or of pyrites, which, however much in vogue they may formerly have been, seem at present universally thrown aside as inadequate. Indeed Dr MacCulloch, who, so far as I recollect, is the only geologist of name, that has stated any specific objections to the hypothesis advocated in my work, admits, at the same time, that there is no other chemical explanation deserving of a moment's attention ; so that the question reduces itself simply to a comparison between the rival claims of this, and of other theories in which the phenomena are not resolved into processes of a chemical nature.

The objections advanced by Dr MacCulloch may perhaps be dismissed with the remark, that every one of them appears to have been answered, as it were, by anticipation, in the 4th chapter of my work on Volcanos, and that nearly in the order in which he has propounded them ; so that I cannot help flattering myself, that this geologist would find in my treatise, which, from his not quoting, I conclude he had never seen, a solution of the difficulties that have embarrassed him *.

* Another objection I have sometimes heard advanced against the chemical theory, is the mean density of the earth, which is thought to be greater than would be the case, if the interior consisted of the metallic bases of the earths and alkalies. But those who make this objection, forget, that although potassium and sodium are very light, calcium, aluminum, and silicon are by

There is, however, another hypothesis, which, for distinction's sake, I shall denominate the mechanical one, founded on the assumption now generally embraced, as to the interior of the earth enjoying throughout a higher temperature than that of its surface, independently of any chemical or electrical agencies, by which it may in certain parts be affected.

On the mode, however, in which this central heat is to operate, in bringing about the phenomena of volcanos, a great division of opinion exists. One set of philosophers, for example, content themselves, with tracing these effects simply to the contraction of the external crust of the earth upon its contents; and in this way they imagine some of the melted matter within, to be from time to time expressed through those portions of the surface which present the least resistance, somewhat in the same manner, I suppose, in which the juice is forced by pressure through the rind of an orange.

Others, on the contrary, with rather more attention, as it appears to me, to the facts of the case, conceive the phenomena to arise primarily from water being brought into contact with this incandescent material, and in consequence becoming volatilized in the form of steam, to the elasticity of which they attribute some of the more remarkable effects.

But it cannot be too constantly kept in mind, that the concomitants and sequelæ of an eruption are various and complicated, and that no theory ought to be admitted, which does not embrace an explanation of them all. Now, of these two hypotheses, the former takes into the account only one single effect, namely, the emission of lava-currents *, overlooking entirely the

no means so; and, besides, that in calculating their specific gravity in the interior of the globe, we ought to take into account the increase of density produced by the immense compression. Indeed, if Professor Leslie is to be believed, the difficulty seems to lie the other way; for, in his opinion, the specific gravity of the earth's would be increased so much beyond that of the mean density of the globe, owing to this cause, that he thinks it necessary to consider its centre as hollow, or as filled merely with light, the rarest substance known.

* In an article in the Foreign Quarterly Journal, which has appeared since this memoir was written, headed "Fourier on Heat," it is remarked: "The phenomena of volcanos, hot springs, and earthquakes, are explained with singular felicity on this hypothesis (viz. that of a central heat), they ap-

various gaseous matters disengaged, or the saline efflorescences deposited; whilst the latter affords a rational solution of the explosions which accompany the paroxysms of a volcano,—of the power which sets in motion the masses of ejected matter, but omits to consider most of the remaining phenomena. On the other hand, the chemical theory, which I have adopted in my treatise, professes to embrace not only all that has been observed to occur in a volcano, as well during the periods of its activity as of its partial intermittence, but also those feebler indications of the same cause which are recognised as taking place in thermal waters, and the like.

But the phenomenon of all others most irreconcileable with the mechanical hypothesis, is that evolution of azotic gas which is so constantly present in warm springs, an effect, which can in no degree be explained by any such cause as the access of water to an incandescent substance, and still less referred to the expression of a portion of any melted matter which the interior of the globe may contain. To suppose it to arise from a distillation of organic bodies imbedded in any of the strata that have been affected by the internal heat, seems equally absurd, since in that case it ought to be evolved most abundantly from rocks which are most rich in organic remains, whereas the very reverse of this appears nearer the truth; the limestones of the Pyrenees, for example, which give out azote so copiously, if not absolutely without traces of animal matter, containing much too small a quantity to afford a regular supply of this gas.

Neither would the operation of heat upon animal matter disengage this element in the state of purity in which it usually appears.

pear, indeed, to be simple and necessary consequences of the progressive cooling of the earth." And again, in another passage: "The expansive power of the gases, which, it is very probable, are formed during the consolidation of the fluid matter, also explains the origin of earthquakes." I quote these two passages as specimens of the loose manner in which this subject is often treated. The phenomena of volcanos, "explained with such singular felicity," appear to me to reduce themselves to a single one, namely, the emission of lava: for though the reviewer states, that gases are probably formed during the consolidation of the fluid matter, he has nowhere told us in what that probability consists, or why a mixture of lime, alumina, iron and silica, in the proportions which pure lava contain, should copiously evolve aëriform fluids, foreign to their nature and constitution.

In short, the only known process, by which we can account for so constant a supply of azotic gas, as we find to be disengaged from the interior of the earth through the medium of thermal waters, seems to be that of a combustion, which, however excited, is in part at least maintained by atmospheric air. I humbly conceive, therefore, that this one phenomenon is sufficient to confer on the chemical theory of volcanos a decided advantage over the mechanical one; the characteristic of which, in all its modifications, is to reject entirely the theory of combustion of any kind constituting a part of the operations.

Neither is the opinion, that volcanic action arises from the access of water to the unoxidized nucleus of the globe, at all inconsistent with the above position, for the combustion, *excited* in the preceding manner, may very well be imagined to have been *kept up* by the oxygen of the atmospheric air, which would necessarily find its way, wherever a partial vacuum had been occasioned by the condensation of a portion of the steam, which would, in the first instance, at once produce and occupy the cavities immediately surrounding the focus of the action *.

On any hypothesis, indeed, it seems perfectly unnecessary to imagine, that water has been the sole agent in maintaining the fires it may have excited; and a little consideration may easily convince us, that such cannot be the case.

Monsieur Neckar of Geneva, well known for his various papers on geology, and especially on that department of it which has reference to the question here discussed, has taken the trouble to calculate, that if the above supposition were correct, a single eruption, such, for instance, as that which took place from Etna in 1669, would have produced an expenditure of water, and an evolution of hydrogen, so enormous in quantity as to have affected materially the general economy of nature, and a repetition of them such as to have caused even a sensible diminution in the depth of the Mediterranean. As the calculation

* That atmospheric air does actually make its way into the recesses of a volcano, seems to follow from the observations on Vesuvius, stated in a late number of the Royal Institution Journal, by Dr Donati, who mentions his having heard, during the continuance of an eruption, the air rushing in through the various spiracles of that volcano, with a loud and almost musical sound.

itself is curious, I shall avail myself of the kind permission of its author to publish it, and shall afterwards proceed to shew, that though it presses hard against the notion often entertained of the chemical theory *, it cannot operate as an objection to that view of it, which I have adopted in my description of volcanos, and to which I have ever since found reason to adhere.

According to Borelli, (See Ferrara, Description de l'Etna, p. 200), the lava which proceeded from Etna in 1669 was five miles in breadth, fifteen in length, and from 50 to 100 feet in thickness, which gives a bulk equal to about 93,838,950 cubic feet. Let us set it down at 94,000,000 of cubic feet, and as the most compact lava has the specific gravity of 3, let us reduce the quantity to one-half, or to 47,000,000 of cubic feet, in order that we may be justified in calculating it as having that specific gravity. Now, as a cubic foot of water weighs 70 lb., a cubic foot of lava of the specific gravity of 3. will weigh 210 lb.; and the 47,000,000 cubic feet of lava, multiplied by this latter sum, will give, as the weight of the whole mass emitted during the eruption, 9,870,000,000 lb.

Now, according to Dr Kennedy, 100 parts of lava consist of the following ingredients:

Silica, . .	51	containing of Oxygen	25
Alumina, . .	19	. . . .	9
Lime, . .	10	. . . .	3
Oxide of Iron, .	15	. . . .	3
Soda, . .	4	. . . .	1
Muriatic Acid,	1	. . . .	0
	100		41

Consequently, of these 9,870,000,000 lb., two-fifths consist of oxygen, so that 3,938,000,000 lb. of the latter element must have been expended in the process. Now, as water consists of 89 by weight of oxygen, and 11 of hydrogen, this quantity of oxygen would require the consumption of 4,437,956,169 lb. of water, equal to 63,798,024 cubic feet. Now this would correspond to a depth of nearly four inches of water to a league square. The hydrogen disengaged by the decomposition of this quantity of water would be 487,955,056 lb.; now, as a cubic foot (1728

* See, for instance, Dr MacCulloch's late work.

cubic inches) of hydrogen weighs only 36.6 grains, and as a French lb. contains 7561 English troy grains, every lb. of hydrogen would occupy a volume of about 20 cubic feet. Hence 487,955,056lb. of hydrogen would occupy 9,759,101,120 cubic feet; or, according to the same calculation, 14 square leagues covered to 4 inches, or 1 inch covered to 56 inches.

For, as 663,000,000 : 4 : : 9,760,000,000 : 56.

But it will be directly perceived, that all this calculation has reference to a different hypothesis from the one I have adopted; for, if we only allow that atmospheric air finds admission to the immediate seat of the action, it will follow that, at this high temperature, its oxygen will enter into union with any hydrogen that may have been evolved, so that a comparatively small quantity of water will serve the same office in this great natural laboratory, which nitre is known to fulfil in our oil of vitriol manufactories; the same portion of this fluid serving over and over again as the *carrier* of oxygen to the metallic matter which is capable of decomposing it, just as the nitrous gas generated by the nitre furnishes oxygen to the sulphurous acid, owing to its previous conversion into nitrous acid vapour.

Even setting aside these considerations, the validity of which is dependent upon the admission of this particular theory, it must be acknowledged as a matter of fact, that sulphurous acid and sulphuretted hydrogen are both common products of volcanic action; now it is the known property of these two gases to decompose each other when brought into contact, and if moist*, to generate water by the union of the oxygen of the former with the hydrogen of the latter. In both these ways, probably, it happens, that, although water is the *prime mover* in the chain of effects, atmospheric air is the principal supporter of the combustion so excited; and consequently, that, in conformity with the other arrangements of nature, the relations between the sea and land remain unaltered by the process, however often it may be repeated, the whole of the water at first decomposed being sooner or later returned to its original receptacle.

* When dry, a solid body is produced by their union, called Hydrosulphurous Acid, but this again is resolved into sulphur and water, so soon as any moisture is present.

If it be asked why, admitting that volcanic action takes place generally wherever thermal waters occur, and consequently that it is found in the interior of continents, I still think it necessary to regard water as the exciting cause,—I reply, that the large quantities of hydrogen given off in combination with sulphur, the free muriatic acid present in the vapour evolved, together with the common salt and carbonate of soda that effloresce in the spiracles of most volcanos, appear to me inexplicable on every other supposition. Neither can it be denied that the great majority of those in activity are near the sea, although the recent investigations of Humboldt have attached a greater currency to the statements which had been before given in my Description of Volcanos, on the authority of Remusat and Klaproth, with regard to the existence of burning mountains still in a state of vigorous action in central Asia.

These statements excited but little attention at the time they were put forth, because it was seen that the necessary details were too imperfectly known to allow of our building much upon their assumption; neither do I see that Humboldt himself, in his otherwise interesting memoir *, has been able to collect many more well authenticated particulars relative to this portion of the geography of central Asia.

Yet, taking the position of the supposed volcanos as there given, we shall see nothing very inconsistent with that in which the majority of other igneous mountains are found to be placed. The extinct volcano of Aral-tube, which lies between the two chains of the Great Altai and the Teen-shan or Celestial Mountains, is an island in the Lake of Alakul.

The Solfatera, as Remusat calls it, or the active volcano, as Humboldt is inclined to consider it, which goes by the name of Peechan or the White Mountain, lies on the northern declivity of the Celestial Mountains, very near the Lake of Issikoul, which Humboldt admits to be twice as considerable as that of Genear.

In like manner, the Solfatera of Urumtzi, and the fissures in its neighbourhood, which give out vapours of sal-ammoniac, lie near the Lake of Darlai; and the volcano of Hotscheu, which

* See this Journal, October 1831, and also present Number.

is situated to the south of the same chain, is encompassed by shallow pools of water.

Thus it appears, that even if we admit the information given with respect to places, of which no European has yet published a report from personal inspection, there is nothing irreconcileable with the general law, which seems to prevail in other parts of the globe, with regard to the vicinity of large masses of water being most favourable to the development of volcanic energy.

It may be true, as Humboldt has observed, that this relation depends in part upon the configuration of the earth's surface in the neighbourhood of the sea, and the inferior resistance opposed in such situations to the escape of the melted matter.

It may also be true, that where ancient revolutions have produced fissures in the crust of the earth at a distance from the sea, phenomena of a genuine volcanic character may occasionally manifest themselves, and hence, as we so frequently observe hot and carbonated springs near extensive faults or other dislocations of the strata, so in countries much subject to volcanic operations, we may sometimes meet with burning mountains at a distance from the sea, as we find to be the case at Jorúllo in Mexico, and at Tolima in the central Andes.

I can also readily understand the occurrence of volcanos in the depressed portions of Central Asia contiguous to large and numerous lakes; nor is it material, whether these lakes shall turn out to be salt, like the Caspian Sea or the Lake of Aral, or to contain only fresh water.

It is quite a misconception to suppose, as the writer of an article on Lyell's Geology in the Quarterly Review appears to do, that the advocates of the chemical theory of volcanos ever regarded *sea*-water as the necessary cause of subterranean movements. It is the *depth*, and not the peculiar constitution of the ocean, which supplies us with a reason of the greater frequency of volcanic phenomena in its immediate neighbourhood, since this depth will cause it to exert a pressure sufficient to inject a portion of its contents through the fissures of the subjacent rock, and thus to maintain a more ready communication with the combustible materials existing in the interior of the globe, than elsewhere prevails. When in this manner it becomes the *agent* whereby the combustion is kindled, the constituents of those salts which are held by it in solution will of course be detected among the ejected substances, but no one has ever supposed the latter to exert any influence upon the character of the phenomena thereby produced.

The writer of the above article seems also to go so far, when he asserts, that the position of volcanos near the sea furnishes no proof of the chemical theory, as being explicable, from the circumstance of the elevated portion of the earth's crust having suffered most in former ages from the exertion of subterranean energy, and therefore being least exposed to it at present. Has the elevation of the Apennines, I may ask, exempted the Italian Peninsula from such effects, or did that of the Carpathians appear to exhaust the volcanic materials in Hungary, so long as large fresh-water lakes existed in that country to excite their action?

The very idea, too, of an exhaustion of the materials seems inconsistent with the views of those, who imagine with Cordier, that the ejections of a volcano constitute part of the general fluid contents of the globe, which, therefore, under such circumstances, ought to be every where alike present.

Neither does the existence of volcanos in certain continuous lines only, and not generally along the coasts of all regions, appear consistent with this notion, since there is no reason why the pressure exerted, and the resistance opposed, should not, on an average, be the same along the coasts of Germany or Scandinavia, as of Italy and South America.

It would seem, then, that if we were to estimate the relative probability of the above theories by their capability of explaining the various phenomena, which form the aggregate of our knowledge on this subject, the lowest place must be assigned to that mechanical hypothesis, which, on the authority of some great names, seems in the greatest repute at present.

It applies indeed only to one phenomenon, and that neither the most constant nor the most essential of the concomitants of volcanic action,—namely, the emission of lava-currents; whilst the explosive force by which the ejections of loose materials are brought about, no less than the chemical nature of the ejections themselves, are left unexplained. Still less does the hypothesis pretend to account for the emission of aqueous vapour, or of the various aëriform fluids which are so commonly present.

Considerably higher in the scale of probability, is that modification of the above theory advocated by my friend Professor Lyell *, in which the phenomena are deduced from the occasional descent of a body of water derived from the sea into the interior of the earth, where it meets with a mass of matter in an incandescent, if not in a fluid, condition.

We have here an explanation of more at least of the circumstances of the case, such as the emission of steam, the occurrence of sea-salt, and the general position of volcanos near the coast; and we have likewise an ingenious cause assigned † for the intermittent character of the eruptions, and for the force with which the lava is propelled upwards to the spots at which it finds a vent. But the hypothesis does not sufficiently explain the nature of the chemical products evolved, and more especially that of the gases which accompany its operations in all their various stages.

Even the chemical theory, as originally propounded, leaves out of sight the constant production of nitrogen, or of ammoniacal salts derived from it, in all volcanic processes, and cannot be pronounced adequate to account for the phenomena, unless it be modified by the admission, that atmospheric air as well as water is concerned in maintaining that combustion which is indicated as its cause.

The circumstance, however, which has most contributed to give a currency to the mechanical hypothesis, is the general belief entertained of the high temperature existing in the interior of the globe, which, as it appears to imply that there must be occasional vents for the subterranean fire hence supposed to exist, has induced a reluctance in the minds of many to calling in the aid of any new and hypothetical principle.

Undoubtedly the idea of a central heat has to boast the authority of many distinguished supporters, though it must be remarked at the same time, that one of the profoundest of the philosophers who have entertained this opinion, admits, that it derives no sort of confirmation from any phenomena observable on

* See Lyell's Geology, p. 466. *et seq.* † Ib. p. 460.

the surface, the actual temperature being at present as nearly as possible that which would be imparted to it by solar radiation alone *.

As we descend, however, into the interior of the globe, an augmentation of temperature becomes sensible to a degree, which leaves us in no doubt as to the existence of some other cause of heat, whatever uncertainty may remain as to its nature. That it cannot be entirely referred to artificial sources, such as the presence of workmen, lights, &c. seems to follow from its being manifest in neglected as well as in frequented mines, and that it is not attributable to the condensation of air, is implied by the fact, that water pumped up from deep artesian wells indicates a temperature equally elevated with that from mines.

Nevertheless, the general tenor of the observations seems rather to suggest a local and variable, than a general and uniform cause. The heat of mines is neither equal for equal depths in the same district, nor, when examined in different ones, does it appear to depend upon the relative depth of the place below the level of the sea, as ought to be the case, if it arose from an intensely heated body occupying the interior of the globe.

Thus, M. Cordier has shewn, that in Brittany two different mines indicate an increase of 1° of Fahrenheit, the first for every 57 feet, and the second for every 206 feet; and that the mines of Freyberg in Saxony, and those of Schemnitz in Hungary, shew an elevation of temperature sometimes more considerable in proportion to their depth than those of Brittany, although the former are at so much higher a level above the sea than the latter. The case is rendered still stronger, if we compare the mines of Cornwall, or of Newcastle, with those of South America, the former of which are often below the sea, whilst the latter are many thousand feet above its level, and yet, although the lowest point to which they are worked must be above the mouth of any of those noticed in England, the increase of temperature seems to be as great in both,—that in Guanaxuato being 1° of Fahrenheit to every 46 feet, whilst that in Dolcoath mine is the same to only 45.

In short, nothing can be more capricious, or seemingly irre-

* See Fourier's Memoir on the Temperature of the Terrestrial Globe.

ducible to any fixed law, than the temperature of the interior of the earth; and Cordier himself, who founds upon it a theory as to the existence of a central heat, confesses "that the differences between the results collected in the same place do not depend solely upon the imperfect nature of the experiments, but also upon a certain irregularity in the distribution of the subterranean heat in different countries."

Before, therefore, we refer the internal warmth of the globe to a cause, which should imply a greater uniformity, and a less anomalous distribution, than seem consistent with fact, let us consider whether there are not certain causes in continual, though in less regular operation, which may supply us with a solution of this problem.

We have already suggested the probability that volcanic action, though most intense in certain situations and along particular lines of country, manifests itself likewise in a minor degree wherever thermal or carbonated waters issue from the earth; perhaps, indeed, likewise in those spots, where accumulations of carbonic acid take place, as at the bottom of neglected mines or wells. This, therefore, may be one principal cause of the higher temperature detected as we descend into the interior of the earth; but there are not wanting other processes, the existence of which cannot be called in question, calculated to give rise to a considerable elevation of its temperature.

The interesting discovery of Mr Fox, with respect to the electro-magnetic properties of metalliferous veins in the mines of Cornwall, seems to hold out to us a completely new field of speculation, both as to the changes that may be going on underneath, and the influence which these changes may exert upon the temperature of the globe; so that, in the absence of any sufficient information on these points, it would surely be precipitate, to pronounce upon the necessity of assuming one general and equable cause, for that which may be derived from so great a variety of natural processes.

It is true, that Sir H. Davy, in one or two of his later publications, has shewn himself out of conceit with the theory, which his own discoveries had originally suggested, and that he seems to have inclined in preference to an explanation founded on the doctrine of a central heat. Nevertheless, it is remarkable that the grounds on which he renounced his former views are nowhere stated, and that he himself admits, in the very place in which his preference for the contrary opinion is recorded, that the experiments and observations on Vesuvius, which it was the object of his memoir to detail, whilst they are inconsistent with every other chemical theory of volcanos, may be accounted for on this.

The authority, therefore, of Sir H. Davy, may, I conceive, on this occasion be fairly pleaded against himself, and the weight of his *ipse dixit* in the two latter years of his life, be viewed as counterbalanced by the contrary judgment he had pronounced, apparently on the same evidence, at an earlier period; neither perhaps is it inconsistent with what we know of his character, to suppose that he should have acquired a distaste for the theory in question, when he found it seized upon and illustrated by a humble class of inquirers.

With regard to the authority of Fourier, it would be well, if those who appeal to his great name in corroboration of this doctrine of a central heat, would give themselves the trouble to consider what was the real scope of his celebrated memoir. They would then be convinced, that the results of his analytical inquiry go no farther, than to demonstrate the compatibility of such an internal heat with the phenomena presented at the surface. The proofs, therefore, of such a cause must be sought for elsewhere; for, as we have already stated, the phenomena of climate are such as may be fairly deduced from the effects of solar radiation, modified by peculiarities of local situation, and therefore add nothing to the evidence derived from the internal temperature in favour of the existence of a central heat.

Analysis of Professor Ehrenberg's *Researches on the Infusoria.* By Meredith Gairdner, M. D. Communicated by the Author. (Continued from p. 225.) With a Plate.

III. *Systematic Classification.*

The foregoing observations have no doubt prepared the mind of the reader for an entire change in the distribution of this class of the animal kingdom. When the microscope received no aid in the unravelling of their structure from the use of coloured substances or other artificial means, their apparently homogeneous tissues furnished no distinctive characters, except the varieties of external form, the presence or absence of ciliæ and other appendages, which are so uncertain and so changeable, and which have been long ago rejected from other departments of zoology as the fundamental bases of division. Upon this basis rest the systems of Müller, of Bory St Vincent, and of all other systematologists. Cuvier, in the last edition of the *Regne Animal*, has endeavoured in vain to reduce into a connected system a few isolated observations of more importance on some individuals of the class, furnished by Dutrochet.

It is now necessary to reduce these animals to the general rules of zoology, and to form a "distribution according to their organization." Dr Ehrenberg cannot be accused of precipitancy in erecting a new system upon his own observations, which have not of course extended to all the species already described by naturalists; but by numerous microscopic observations pursued night and day with indefatigable industry, he has been enabled to reduce all the *principal* forms to fixed principles, upon which he has constructed the two following tables, which remain to be increased by future observations, but of themselves will, at first sight, be seen to form an immense accession to the domain of natural history.

It will be requisite, however, in the first place, to make a few observations upon the principles which have guided him in their construction. He has included under his categories those genera or species *only* whose digestive organs he has demonstrated himself by his new method of observation. Many other species which he has examined, but whose organization has not been subjected to this scrutiny, as well as some genera which either oppose his system, or regarding whose structure we are quite ignorant, he has classed in an appendix under the heads to which they *probably* belong.

He has rejected from the Infusoria the genera *Cercaria*, Nitsch, *Spermatozoon*, Baer, and the *Vibrio fluviatilis* and *aceti* Müller, to which he has given the generic name of *Anguillula*.

None of these animals excite any currents when immersed in a solution of coloured particles, nor do they possess any organs to which we can attribute this faculty. Their most appropriate place is probably among the Entozoa; although the structure of the seminal animalcules has not been as yet fully made out.

They may be distributed into two very natural classes according to their internal structure; those provided with several internal cavities or stomachs—the *Polygastrica;* and those provided with but a single stomach or alimentary cavity, and possessing peculiar rotatory organs surrounding the mouth—the *Rotatoria.* The first class is much simpler in its structure than the other. They possess no vascular or nervous systems. The genus *Euglena* presents the combination (well worthy of the attention of the observing naturalist) of an immediate spontaneous division, with indications of eyes, and consequently of a nervous system; indeed the sense of taste, which they distinctly possess, would lead us to expect these organs. The Polygastrica, as they are the most imperfectly known, so they will probably stand most in need of farther changes. Dr Ehrenberg has classed them under two groups. In the first are arranged those which, from their minuteness, are very difficult to observe, and in which, although possessed of a distinct mouth and stomach, no oral orifice or excretion of colouring matter has been observed. It is not probable, however, that the same orifice performs the function of anus as well as mouth. To them Dr Ehrenberg has given the name of *Anentera* *. The second group which is by far the largest, the *Enterodela,* possess a distinct orifice for the ejection of the excrementitial colouring matter; its position, as well as that of the mouth, and the arming of the latter, furnish good systematic characters for the subordinate divisions.

The class of *Rotatoria* is much more complicated in its structure than the former. They are even more highly organized than the Entozoa of Rudolphi. They are, however, well distinguished from the Mollusca and Crustacea, with which they agree in the possession of nerves and vessels, by the want of a central organ for the propulsion of the circulating fluid. Most of the genera possess eyes, which furnish very good characters

* From the privative α, and εντερον intestine in the sense of Aristotle.

for their systematic subdivision. M. Ehrenberg has not resorted for this purpose to the masticating organs which we have already seen attain in some *(Hydatina and Philodina aculeata)* a high state of development, because their exposition is both exceedingly difficult and necessitates the destruction of the animal. Good characters are also furnished by the nature of the rotatory organs.

The construction of these tables brings into view a principle which has not been hitherto recognised, viz. that the naked infusoria and those provided with a crustaceous or corneous covering, are intimately connected together, and very often entirely agree with one another in external and internal structure, with the single exception of the consistency of their coat. Two parallel series are thus formed, the *Nuda* and *Loricata* of Dr Ehrenberg, answering to certain of the *Gymnodes* and *Crustodes* of Bory St Vincent, which had been hitherto separated under entirely distinct divisions. The number of the *Infusoria Loricata* is very small among the Polygastrica, but bear a much more equal proportion to the *Nuda* among the Rotatoria. The number of loricated polygastrica will be much increased if we refer to the animal kingdom the family of the Bacillariæ. This family which stands in such close relations with some sea algæ, such as the *Girodella*, *Schizonema* and *Micromega*, and with some of the small fresh-water algæ, will most probably come under this head by the demonstration of an absorption of colouring matter into several internal stomachs in all the species of the genus *Arcella*. A similar nutritive function has been observed in two species of the genus *Difflugia*, so long hovering between vegetable and animal life, viz. the *proteiformis*, Le Clerc, and a new species discovered by Dr Ehrenberg at Berlin —the *acuminata*.

TABLE.

Phytozoa (Goldfuss).—*Animalia Infusoria* (Müller).—*Animaux Microscopiques* (Bory St Vincent).

PHYTOZOA.

CLASSIS I.—*POLYGASTRICA.*

Animalia evertebrata apoda, nonnulla caudata, vasa sanguinifera et systema nerveum nullibi conspicua. Oculorum raudimenta paucis. Os omnibus aliis vibrantibus coronatum nudumve ventriculis pluribus appendiculatis aut canali alimentario perfecto polygastrico auctum. Pharynx non discretus inermis. Partus. Ovipara? (vivipera) et sponte dividua.

A. *Arentera.*

Ore ventriculis pluribus appendiculato, ano discreto nullo.

ORDO I. NUDA. — ORDO II. LORICATA.

Familia I. Gymnica.

Corpore non ciliato, ore ciliato nudove.

Sect. I. Monadina.

A. Pullis internis nunquam conspicuis, corpore in binas aut quaternas partes sponte dividuo.
- *a.* Cauda nulla.
  - *α.* pellucida.
    Monasermo. Müller.
    15 species.
  - *β.* obscura.

Familia II. Epitricha.

Corpore ciliato, ore ciliato nudove.

Sectio II. Peridinæa.

Pullis internis conspicuis nullis.
- *a.* Ciliorum ordine transverso.
  Peridinium cinctum. Vortic. cin. Müller.
  2 species.
- *b.* Ciliorum ordine longitudinali.
  ? *Cyclidium glaucoma.* Müller.
  4 species.

Familia III. Pseudopodia. — Familia I.

Corpore proteo, processibus pediformibus variabili.

Sectio III. Amoebaea.

Amœba diffluens. Proteus diff. Müller.
2 species.

Sectio I. Bacillaria.

Cum lorica dividua.

Sectio II. Arcellina.

Lorica non dividua.
- *a.* Lorica urceolata.
- *b.* Lorica scutellata.
  Arcella vulgaris. Nov. gen.
  3 species.

B. *Enterodela.*

Tubo intestinali perfecto (ore anoque terminato) polygastrico.

Familia IV. Anopisthia. — Familia II.

Ore anoque contiguis in eadem fovea.

ORDO I. NUDA.

SECTIO IV. VORTICELLINA.

A. Corpore pedicellato, pedicello filiformi nudo (nec vaginato), sæpe ramoso.
  a. Pedicello in spiram contractili.
    Vorticella convallaria. Müller.
    5 species.
  b. Pedicello in spiram non contractili.
    Epistylis digitalis. Vort. dig. Müller.
    3 species.
B. Corporis pedicello nullo.
  a. Ciliorum corona simplici.
    Trichodina grandinella. Trichoda gr. Müller.
  b. Ciliorum corona simplici.
    Stentor Polymorphus. Oken.

ORDO II. LORICATA.

SECTIO III. OPHRYDINA.

A. Corpore nudo pedicellato, pedicello filiformis vaginato.
  a. In spiram contractili.
    Carchesium fasciculatum. Vort. fasc. Müller.
    3 species.
B. Corpore gelatino involuto nec pedicellato.
    Ophrydium versatile. Vort. vers. Müller.
    1 species.
C. Corpore vagina membranacea incluso.
  a. Non pedicellato.
    Vaginicola crystallina. N. sp.
    3–6 species.
  b. Pedicellato.
    Tintinnus.

FAMILIA V. ENANTIOTRETA.

Ore anoque oppositis terminalibus.

SECTIO V. ENCHELIA.

A. Ore transverso truncato.
  a. Corpore non ciliato.
    Enchelys pupa. Müller.
    2 species.
  b. Corpore ciliato.
    Coleps hirtus. Nitsch.
    3 species.
  c. Corpore setoso.
    Actinophrys sol. Trichoda sol. Müller.
    2 species.
B. Ore obliquo (sæpe ciliato.)
  a. Corpore non ciliato.
    α. In collum capitatum non extensili.
      Trichoda carnium. Müller.
      3 species.
      ? *Bursaria.*
      1 species.
    β. In collum capitatum extensili.
      Lacrymaria olor. Vibrio olor. Müller.
      2 species.
  b. Corpore ciliato.
    Leucophrys patula. Trich. pat. Müller.
    3 species.

FAMILIA VI. ALLOTRETA. Familia III.

Ore anove terminali.

SECTIO VI. TRACHELINA.

A. Ore inermi infero.
  a. Labio superiore prælongo.
    Trachelius fasciola. Vibr. fasc. Müll.
    4 species.

SECTIO IV. ASPIDISCINA.

Aspidisca lynceus. Trich. linc. Müll.
1 species.

ORDO I. NUDA. ORDO II. LORICATA.

b. Labio superiore brevi dilatato obliquo.
Loxodes cucullulus. *Kolp. cucull.* Müller.

B. Ore uncino suffulto.
Glaucoma scintillans. Nov. gen
1 species.

FAMILIA VII. KATOTRETA. Familia IV.

Nec ore, nec ano terminali.

SECTIO VII. KOLPODEA.

Nuda aut ciliata.

A. Proboscide brevi inermi.
a. Corpore partim ciliato.
Kolpoda cucullus. Müller.
2 species.
b. Corpore ubique ciliato: turgido.
Paramæcium chrysalis. Müll.
2 species.

B. Proboscide nulla.
Amphileptus anser. *Vib. anser.* Müller.
2 species.

SECTIO VIII. OXYTRICHINA.

Setosa aut uncinata.

a. Uncinis stylisque nullis.
Oxytricha pellionella. Bory.
4 species.
b. Uncini; styli nulli.
Kerona pustulata. Müller.
1 species.
c. Styli; uncini null.
Urostyla grandis. Nov. gen.
2 species.
d. Uncini, stylique.
Stylonychia mytilus. *Ker. myt.* Müller.
2 species.

SECTIO V. EUPLOTA.

Euploea charon. *Trich. char.* Müll.

CLASSIS II.—*ROTATORIA.*

Animalia evertebrata radiata apoda sæpe caudata, ciliis peculiaribus rotantia. Ganglia nervea pharyngea plura (cerebralia ?), annulus nervæus nuchalis et nervus abdominalis in majoribus conspicua. Sæpissime oculi pigmento læte rubro. Canalis alimentarius simplex; ventriculi species nonnullis, appendices cæcæ apud alia. Pharynx sæpius maxillis armatus, nonnunquam dentigeris. Vas dorsale immobile, ramosum. Succi corporis pellucidi. Hermaphrodita. Ovipara et vivipara, nec sponte dividua.

ORDO I. NUDA. ORDO II. LORICATA.

FAMILIA I. MONOTROCHA.

Ciliorum corona simplici integra.

SECTIO I. ICHTHYDINA.

A. Cæca.
a. Dorso glabro.
Icthydium podura. *Cerc. pod.* Müller.
1 species.

SECTIO I. STEPHANOPINA.

A. Cæca.
a. Cauda simplici.
Monura colurus. Nov. gen.
1 species.

ORDO I. NUDA.

b. Dorso setoso.
Chætonotus larus. Trich. larus. Müller.
2 species.

ORDO II. LORICATA.

b. Cauda furcata.
Colurus uncinatus. Brachionus unc. Müller.
2 species.

B. Oculis duobus.
Stephanops lamellaris. Brach. lam. Müller.
1-2 species.

FAMILIA II. SCHIZOTROCHA.

Ciliorum corona simplici laciniatim constricta variabili.

SECTIO II. MEGALOTROCHÆA.

A. Oculo unico.
Microcodon clavus. Nov. gen.
1 species.

B. Oculis quatuor.
Megalotrocha alba. Nov. sp.
1 species.

SECTIO II. FLOSCULARIA.

A. Cæca.
a. Gelatina corpus involvente.
α. Organo rotatorio bilobo et subquadrilobo.
Lacinularia socialis. Oken.
1 species.
β. Org. rot. multifido.
Floscularia ornata. Oken.
1 species.
b. Vagina corporis membranacea.
Melicerta ringens. Schrank.
1 species.

FAMILIA III. POLYTROCHA.

Ciliorum coronulis pluribus.

SECTIO III. HYDATINA.

A. Cæca.
a. Simplicia.
α. Maxillæ dentatæ.
Hydatina senta. Vort. senta. Müller.
2 species.
β. Maxillæ inermes.
† Ore recto terminali.
Enteroplea lacustris. Nov. gen.
1 species.
†† Ore obliquo infero.
Pleurotrocha petromyzon. N. g.
1 species.
b. Composita.
Zoobotryon pellucidus. Nov. g.
1 species.

B. Oculo unico.
a. Frontali.
Furcularia gibba. Nov. sp.
2 species.
b. Dorsali.
α. Cauda setacea nec furcata.
Monocerca Rattus. Trich. Rat. Müller.
2 species.
β. Cauda simpliciter furcata.
† Ciliis rotatoriis æqualibus.
Notommata lacinulata. Vort. lac. Müller.
8 species.

SECTIO III. EUCHLANIDOLA.

A. Cæca.
Lepadella ovalis. Brach. oval. Müller.
1 species.

B. Oculo unico.
a. Lorica depressa.
α. Cauda simplici.
Monostyla cornuta. Trich. corn. Müller.
2 species.
β. Cauda furcata.
Euchlanis macrura. Nov. gen.
2 species.
b. Lorica turgida aut angulosa.
α. Cauda simplici.
Mastigocerca carinata. N. gen.
1 species.

ORDO I. NUDA.

†† Ciliis rotat. inequal partim longioribus, setaceis tentaculiformibus.

Scaridium longicaudum. Trich. lon. Müller.
1 species.

Dinocharis pocillum. Trich. poc. M.
3 species.

C. Oculis binis aut bis acervatis.

a. frontalibus simplicibus.
Diglena catellina. Cer. cat. M.
3 species.

b. dorsalibus simplicibus.

α. Cauda simplici.
Rattulus lunaris. Bory.
1 species.

β. Cauda furcata.
Distemma forcipatum. Cerc. for. M.
3 species.

c. dorsalibus acervatis.
Theorus vernalis. Nov. gen.
1 species.

D. Oculis tribus.

a. uno dorsali, duobus frontalibus.
Eosphora Najas. N. gen.
1 species.

b. tribus dorsalibus.
Norops dorsalis. N. gen.
1 species.

E. Oculis pluribus in circulum dispositis.
Cyclogena lupus. Cerc. lup. M.
1. species.

ORDO II. LORICATA.

β. Cauda furcata.
Salpina mucronata. Brach. muc. Müller.
5 species.

C. oculis quatuor.
Squamella bractea. Brach. bract. M.
1 species.

FAMILIA IV. ZYGOTROCHA.

Ciliorum coronulis binis.

SECTIO IV. PHILODINÆA.

A. Cæca.
Callidina elegans. Nov. Gen.
1. species.

B. Oculis duobus.

a. frontalibus (ante org. rotataria).

α. Cauda ter furcata.
Rotifer vulgaris. Schrank.
3 species.

β. Cauda quinque apicibus.
Actinurus neptunius. N. G.
1 species.

b. dorsalibus (pone org. rot.)

α. Cauda simpliciter furcata.
Monolabis conica. N. G.
1 species.

β. Cauda ter furcata.
Philodina erythrophthalma, N. G.
3 species.

SECTIO IV. BRACHIONÆA.

A. Cæca.
Noteus Bakeri. Brach. Bak. M.
1 species.

B. Oculo unico.

a. Cauda nulla.
Anuræa palea. Bory.
1 species.

b. Cauda furcata.
Brachionus urceolaris. Müller.
3 species.

C. Oculis duobus.
Pterodina patina. Brach. pat. M.
1 species.

N. B. In hâc tabula, illas species solummodo ordinandas judicavi, quibus Professor Berolinensis ventriculos singulos pluresve demonstraverat, materiæ colorantis, prehensione et deglutitione. M. G.

IV. *Geographical Distribution.*

No sooner is the organized structure and physiological importance of the class of infusory animals distinctly recognised, than their geographical distribution becomes a subject of interest, and the question presents itself:

" Whether the forms of infusory animals, which fill the waters of the earth in such countless numbers, and which, with many, form the germs of organic life, are the same in all quarters of the world? Or whether a climacteric difference can be observed to exist between these minute living bodies, corresponding to that subsisting between the larger animals?"

The subject is not altogether new, although all former observations were isolated, imperfect, and contradictory. Gmelin, in the 13th edition of the *Systema Naturæ*, describes two species of the genus Vorticella, one peculiar to the Atlantic, the other to the Indian Ocean. It is very difficult to decipher the animals to which he alludes. It is certain, however, that they are not Vorticellæ; and it is very doubtful if they are infusoria at all. Riche, in 1791, on d'Entrecasteaux's Voyage in search of Lapeyrouse, made a few observations on the infusoria of the Pacific Ocean; and Bosc, in 1802, on those of North America; but both these observers, from their imperfect means of observation, either mistook the larvæ of Entomastraci for infusory animals, or came to the conclusion that they did not differ from those of Europe. Chamisso, in Kotzebue's voyage round the world, in 1815, made a few observations on the coast of Brazil, on the animal to which the sea owed its green colour, which he described under the name of the *Paramæcium oceanicum:* it is closely allied in form to the *Cercaria viridis.*

M. Ehrenberg has had opportunities of furnishing a few data for the solution of the question during the two very extensive journeys which he has made into the three quarters of the old world; the first in company with Dr Hemprich into Africa and Arabia; the second very lately with Baron Alexander Humboldt into Russia, Siberia, and the Altayan Mountains. During both of these journeys he prosecuted with indefatigable industry his observations on these microscopic creations, wherever opportunity offered; though, from their inferior importance, they were necessarily subordinate to the collection and description of the larger animals. These circumstances, together with the caution necessary in the use of instruments of brass in the presence of half civilized people, fatigue, disease, &c. have much circumscribed the extent of his researches, which cannot therefore be regarded as fixed principles, but as serving as the foundation of a more extended series by the labours of future travellers.

1. *In Terrestrial Waters.*—On his first journey into Africa and Arabia, he made observations in ten different localities, besides one on the coast of the Adriatic, of which the following is a synoptic table:

I. *Adriatic Sea, at Cattaro.*—1 Form.

E.	Monura Colurus, n. sp.	$\frac{1}{24}'''$

II. *Mediterranean Sea at Alexandria.*—3 Forms.

	Bacillaria Cleopatræ, n. sp.	$\frac{1}{40}'''$
	——— Ptolemæi, n. sp.	$\frac{1}{300}$
*	Zoobotryon pellucidus, n. g.	1—1

III. *Oasis of Jupiter Ammon near Siwa.*—8 Forms.

† E.	Anguillula fluviatilis,	$\frac{1}{3}'''$
	Bacterium triloculare, n. sp.	$\frac{1}{250}$
	Cyclidium inane, n. sp.	$\frac{1}{300}$
E. ?	Enchelys Pupa ? Müller,	$\frac{1}{24}$
	Hydrias cornigera, n. g.	$\frac{1}{16}$
	Monas glaucoma, n. sp.	$\frac{1}{140}$
E.	——— termo, Müller,	$\frac{1}{1664}$
	Trichoda Nasarmonum, n. sp.	$\frac{1}{24}$

IV. *Boulak near Cairo, in stagnant Nile water.*—6 Forms.

	Bacterium simplex, n. sp.	$\frac{1}{180}'''$
E.	Monas atomus, Müller,	$\frac{1}{400}$
E.	Paramæcium chrysalis, Müller,	$\frac{1}{16}$
	Trichoda ovata, n. sp.	$\frac{1}{40}$
	Typhlina viridis, n. g.	$\frac{1}{60}$
E.	Vorticella convallaria, Müller,	$\frac{1}{16}$

* This singular genus is remarkable for its size. It resembles very much a Fucus, and often attains a foot in diameter. This mass is not, however, formed of a single animal, but consists of many thousand microscopic animalcules united together by a gelatinous filamentous network. The animal, which adheres in clusters to the extremities of the connecting filaments, is allied to the group of the Vorticellæ.

† This genus, which has been formerly noticed as probably belonging to the class of Entozoa, is included in these geographic indications, as it has hitherto been reckoned among, and is generally known only as an infusory animal.

V. *Suez on the Red Sea, in sea-water.*—2 Forms.

	Vorticella parasitica, n. sp.	$\frac{1}{2}'''$
	Zoobotryon pellucidus, n. sp.	1 to 6 body $\frac{1}{2}$

VI. *Tor, on the Red Sea, in sea water, wells, and infusions.*—10 Forms.

	Cyclidium glaucoma, Müller,	$\frac{1}{10}'''$
	Disoma vacillans, n. g.	$\frac{1}{32}$—$\frac{1}{24}$
	Discocephalus rotatorius, n. g.	$\frac{1}{32}$
	Echinella splendida, n. sp.	$\frac{1}{2}$
	Fragilaria diophthalma, n. sp.	$\frac{1}{80}$
E.	Kolpoda cucullus, Müller,	$\frac{1}{32}$
E.	Monas termo, Müller,	$\frac{1}{1664}$
	Stylonychia cimex, n. g. (Kolpoda lamella, Müller)	$\frac{1}{32}$—$\frac{1}{24}$
E.	Trachelius lamella,	$\frac{1}{24}$
E.	Vibrio rugula, Müller,	$\frac{1}{80}$
	Vorticella arabica, n. sp.	$\frac{1}{2}$

VII. *Wadi Esle, in Mount Sinai. Observed at Tor, in the water which had been sent with confervæ from Wadi Esle.*—18 Forms.*

E ?	Ambleyura serpentulus (Vib. serp. Müller),	$\frac{1}{80}'''$
	Anguillula fluviatilis,	$\frac{1}{80}$
	Bacterium scintillans, n. sp.	$\frac{1}{500}$
E.	Closterium lunula, Nitsch,	$\frac{1}{12}$
	——— multistriatum, n. sp.	$\frac{1}{12}$
E.	Cocconema cistula, n. sp.	$\frac{1}{32}$—$\frac{1}{24}$
	Cyclidium glaucoma, Müller,	$\frac{1}{140}$
*	Fragilaria bipunctata, n. sp,	$\frac{1}{32}$—$\frac{1}{24}$
	——— multipunctata, n. sp.	$\frac{1}{24}$

* Dr Ehrenberg carried on a series of observations on infusions, during a residence for some time at Tor, in expectation of the arrival of Dr Hemprich, previous to setting out on a journey into Abyssinia. The following are the results of these experiments, in his own words:

"Towards the end of October, I placed, in a retired situation in the coral-house of the Greek Nicola Barmili, four glass vessels containing well-water, sea-water, cold infusion of black pepper, and cold infusion of cinnamon. After the first two days, on examining a few drops I could detect no trace of life. The second day the surface of the water was a little dusty. The third day I detected under the dust in the well and sea water, *Monas termo* and *Cyclidium glaucoma*. The same animals existed in the pepper infusion with the addition of some *Kolpoda cucullus*. During the eleven days in which I continued the observations without interruption, no trace of life could be observed in the cinnamon infusion; a few filaments of mould were only formed on its surface. The well water and infusion of pepper, during the remainder of the eleven days, exhibited no more animalcules. In the latter, however, the number of kolpodæ seemed to increase, and that of monads to diminish. The sea-water was much more productive. On the fourth day there appeared, in addition to the monads and cyclidiæ, *Vibrio rugula;* on the eighth day, *Stylonychia cimex, Trachelius lamella,* and *Disoma vacillans.* A journey to Mount Sinai now interrupted my observations for twelve days. On my return, on the 22d of November, I found all the glasses dried up, except that of sea-water, which was larger than the others, in which the *Stylonychia* still exhibited some active motions. No new forms were developed in this water, although I continued my observations for almost two months, the time required to evaporate it to dryness. The result of these observations is, that, in stagnant well-water, and pepper infusion, European forms only appeared; but, in the stagnant sea-water, some which were peculiar. Further, that in Arabia as in Europe, monads are the first which appear in stagnant water."

	Lepadella emarginata, n. sp.	$\frac{1}{24}'''$
E.	Monas termo, Müller.	$\frac{1}{1800}$
E. ?	Monocerca Rattus ? (Trichoda, Müller)	$\frac{1}{18}$
E.	Navicula fusiformis, n. sp.	$\frac{1}{24}$
	——— interrupta, n. sp.	$\frac{1}{64}$—$\frac{1}{32}$
	Paramæcium ? sinaiticum, n. sp.	$\frac{1}{24}$
	Rotifer erythræus, n. sp.	$\frac{1}{20}$
	Trichoda asiatica, n. sp.	$\frac{1}{72}$
E. ?	——— pyrum ? (Kolp. pyrum, Müller)	$\frac{1}{100}$

VIII. *Suckot, in Nubia, in stagnant Nile water.*—2 Forms.

	Distigma Planaria, n. g.	$\frac{1}{20}'''$
E.	Rotifer vulgaris, Schrank ?	$\frac{1}{16}$

IX. *Island of Argo, on the Nile, in Dongola.*—3 Forms.

	Cyclidium lendiforme, n. sp.	$\frac{1}{265}'''$
E.	Paramæcium Chrysalis, Müller,	$\frac{1}{20}$
	Trichoda æthiopica, n. sp.	$\frac{1}{50}$

X. *Kasr Dongola, Fortress in Dar Dongola.*—10 Forms.

E.	Anguillula inflexa, n. sp.	$\frac{1}{4}'''$
	——— dongolana, n. sp.	$\frac{1}{4}$
	Cyclidium planum, n. sp.	$\frac{1}{220}$
E. ?	Cycloglena elegans ? n. g.	$\frac{1}{16}$
E. ?	Diglena catellina ? (Cerc. catell. Müller)	$\frac{1}{16}$
E. ?	——— aurita, n. sp.	$\frac{1}{16}$
E. ?	Ichthydium Podura (Cerc. Pod., Müller)	$\frac{1}{24}$
	Monas glaucoma, n. sp.	$\frac{1}{30}$
E.	Paramæcium chrysalis, Müller,	$\frac{1}{20}$
	Pandorina hyalina, n. sp.	$\frac{1}{60}$

XI. *Island of Masoua, in the Red Sea.*—1 Form.

	Zoocladium niveum, n. g.	5'''—3'''

In all 64 forms, which are reducible into 57 distinct systematic species, observed in tropical regions, with the single exception of one at Cattaro, of which it will be seen, from an inspection of the table, that 14 are species which have been observed in Europe (Leipzig and Berlin) *, and 8 so closely allied to some forms exhibited there †, that Dr Ehrenberg has not ventured to characterize them by a distinct name; leaving 35, or about two-thirds of the whole, peculiar to tropical countries, and which they possess in addition to many European species.

* These are preceded in the Table by the letter E.

† These are preceded by an E ?

It is remarkable that, of these 57 species, there are only 7 which belong to genera not found in Europe, and that each of these species forms the type of a distinct genus, in none of which more than one has yet been found, viz.

Distigma.	*Hydrias.*	*Zoobotryon; and*
Disoma.	*Typhlina.*	*Zoocladium.*
Discocephalus.		

Another singular fact exhibited by this table is, that on no one point of observation has more than two species of one genus been discovered. Only the genera *Trichoda* and *Cyclidium* present four species; all the others less, and by far the greater number only one.

The following species are those characterized by the greatest geographical extension.

Anguillula fluviatilis,	Stations III. & VII.
Monas termo,	——— III. VI. & VII.
——— glaucoma,	——— III. & X.
Paramæcium Chrysalis,	——— IV. IX. & X.

We shall now present a similar analysis of M. Ehrenberg's Russian observations. Notwithstanding the rapidity of his journey, he succeeded in establishing differences among the infusoria of no less than 21 different points of this vast empire, in the Northern Urals, the Siberian Steppe, the shores of the Caspian, and the Altai range, even to the Chinese Dzungarei:

I. *Salt Lake of Kurotschkinsk near Astrachan; water examined in Astrachan.* 46° N. Lat. 66° E. Long. ?—1 Form.

	Monas erubescens, n. sp.	$\frac{1}{144}'''$

II. *Buchtarma, in the Altai Mountains, on the Irtysch.* 49° N. Lat. 101° E. Long.—6 Forms.

	Bacillaria elongata, n. sp.	$\frac{1}{40}'''$
E.	Diglena capitata, n. sp. ?	$\frac{1}{36}$
E.	Monas mica, Müller, ...	$\frac{1}{120}$
E.	Navicula fulva, ...	$\frac{1}{60}$
E.	——— gracilis, n. sp.	
	——— fusiformis, n. sp.	$\frac{1}{36}$
	——— ventricosa, n. sp. . . .	$\frac{1}{36}$

III. *Syrjanofskoi, in the Altai Mountains.*—9 Forms.

	Astasia viridis, n. sp.	$\frac{1}{100}'''$—$\frac{1}{75}'''$
	Bacterium deses (Enchelys deses, Müller) .	$\frac{1}{100}$
E.	Coleps hirtus, Nitsch, ...	$\frac{1}{80}$
E.	Loxodes cucullulus, (Kolpoda cucull. Müller) .	$\frac{1}{35}$
	Monas umbra, n. sp.	$\frac{1}{200}$
E.	Navicula gracilis, n. sp.	$\frac{1}{120}$
E.	Oxytricha lepus, Bory, ...	$\frac{1}{45}$
E.	Paramæcium Aurelia, Müller, . . .	$\frac{1}{20}$
	Spirodiscus fulvus, n. sp.	$\frac{1}{100}$

IV. *Prochodnoi, Alp of the Altai, near Riddersk; examined in Riddersk.*—2 Forms.

	Rotifer vulgaris, Schrank, ...	$\frac{1}{8}'''$—$\frac{1}{7}'''$
	Trichodina grandinella, (Trichoda grand., Müller)	$\frac{1}{96}$

V. *Smeinogorsk in the Altai Mountains.*—8 Forms.

E.	Anuræa palea, Bory, (Brachiosus, Müller) .	$\frac{1}{8}'''$
	Bodo viridis, n. g.	$\frac{1}{500}$
E.	Diglena catellina, ...	$\frac{1}{20}$
	Gonium hyalinum, n. sp. (a single globule $\frac{1}{860}$)	$\frac{1}{172}$
	Monas kolpoda, n. sp.	$\frac{1}{860}$
E.	——— uva, Müller, ...	$\frac{1}{860}$
E.	Navicula gracilis, n. sp.	$\frac{1}{60}$—$\frac{1}{50}$

VI. *Koliwan, at the River Belaja, in the Altai Mountains. Observed with conferva at Smeinogorsk.*—2 Forms.

E.	Closterium lunula, Nitsch, ...	$\frac{1}{8}'''$
E.	Monas termo, Müller, ...	$\frac{1}{800}$

VII. *Uralsk, on the River Ural.*—7 Forms.

E.	Aspidisca Lynceus, (Trichoda, Müller) . .	$\frac{1}{96}'''$
E.	Kolpoda cucullulus, Müller, . . .	$\frac{1}{100}$
	Navicula fusiformis, ...	$\frac{1}{20}$
E.	Oxytricha pullaster, (Kerona, Müller) . .	$\frac{1}{48}$
	Paramæcium compressum, n. sp. . . .	$\frac{1}{18}$
E.	Trachelius fasciola, (Vibrio, Müller) . .	$\frac{1}{36}$
E.	Vibrio rugula, Müller, ...	$\frac{1}{96}$

VIII. *Saratof on the Wolga.*—6 Forms.

E.	Amæba diffluens, (Proteus, Müller) . .	$\frac{1}{36}'''$
E.	Exilaria flabellum, n. sp.	$\frac{1}{80}$
	Fragilaria angusta, n. sp.	$\frac{1}{48}$
E.	——— pectinalis, Lyngbye, . . .	$\frac{1}{48}$
	——— scalaris, n. sp.	$\frac{1}{48}$
	Gomphonema rotundatum, p. sp. . . .	$\frac{1}{24}$—$\frac{1}{20}$

IX. *Ilezkaja Saschtschita Steppe, near Orenburg. Salt water observed at Orenburg.*—6 Forms.

Anguillula recticauda, n. sp. . . . . $\frac{1}{8}'''$
E. Bacterium monas, n. g. . . . . . $\frac{1}{336}$
——— cylindricum, al. sp. . . . . $\frac{1}{36}$
E. Doxococcus globulus, (Volvox, Müller) . . $\frac{1}{72}$
E. Loxodes cucullulus, (Kolpoda, Müller) . . $\frac{1}{80}$
E. Monas atomus, Müller, ... $\frac{1}{288}$

X. *Orenburg, on the River Ural.*—3 Forms.

Navicula gibba, n. sp. . . . . . $\frac{1}{12}'''$—$\frac{1}{10}'''$
——— uncinata, n. sp. . . . . . $\frac{1}{20}$
——— turgida, n. sp. . . . . . $\frac{1}{36}$—$\frac{1}{24}$

XI.—*River Sakmara West from Orenburg: examined with confervæ at Uralsk.*—1 Form.

E. Carchesium fasciculatum (Vorticella, Müller,) . $\frac{1}{36}'''$

XII.—*Platofski Steppe between Barnaul and Kolivan in East Siberia.*—1 Form.

Astasia hæmatodes, n. g. . . . . . $\frac{1}{33}'''$

XIII.—*Kyschtym in the Southern Urals; with confervæ of marsh water.*—2 Forms.

E. Pandorina morum, Bory, ... $\frac{1}{24}'''$—$\frac{1}{10}''$
Trichodiscus sol, n. g. . . . . . $\frac{1}{6}$

XIV.—*Troizk East from the Urals in the Siberian Steppe; from confervæ of a salt lake.*—1 Form.

E. Gomphonema discolor, n. sp. . . . . $\frac{1}{50}'''$

XV.—*Barnaul in East Siberia on the Obi.*—8 Forms.

E. Leucophrys? fluida, Müller, ... $\frac{1}{36}'''$
E. Monas atomus, Müller, ... $\frac{1}{500}$
——— ovalis, n. sp. . . . . . $\frac{1}{800}$
E. Navicula gracilis, n. sp. . . . . $\frac{1}{48}$—$\frac{1}{36}$
——— fusiformis, n. sp. . . . . $\frac{1}{36}$
Trichodina stellina, (Vorticella Müller,) . . $\frac{1}{24}$
Trichodiscus Sol, n. g. . . . . . $\frac{1}{34}$
E. Vibrio rugula, Müller, ... $\frac{1}{48}$

XVI.—*Petropawlofsk in West Siberia in the Ischim; from salt water of the Steppe.*—3 Forms.

Anguillula inflexa, n. sp. . . . . . $\frac{1}{6}'''$

E.	Colurus uncinatus, (Brachionus, Müller), . .	$\frac{1}{45}'''$
E.	Vibrio lineola, Müller, ...	$\frac{1}{300}$

XVIII.—*Catharinenburg on the Iset in the Urals; from the river, marshes, and the Lake Schartash.*—26 Forms.

E.	Actinophrys Sol, (Trichoda, Müller), . .	$\frac{1}{100}'''$—$\frac{1}{75}'''$
F.	Amceba diffluens, (Proteus, Müller), . .	$\frac{1}{50}$—$\frac{1}{25}$
E.	Arcella vulgaris, n. g.	$\frac{1}{100}$—$\frac{1}{40}$
E.	Aspidisca Lynceus, (Trichoda, Müller), . .	$\frac{1}{100}$—$\frac{1}{75}$
	Bacterium ? fuscum, n. g. . . .	$\frac{1}{125}$
	Bodo didymus, n. g.	$\frac{1}{800}$—$\frac{1}{600}$
	—— vorticellaris, al. sp.	$\frac{1}{100}$
E.	Closterium lunula, Nitsch. . . .	$\frac{1}{10}$
E.	Cocconema cistula, ...	$\frac{1}{125}$—$\frac{1}{50}$
	Cyclidium ? margaritaceum, n. sp. . .	$\frac{1}{125}$—$\frac{1}{100}$
E.	Doxococcus pulvisculus, n. g. . . .	$\frac{1}{125}$—$\frac{1}{100}$
	———— inæqualis, al. sp. . . .	$\frac{1}{20}$
E.	Exilaria panduriformis, n. sp. . . .	$\frac{1}{36}$
	Fragilaria bipunctata, n. sp. . . .	$\frac{1}{100}$
	———— scalaris, ...	$\frac{1}{75}$
	Gomphonema constrictum, n. sp. . . .	$\frac{1}{75}$
E.	Kerona pustulata, Müller, . . .	$\frac{1}{30}$
E.	Monas termo, Müller, ...	$\frac{1}{2000}$—$\frac{1}{1800}$
E.	Navicula fulva, (Bacillaria, Nitsch) . .	$\frac{1}{36}$
E.	———— gracilis, n. sp.	$\frac{1}{125}$—$\frac{1}{100}$
	———— turgida, n. sp.	$\frac{1}{50}$—$\frac{1}{10}$
	———— velox, n. sp.	
E.	———— ulna, (Bacillaria, Nitsch), . .	$\frac{1}{10}$
E.	Trachelius fasciola (Vibrio, Müller,) . .	$\frac{1}{60}$—$\frac{1}{50}$—$\frac{1}{25}$
E.	Trichoda ? Paramæcium, n. sp. . . .	$\frac{1}{100}$
E.	Vorticella convallaria, Müller, . .	body $\frac{1}{80}$

XVIII.—*Nishne Tagil in the North Urals on the Tagil.*—1 Form.

	Vorticella convallaria, Müller, . .	body $\frac{1}{80}'''$

XIX.—*Tobolsk in North West Siberia on the Irtysch and Tobol.*—21 Forms.

	Anguillula fluviatilis, Müller, . .	young $\frac{1}{12}'''$
E.	Arcella vulgaris, n. g.	$\frac{1}{100}$—$\frac{1}{20}$
E.	Bacterium Monas, n. g.	
E.	Brachionus urceolaris, Müller, . . .	$\frac{1}{20}$—$\frac{1}{10}$
E.	Closterium trabecula, n. sp. . . .	$\frac{1}{8}$
E.	Colurus uncinatus, ...	
E.	Difflugia proteiformis, Le Clerc. . . .	$\frac{1}{50}$
E.	Eosphora Najas, n. g.	$\frac{1}{8}$
	Fragilaria angusta, n. sp.	$\frac{1}{4}$

	Hydatina ? leptocerca, n. sp.	1/24
	——— ? laticauda, n. sp. . . .	1/24
E.	Kolpoda cucullus, Müller, . . .	1/100—1/75
	Monas hyalina, n. sp.	1/500
E.	Monostyla ? lunaris, n. g.	1/24
E.	Monura colurus, n. g.	1/36
	Navicula turgida, n. sp.	1/56
E.	Salpina ? bicarinata, n. sp.	1/10
	Trachelius globuliferus, n. sp. . . .	1/100
F.	——— trichophorus, n. sp.	1/100
	Vibrio amblyoxis, n. sp.	1/50
E.	Urocentrum turbo, Nitsch, . . .	1/45

XX.—*Bogoslofsk in the North Urals on the Turia, near* 60° *N. Lat.* —6 Forms.

E.	Coleps hirtus, Nitsch, ...	1/80‴
E.	Colurus uncinatus, (Brachionus, Müller), .	1/45
	Hydatina ? terminalis, n. sp. . . .	1/36
E.	Lepadella ? triptera, n. sp.	1/25
E.	Paramæcium chrysalis, Müller, . . .	1/25
E.	Vorticella microstoma, n. sp. . . body	1/96

XXI.—*Petersburg on the Neva; in the Neva water, confervæ of marshes and vegetable infusions.* 60° *N. Lat.* 48° *W. Long.*—23 Forms.

	Bacterium enchelys, n. g.	1/240‴
	——— punctum, al. sp.	1/336—1/333
	——— termo, al. sp.	1/500
E.	——— tremulans, al. sp.	1/288
E.	Cyclidium glaucoma, Müller, . . .	1/144—1/120
E.	Glaucoma scintillans, n. g. . . .	1/50...1/40
E.	Kerona pustulata, Müller, . . .	1/24
E.	Kolpoda cucullus, Müller, ...	1/144—1/75
E.	——— lens, Müller, ...	1/24
E.	Monas guttula, n. sp.	1/154—1/192
	——— hyalina, n. sp.	1/500—1/384—1/240
	——— umbra, n. sp.	1/1000
	——— volvox, n. sp.	1/288—1/144
E.	Paramæcium Aurelia, Müller, . . .	1/18
E.	——— Chrysalis, Müller, . . .	1/12—1/8
	——— ovatum, n. sp. . . .	1/24
E.	Spirillum volutans, (Vibrio spirillum, Müller,) .	1/192—1/89
E.	Trachelius anas, (Trichoda, Müller,) . .	1/24
E.	——— falx, Schrank, ...	1/36
E.	——— lamella (Kolpoda, Müller,) . .	1/75—1/48
E.	Trichoda ? Paramæcium, n. sp. . . .	1/90—1/88

E. Trichodina comosa, n. g. . . . . $\frac{1}{46}'''$
E. Vibrio rugula, Müller, ... $\frac{1}{96}$—$\frac{1}{48}$
E. Vorticella convallaria, Müller, . . body $\frac{1}{48}$—$\frac{1}{46}$
β Pyriformis.

In all 148 forms reducible to 113 distinct species, which extend through 51 genera. 95 species comprised in 39 genera, belong to the first class of Phytozoa, the *Polygastrica*. The other 18 species in 12 genera, belong to the *Rotatoria*. Assuming the chain of the Urals and the river of the same name as the boundary betwen Europe and Asia, 31 species belong to the former, and 82 to the latter. It will also be seen from an inspection of the table, that 69 species * agree with those which have been described in Europe by Muller, or since discovered at Berlin. The other 44 belong, like the tropical species, for the most part to European genera. The following genera, which were first discovered on this journey, have been all since detected at Berlin, viz.

Arcella.	*Bodo.*	*Trichodiscus.*
Astasia.	*Eosphora.*	

So that there is no genus which can be regarded as peculiar to these regions.

The genera which contain the greatest number of species always belong to the Phyt. polygastrica, viz.

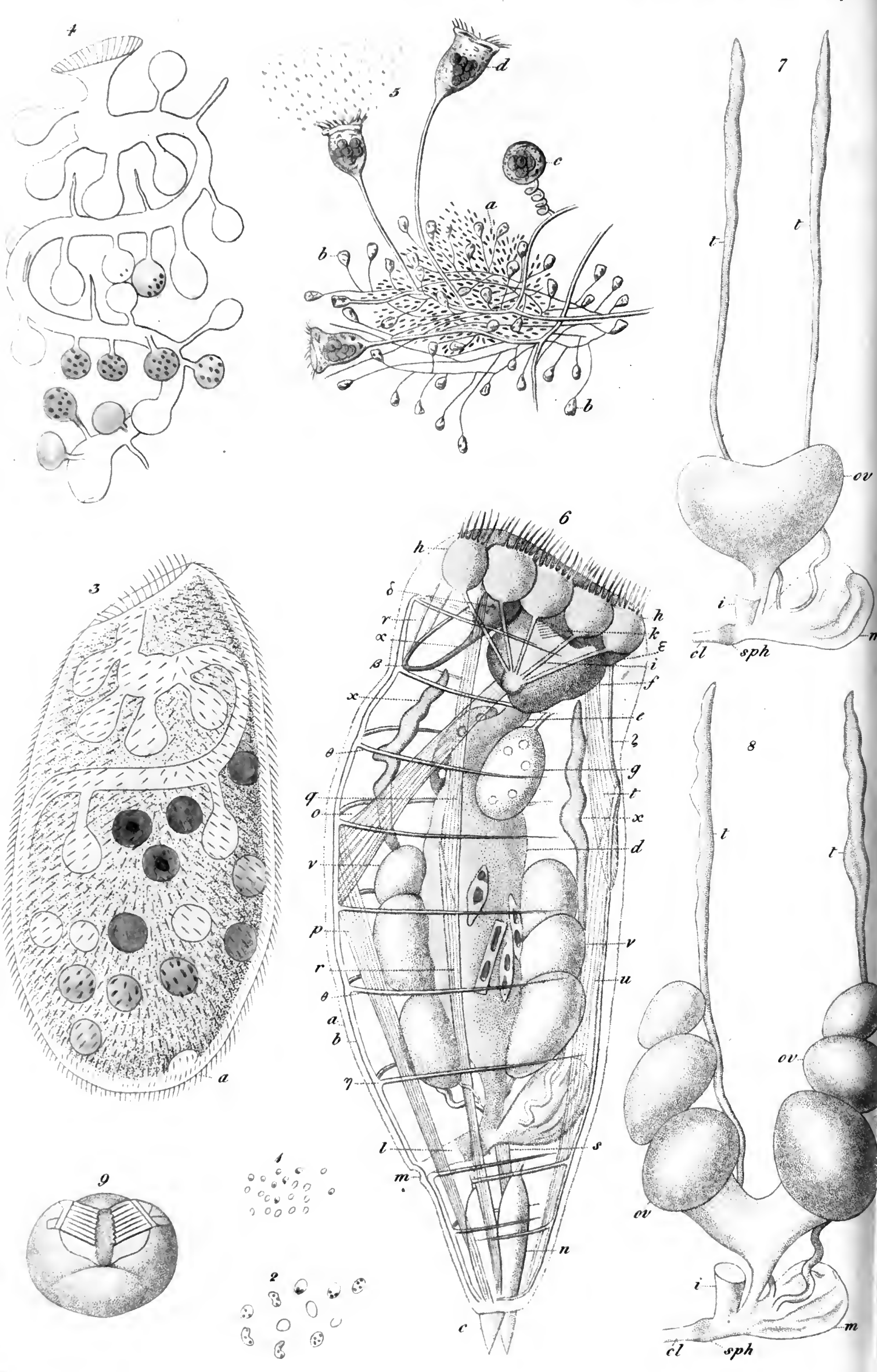
6 species of *Trachelius.*
7 —— of *Navicula.*
8 —— of *Bacterina.*
13 —— of *Monas.*

Upon comparing together the African and Russian tables, we find, that the Infusoria which occur, 1. at Petersburg and Bolgoslofsk, in lat. 60°; 2. at Sinai, in lat. 28°; and, 3. in Dongola, lat. 19°; are:

Polygastrica—4.	*Rotatoria*—none.
Cyclidium glaucoma.	
Kolpoda cucullus.	
Paramæcium chrysalis.	
Trachelius lamella.	

The species which extend over a still greater space, being found at Berlin, the Altai Mountains, Sinai, and Dongola, are:

* Preceded in the Table by the letter E.



F. Mitchell sculpt.

Polygastrica—4.	*Rotatoria*—3.
Closterium lunula.	(Anguillula fluviatilis.)
Kolpoda cucullus.	Diglena catellina.
Monas termo.	Kotifer vulgaris.
Navicula fusiformis.	

Only one species has been found in all the points to which Dr Ehrenberg's observations have extended, viz. at Sinai, Dongola, Berlin, Petersburg, Bogoslofsk, and the Altai Mountains, the Kolpoda cucullus.

2. *In Subterranean Waters.*—As it was one of the principal objects of Humboldt's journey through the Russian dominions to examine all the more important mines in the empire, an opportunity was given to Dr Ehrenberg of determining the presence or absence of infusory animals in situations excluded from the light of day, one of the principal agents in the production of these animals upon the hypothesis of the *generatio primitiva.* For this purpose he took the precaution of enclosing the stagnant water, mould, and other substances brought to the surface for examination, in well dried glass flasks, so as to preclude the possibility of their being carried thither from the surface; and in one instance, the depth was such that it was not even probable that they had penetrated so far along with the surface water, but had been generated in the place where they were found.

His endeavours were long unsuccessful. They were at last found in tolerable numbers in two situations:

1. At the depth of 56 archines (fathoms), in the silver mines of Smeinogorsk, in the Altai Mountains, the following species:

Anguillula fluviatilis,	$\frac{1}{13}'''$
Kolpoda cucullus,	$\frac{1}{100}$
Loxodes cuculullus,	$\frac{1}{60}$
——— cucullio,	$\frac{1}{75}$

It will be seen from the Russian table, that none of these species were found at Smeinogorsk in the waters at the surface.

2. At the depth of 6 archines, in the copper-mine of Soimonofskoi, in the Southern Urals, in addition to the preceding species,

Monas atomus,	$\frac{1}{300}'''$
——— enchelys,	$\frac{1}{100}$
——— termo,	$\frac{1}{1000}$

It will be seen that the *Kolpoda cucullus* is again found in both these situations.

3. *In Atmospheric Waters.*—The occurrence of infusory animals in this situation became an object of interest ever since Humboldt drew the attention of naturalists to those currents of air which often ascend to the height of 18,000 feet above the earth's surface, and are capable of carrying into the atmosphere many minute bodies which may be deposited on the summits of lofty mountains, or conveyed to distant plains. Not to mention the idea of Spallanzani, of minute infusoria hovering in the atmosphere, Gleichen's observations of their existence in snow melted in a room, might lead to the supposition of their existence in the atmosphere.

The burning plains of Africa present peculiar advantages for the decision of the question. During the day, the scorching rays of the meridian sun destroy every trace of life except the lizard; and during the night, the heavy dews afford atmospheric water in a state of great purity. During Dr Ehrenberg's journey into Africa, he made a point of examining, at almost every resting-place, the dew-drops which deposited themselves so abundantly on their instruments, &c. during the night. Each time he examined from fifteen to twenty drops, so that the aggregate number cannot have been short of 300 drops; but *in not one instance has he seen a single living animal.*

With this we conclude our analysis of Dr Ehrenberg's observations, which have already extended perhaps to too great a length. The author, however, was unwilling to give an imperfect account of these discoveries, which will form so important an epoch in zoological and physiological science. The friend of science cannot, however, help regretting, that while our continental neighbours are adding such important accessions to her domains, not one Briton figures in the annals of Phytozoölogy; for we can hardly except from this censure the names of Home and Baer, who have given us a few details on the Vibrio of wheat. I shall only add a single reflection which is naturally suggested by the foregoing subject. When we consider the infinity of animals with which the material world is filled, their multitude is truly amazing. Every green leaf swarms with inhabitants. The bodies of other animals are in a manner filled with intestine life. The seas, lakes, marshes, and rivers of our planet teem with numberless living creatures. Without adding to these the gradations which Mr Locke has shewn to be more than probable in the intellectual world, we might almost conclude that the strength of creative energy has been more lavishly expended upon the animate than upon the inanimate world; and that notwithstanding the immense system of bodies into which Nature has so curiously wrought the mass of dead matter, and the several relations which these bear to each other, there is something still more wonderful in contemplating the world of life with which every part of the universe is furnished.

Explanation of Plate IV.

Fig. 1. *Monas termo,* Müller, viewed with a power of 800. Its dimensions by the glass micrometer, were from $\frac{1}{1500}$ to $\frac{1}{2000}$ of a line. Even in this minute creature, when treated with infusion of indigo, can be perceived distinctly, in the hinder part of the body, from four to six blue points, which the analogy of the larger infusoria leaves no doubt to be as many digestive sacs. The smaller end, or fore part of the animal, always appears perfectly transparent. About 500 millions of these animalcules may be calculated to exist in a single drop.

Fig. 2. *Monas atomus,* Müller, magnified 380 times. Its real dimensions are about $\frac{1}{288}'''$. In this species the circumscribed cavities, filled with colouring matter, are equally distinct. In the midst of these are often seen others, of exactly the same form, but quite transparent, of which Müller made a separate species, *M. lens.* The *M. atomus* has often a transverse fissure or contraction—the commencement of a gemmiparous propagation.

Fig. 3. The *Leucophrys patula,* Ehr., *Trichoda pat.* Müller, magnified 380 times. This beautiful animal is remarkably characterized by the singular form of its intestinal canal, and by the innumerable ciliæ with which its body is everywhere beset. Many of the sacs, cæca, or stomachs, which exist in greater or less numbers in the interior of the animal, resemble very closely the ova of some of the *Infusoria Rotatoria;* but their real nature appears on the exhibition of coloured infusion, for, from being perfectly transparent, and with a sort of granular aspect, they become beautifully coloured, although no canal of communication is visible between them and the main tube. *a* designates the orifice of the anus, distinguished by the discharge of coloured matter in large irregularly coherent masses.

Fig. 4. The intestine of the *Leucophrys patula,* as it appears during the varied

contractions and contortions of the animal; when the connexion of the different sacs with the intestinal canal becomes very apparent.

Fig. 5. Represents the structure and development of the *Vorticella Convallaria*, Müller. In consequence of ignorance of this, no less than six different species have been formed of this animal, according to its appearance at different stages of its development.

At *a* appears a network of innumerable minute points attached to the roots of the adult animal. Their size is about $\frac{1}{1000}'''$. They experience a vibratory motion, but are never detached from their original seat, so that they are probably connected with the roots by fine peduncles, too minute to be visible. They closely resemble the network of ova, whose actual exclusion from the parent animal, Dr Ehrenberg has frequently seen in the *Kolpoda cucullus*. Their actual production from the adult *V. convallaria* has never yet been seen, but this analogy makes it more than probable they are of the same nature, or, at most, the very next grade in the progressive development of the animal.

At *b* the same animal is seen further advanced, and already furnished with a distinct peduncle and head, the latter of which is even now capable of causing currents of coloured particles in the water. Schrank gave to the animal under this form the name of *V. monadica*. Still later they appear as at *c*, where the spiral shortening of the peduncle is most apparent.

At *d* the animal is in its perfect state. We need not repeat here what we have already noticed, of this animal propagating itself also by a longitudinal and transverse division, and also by gemmules.

Fig. 6. Lateral view of the *Hydatina senta*, Ehrenberg, *Vorticella senta*, Müller, magnified 380 diameters, the true length of the animal being about $\frac{1}{8}'''$.

a External tunic of the integuments.
b Internal ditto.
c Bifid tail.
d Intestinal canal.
e Œsophagus.
f Bulb of the œsophagus.
g One of the glandular bodies which embrace the œsophagus.
h Rotatory organs. When seen vertically, whilst in full activity, they are seventeen in number, and each is provided with six ciliæ.
i Ligamentous bands, to which the rotatory organs are attached, and by which their motions are regulated.
k Mouth, with its mandibules or teeth.
l Cloaca communis for the intestine and oviduct.
m Orifice of the anus.
n Caudal muscles.
o Musculus dorsalis anterior.
p Musculus dorsalis posterior.
q Musculus lateralis dexter anterior.

r Musculus lateralis dexter posterior.
s Portion of the musculus lateralis sinister posterior.
t Musculus ventralis anterior.
u Musculus ventralis posterior.
v Ovaria.
x Male seminal organs, testes.
α Nervous circle in the neck.
β Cervical ganglion.
γ Recurrent nerves.
δ Great œsophageal ganglion; above œsophagus.
ι Œsophageal ganglia; on sides of œsophagus.
ζ Ventral nerve.
η Great dorsal vessel.
θ Transverse twigs, given off from the dorsal vessel.

N. B.—The foreign bodies which are seen in the cavity of the intestine are individuals of the *Navicula fulva* and *N. gracilis*, which the animal has swallowed, and with which the digestive cavity is sometimes completely filled.

Fig. 7. Generative organs in their unimpregnated state; and,

Fig. 8. The same organs impregnated. In these two figures,
t Represents the testes, or male seminal organs.
o v The ovaria.
i The extremity of the intestine.
c l The cloaca communis.
s p h A muscular-looking body, embracing the cloaca,—sphincter?
m Singularly contractile body, into which are inserted the openings of the testes (vasa deferentia ?) and which not improbably performs the function of a musculus ejaculatorius.

Fig. 9. Appearance of the mouth, with its mandibules or teeth, when separated from the body by pressure between two fine laminæ of mica, along with the bulb of the œsophagus.

Addendum.

A remarkable deviation from the normal structure of the male generative organs among the *Inf. Rotatoria* characterizes the *Rotifer vulgaris*, Schrank, and the *Philodina erythrophthalma*, Ehrenberg. They are unprovided with the singularly contractile organ which usually embraces the excretory ducts of the male testes, and which is very distinct in the *Hydatina*. Its place seems to be supplied by an erectile organ, resembling very much in form the penis of the higher animals, and which projects from the neck. That this is its nature is rendered very probable from the animal frequently inflecting itself nearly double, and applying this organ to the cloacal orifice situated near its posterior extremity, by which the ova and living young (for these species are also viviparous) are excluded. A striking analogy to this position of the male organs is presented by many of the mollusca *.

NOTE.—In the first part of this Memoir, at p. 223, a Note of interrogation has been inadvertently omitted after *Nervous System*, which the reader will be so good as to supply.

Visit to the Valley of Death, in the Island of Java. By A. LOUDON, Esq. In a Letter to Professor JAMESON.

MY DEAR SIR,

THE following is an extract from my journal of a tour through the Islands of Java and Madara last year:—

" *Balor, 3d July* 1830.—This evening, while walking round the village with the Patteh (native chief), he told me that there

* In a late number of Oken's Isis (1831 Heft. 4. p. 403), I observe that Dr Eschweiler considers as fully demonstrated what Dr Ehrenberg only hazards as a probable conjecture, viz. that the Monads and other allied genera are only the young animals of the *Kolpodæ, Paramæciæ*, &c. in their first stage of development. He founds his opinion on the fact of his always having observed monads appear first in the water of a bottle, which he happened to be daily examining, in prosecution of his researches into the ova and early states of some of the microscopic fungi; and that gradually from day to day he witnessed the successive appearance in the water of the *Vorticellæ, Rotatoriæ*, and others of the more complicated forms. He does not mention whether these monads could be detected; nor does he seem to have actually seen the metamorphosis of the simplest *Polygastrica* into the highly organized *Rotatoria*; so that as yet the question remains for solution.

Dr Eschweiler farther seems to consider, the minute gelatinous-looking corpuscles, which adhere to the roots of the vorticellæ, and which seem to be afterwards evolved into perfect animals similar to their parent trunks; as the commencement of animal life, by the spontaneous productions of its first element,—a simple animated vesicle. The hastiness of this conclusion will be at once apparent to those who have perused the body of the above memoir. For we have there seen that although the real source of this reticular spawn-like matter, has not been fully made out with regard to the *Vorticellæ*; the actual exclusion of a substance exactly similar from the body of the *Kolpoda cucullus*, is a matter of actual observation. We are therefore entitled by an almost irresistible analogy to conclude, that both are derived from the same source. M. G.

is a valley only three miles from Balor, that no person could approach without forfeiting their lives, and that the skeletons of human beings, and all sorts of beasts and birds covered the bottom of the valley. I mentioned this to the Commandant Mr Van Spreewenberg, and proposed our going to see it; Mr Daendels, the assistant-resident, agreed to go with us. At this time I did not credit all that the Javanese Chief told me. I knew that there was a lake close to this, that it was dangerous to approach too near, but I had never heard of the Valley of Death.

" *Balor, 4th July.*—Early this morning we made an excursion to the extraordinary valley, called by the natives *Guwo Upas*, or *Poisoned Valley:* it is three miles from Balor, on the road to the Djiang. Mr Daendels had ordered a footpath to be made from the main road to the valley. We took with us two dogs and some fowls, to try experiments in this poisonous hollow. On arriving at the foot of the mountain, we dismounted and scrambled up the side, about a quarter of a mile, holding on by the branches of trees, and we were a good deal fatigued before we got up the path, being very steep and slippery, from the fall of rain during the night. When within a few yards of the valley we experienced a strong nauseous suffocating smell, but, on coming close to the edge, this disagreeable smell left us. We were now all lost in astonishment at the awful scene before us. The valley appeared to be about half a mile in circumference, oval, and the depth from 30 to 35 feet, the bottom quite flat,—no vegetation,—some very large, in appearance, river-stones, and the whole covered with the skeletons of human beings, tygers, pigs, deer, peacocks, and all sorts of birds. We could not perceive any vapour or any opening in the ground, which last appeared to be of a hard sandy substance. The sides of the valley from the top to the bottom are covered with trees, shrubs, &c. It was now proposed by one of the party to enter the valley; but at the spot where we were, this was difficult, at least for me, as one false step would have brought us to eternity, as no assistance could be given. We lighted our cigars, and, with the assistance of a bamboo, we went down within 18 feet of the bottom. Here we did not experience any difficulty in breathing, but an offensive nauseous smell annoyed us. We now fastened a dog to the end of a bamboo, 18 feet long, and sent him in, we had our watches in our hands, and in 14 seconds he fell on his back, did not move his limbs or look round, but continued to breathe 18 minutes. We then sent in another, or rather he got loose from the bamboo, but walked in to where the other dog was lying: he then stood quite still, and in 10 seconds he fell on his face, and never moved his limbs afterwards: he continued to breathe for 7 minutes. We now tried a fowl, which died in 1½ minute. We threw in another, which died before touching the ground. During these experiments we experienced a heavy shower of rain; but we were so interested by the awful scene before us, that we did not care for getting wet. On the opposite side, near a large stone, was the skeleton of a human being, who must have perished on his back, with the right arm under the head, from being exposed to the weather, the bones were bleached as white as ivory. I was anxious to procure this skeleton, but any attempt to get at it would have been madness. After remaining two hours in this Valley of Death, we returned, but found some difficulty in getting out. From the heavy shower, the sides of the valley were very slippery, and had it not been for two Javanese behind us, we might have found it no easy matter to escape from this pestilential spot. On reaching our rendezvous we had some brandy and water, and left this most extraordinary valley, came down the slippery footpath, sometimes on our hams and hands to the main road, mounted our horses, and returned to Balor, quite pleased with our trip. The human skeletons are supposed to have been rebels, who had been pursued from the main road, and taken refuge in the different valleys, as a wanderer cannot know his danger till he is in the valley, and when once there, one has not the power or presence of mind to return.

"There is a great difference between this valley and the *Grotto del Cano*, near Naples, where the air is confined to a small aperture; while here the circumference is fully half a mile, and not the least smell of sulphur, nor any appearance of an eruption ever having taken place near it, although I am aware that the whole chain of mountains is volcanic, as there are two craters at no great distance from the side of the road at the foot of the Djienz, and they constantly emit smoke."—Fahr. 52°.

In the 8th volume of the proceedings of the Batavian Society of Arts and Sciences, Dr Horsefield of the East India House, gives a description of the mineral constitution of the different mountains of Java. He examined several parts of the chain of hills, and states that he heard of this valley, but that he could not prevail on the natives to shew him where it was. I have sent the Doctor a copy of the above extract."

Remarks on the Serrature of the Middle Claw, and the irregular Denticulation of the Beak, in certain Birds. By W. Macgillivray, A. M., &c. Conservator of the Museum of the Royal College of Surgeons, &c. Communicated by the Author.

The serrature of the middle claw of certain species of birds, is a circumstance which must have attracted the notice of every person accustomed to look somewhat minutely to birds. The results of my observation on this subject may be briefly stated as follows. In different birds, the claws are of various forms: sometimes nearly circular in their transverse section, and more or less curved, as in hawks and owls; sometimes flat and expanded, as in grebes; sometimes they have two small sharp margins, and sometimes one of the margins is enlarged. In all birds, the inner margin of the third or middle claw is larger than the outer, and that claw is more or less curved outwards. Claws with small margins, or such as are strong, with a thick margin, are never serrated, as in eagles, pheasants and geese. Claws which have the inner margin dilated, but rather strong, are sometimes undulated, not merely on the edge-line, but along the whole plane of the inner slope, as in some ducks and gulls. In the shearwater and some other birds, the margin, which is dilated, and rather thin, is undulated with irregular serratures. In the herons, in which the middle claw has a thin margin, the serrature is regular; but in the storks and Balearic crane, in which the claw is thicker, the margin is entire. In the genera

Carbo, Pelecanus, Sula, and Phaeton, the margin of the middle claw is thin and distinctly serrated. In the grebes, in which the claws are quite flat and round, the extremity of that of the middle toe is also serrated, or rather cut into by parallel lines. Lastly, In the genus Caprimulgus, in which the inner margin of the middle claw is extremely thin, so as to be quite flexible, that margin is regularly, beautifully, and deeply serrated, insomuch that it may be said to be pectinated; while in the intimately allied genus Podargus, the claws of which are of a different form, the margin is entire.

The serrature of these claws is not like that of the leaves of plants, or the teeth of a saw, but consists of short parallel cuts in the edge of the claw, not at right angles to the central line, but more or less oblique, and directed towards the base, somewhat like the barbs of a quill, parallel, and in contact at the edges. They are in general, but not always, equally distanced; and the thinner the claw is, the more regular they usually are. The serratures towards the end of the claw are more or less broken. Sometimes there is, in consequence, a large piece of the inner edge wanting, and sometimes, especially in very thin claws, as in those of the goatsuckers, the end of the claw is broken off. Such are the facts known to me on this subject.

When certain persons have observed a fact in structure, they are desirous of knowing its relation to function, and employ various methods for this purpose; but, on the whole, conjecture is the mode usually adopted, for observation is not suited to the genius of all who call themselves naturalists, and fancy is a ready solvent for all gordian knots in physiology. In the Journal of the Royal Institution of Great Britain, for October 1830, there is a paper on the Cleanliness of Animals, by Mr Rennie, in which he takes occasion to allude to the pectinated structure of the claw of the middle toe of the fern-owl or goatsucker. The following are his remarks in a condensed form.

The bird alluded to has the middle claw cut into serratures, like a saw or a short-toothed comb. White of Selborne seems to think this structure given for the purpose of enabling it to seize insects. Mr Dillon's observations lead him to suppose that the serratures are employed by the bird to comb its whiskers. Mr Swainson thinks that the fact of an American group of the same birds, which have no whiskers to comb, and an Australian group, which have whiskers, but no serratures on the claws, is discordant with Mr Dillon's opinion. Wilson, the American ornithologist, in describing the Whip-poor-will, says the pectinated middle claw is probably employed as a comb, to rid the plumage of its head of vermin. He makes a similar remark with reference to the Chuck-will's-widow. " Considering the utility of such an instrument," says Mr Rennie, " we may wonder, perhaps, that besides the herons, no other birds are similarly provided for attacking those troublesome insects, which often seriously injure the vigour and health of the animal infested, and sometimes even occasion death." He then proceeds to relate a case of a swallow, which, being infested with vermin, " seemed instinctively courting human aid," and allowed him to free it of its tormentors, after which it flew off joyfully to join its companions. The case is similar to one which occurred to Audubon. A hawk allowed itself to be caught and carried home, sat patiently on a perch until its portrait was leisurely finished, and then flew off in merry mood. In fact, it seemed instinctively desirous of being represented by the artist.

Observation and experiment can alone determine the use of an organ ; but, on the subject in question, we are deficient in facts. Wilson says the Carolina Goatsucker is often employed in riding itself of vermin, by means of its pectinated claw, " at least, when in a state of captivity." But Audubon, who had better opportunities of observing that bird, professes entire ignorance of the use of the claw. Birds, however, which have no pectinated claw, may be seen, in freedom and in captivity, scratching their heads, often very assiduously, and thus the pectination is not at all essential to the purpose. In the deficiency of observed facts, we may sometimes have recourse to analogy and reflection; at least, the truth of an alleged or supposed fact, may sometimes be settled by means of them.

It is a fact that many birds are much infested by vermin, especially about the head. It is also a fact that, in general, these parasitic insects do not injure their patrons in a serious degree, for animals much infested by them, appear to perform all their functions as well as other individuals of the same species less infested. When an animal becomes sickly, its vermin may increase so as seriously to add to its disease, or vermin may become a disease, and injure or destroy the animal; but these are conjectures rather than facts. It is a fact, that birds liable to be infested by vermin are quite unable to rid themselves of their tormentors, the latter enjoying almost perfect immunity, especially about the head, which, with others, is a reason why the head, and especially the anterior part of it, should be more densely peopled than the other parts of the body. It is asserted that gallinaceous and passerine birds wallow in dust for the purpose of ridding themselves of vermin. The reason is doubtful, although the fact is notorious; but it is certain that these birds have vermin, of which they do not succeed in ridding themselves by means of their bills or claws. If an active little bird, like a chaffinch or wren, be not able to wield its bill effectively, how much less chance has the spoonbill, the stork, the goose or the eagle! I have watched gannets as they sat on their nests, or roosted on the rocks, but I never saw one scratch its head, although these birds are sadly infested by insects, and have the middle toe serrated. But against the supposed use of the serrated claw in the goatsucker, the fact is decisive that birds at least as much infested by insects, such as the magpie, auk, and guillemot, have no comb. Besides, the claw in question is so constructed that it could not answer the purpose intended; for the serratures are close, and therefore could not act as a comb, or if the barbs could be introduced between them, they are so thin and delicate that a week's use would render the comb unserviceable. As to the seizing of insects, it being a fact not observed but supposed, it is only necessary to ask if herons, pelicans, and boobies catch insects, or fishes either, with their claws? Lastly, if the pectinated claw be used by the goatsucker for cleaning its whiskers, which become clogged with the scales of moths, why has not the cormorant whiskers to be cleaned, seeing it has the currycomb? In short, we know nothing about the matter; but one fact often throws light on another.

Thus it is a fact that the edges of the bill of the gannet, the booby, and the lesser booby, are irregularly serrated, sometimes deeply and indistinctly, especially in the latter species. The serratures have a regular direction, being inclined inwards or toward the base of the beak. Now, it is a fact, that until the young gannet is fully fledged, it has no serratures on its beak, the edges of which are quite even, and that until it has flown about for some time, and shifted for itself, they remain entire. It is therefore evident that use has broken the edges into irregular serratures, and that the regularity of the direction of these serratures must depend upon the action, or, more probably, chiefly upon the organic structure of the bill, which gives it a tendency, under the application of force, to break in a particular way.

It is also a fact, a curious fact, right to the purpose, that the young gannet has no serratures on its middle claw, until it has left the nest and flown about for some time. It is therefore evident that use produces the serratures of the claw. But gannets never employ their feet in catching fish, and the act of scratching their heads could never break their claws. Wherefore, the serratures are produced in some other way, perhaps by the weight of the bird in settling, and the action of the flexors of the toes in strongly pressing the claw against the rock, whereby the edge of the middle claw, the only one that is thin and flexible, breaks into parallel rents. If this be the case in the gannet, analogy leads us to suppose it to be equally so in the heron and the goatsucker. I am not, however, inclined to run into conjecture, and therefore stop at a point where one can easily look back and separate fact from fancy.

In the mean time, it would be curious to observe whether the young of all birds which have irregularly serrated bills, have the margins even until they leave the nest, as in the case of the gannet; and whether the middle claw of the young of such birds as have that organ serrated in the adult state, is as entire as in the species just mentioned. When these facts are determined, and the habits of the species closely examined, we may be able to discover the real nature of the serrated claw.

With respect to the serrature of the beak, I have still to remark, that it occurs in many birds in various degrees, but always and exclusively in such as have beaks with long, sharp and thin edges. Thus, irregular serratures are occasionally seen in the bill of the terns, and always in the same direction. They are more decided and regular in the genera Sula and Phaeton. In young birds of these genera, they are usually less marked, and sometimes, in old birds, the edges are almost entirely broken. Supposing these fractures or incisions to take place in consequence of the action of the beak, as is the case in the gannet and tern, it is difficult to conceive how that action should produce it. The fishes on which these birds prey are caught by plunging after them, and are swallowed entire, so that the edges of the beak do not come in contact with bone. But the determination of the question must be left to observation, which alone can elicit truth, conjectures as to the uses of organs, and the reasons of facts, being merely useful in leading to experiment, and having a claim upon our credence only in proportion to the general knowledge and correct judgment of their author.

Descriptions of some new Species of Malesherbia, Kageneckia, Quillaja, and of a new Genus of the order Salicariæ. By Mr David Don, Librarian to the Linnean Society; Member of the Imperial Academy Naturæ Curiosorum; of the Imperial Society of Naturalists of Moscow; of the Royal Botanical Society of Ratisbon; and of the Wernerian Society of Edinburgh, &c.

Having already given detailed descriptions of the three genera above mentioned, in two preceding numbers of this Journal, and also of the species then known to me, I shall confine myself in this place to the description of the new species, the numbers of which, for the sake of connexion, are continued from those already described by me.

QUILLAJA, No. 20. p. 229

3. Q. *petiolaris,* foliis longè petiolatis ovalibus dentatis subserratis.

Hab. In Chili. *D. Cuming.* ♄ (V. s. sp. in Herb. Lamb.)

Folia ovalia, dentata, subserrata, glabra, nitida, sesqui v. bipollicaria. *Petioli* ferè unciales. *Stipulæ* parvæ, caducæ. *Flores* nondum vidi.

Obs. Maximè affinis Q. saponariæ, sed abundè diversa petiolis 6-plò longioribus.

KAGENECKIA, No. 20. p. 231.

3. K. *cratægoides*, foliis elliptico-oblongis mucronatis argutè serratis, corymbis axillaribus, laciniis calycinis denticulatis.

Hab. In Chili ad Cumbre Andium claustrum. *Macrae, Cuming.* ♄ (V. s. sp. in Herb. Lamb.)

Arbor sempervirens, cortice plumbeo lævi. *Folia* brevissimè petiolata, elliptico-oblonga, mucronata, argutè serrata (serraturis subspinulosis) rigida, basi sæpiùs rotundata, suprà viridia, lucida, subtùs glauca, utrinque glabra, venosissima, sesqui v. bipollicaria. *Petioli* dilatati, sesquilineam longi. *Stipulæ* minimæ glandulæformes. *Flores* (masculos tantum vidi) albi, corymbosi, ferè *Cratægi oxyacanthæ*. *Corymbi* axillares, multiflori. *Calyx* campanulatus: *laciniis* ovalibus, margine denticulatis, leviterque lanuginosis. *Petala* orbiculata, venosissima, margine puberula. *Stamina* 15: *filamentis* subulatis, imâ basi in annulum prominulum connatis.

4. K. *angustifolia*, foliis lineari-lanceolatis acutis: denticulorum glandulis deciduis, floribus corymbosis.

Hab. In Chili. *D. Cuming.* ♄ (V. s. sp. in Herb. Lamb.)

Arbor sempervirens, *Dodonææ* facie. *Folia* conferta, petiolata, lineari-lanceolata, acuta, serrulata, basi attenuata, utrinque vernice obducta, tripollicaria: *denticulis* apice deciduo subinde obtusis. *Flores* (macsulos tantùm vidi) terminales, corymbosi, albi. *Calyx* cyathiformis: *laciniis* ovatis, acutis, margine puberulis. *Petala* 5, obovata, venosa, ciliata. *Stamina* 15, quorum 5 laciniis calycinis opposita; cæteris per paria petalis oppositis: *filamentis* subulatis, imâ basi in annulum prominulum connatis.

Obs. Folia in toto genere obliquè posita, nec verticalia, coriacea, paginâ utrinque consimili, costâ unicâ prominenti, venisque obliquè transversis, dichotomis, numerosis.

MALESHERBIA, No. 4. p. 322.

3. M. *linearifolia*, villosa; foliis linearibus integris, perianthii fauce dilatatâ, coronâ decemfidâ: laciniis dentatis.

Gynopleura linearifolia, *Cav. Icon.* iv. p. 52. t. 376.

Hab. In Chili montibus, præsertim in tractu Portillo vulgò dicto usque ad Mendoza urbem. *Ludovicus Née.* ☉?

Caulis tripedalis. *Folia* sessilia, linearia, integerrima, semipollicaria; *inferiora* longiora, serrulata. *Flores* axillares (an rectius oppositifolii ?) albi. *Perianthium* fauce dilatatum, campanulatum, limbo 10-fidum; *laciniis exterioribus* lineari-oblongis, obtusis; *interioribus* obovatis, retusis. *Styli* infra apicem ovarii inserti.

I had referred to this plant, with a note of interrogation, under my *M. paniculata*, described in the number above quoted of this Journal; and although I have not yet been so fortunate as to see a specimen, I am now convinced of its being a distinct species.

4. M. *humilis*, villosissima, foliis laciniatis, perianthii fauce dilatatâ, coronâ simplici erosè dentatâ, antheris subrotundis!

Hab. In Chili and Coquimbo. *Mucrae, Cuming.* ♄ (V. s. sp. in Herb. Lamb.)

Herba undique villosissima, mollis. *Caulis* procumbens, ramosissimus, spithamæus. *Folia* sparsa, petiolata, oblonga, laciniata, basi attenuata, semuncialia; *superiora* minora, nonnisi dentata. *Flores* minores, albi, demum exsiccitatione cœrulescentes, copiosissimi, brevissimè pedunculati suboppositifolii. *Perianthiùm* semipollicare, villosissimum: *faux* tubo vix longior: *corona* simplici, brevissimâ, tenuissimè membranaceâ, erosè dentatâ: *limbi laciniis exterioribus* ligulatis, trinerviis; *interioribus* obovatis, retusis. *Filamenta* capillaria, basi in columnam brevem connata. *Antheræ* parvæ, subrotundæ! *Styli* 3, capillares, ovarii trigoni medio inserti. *Capsula* membranacea, oligosperma.

5. M. *coronata*, glanduloso-pubescens; foliis linearibus sinuato-dentatis, perianthii fauce dilatatâ, coronâ simplici integerrimâ!

Hab. In Chili ad Valparaiso. *D. Cuming.* ⊙? (V. s. sp. in Herb. Lamb.)

Herba minutè pubescens, cinerea, glandulisque pedicellatis copiosè ornata. *Caulis* erectus, teres, sesqui v. tripedalis. *Folia* brevissimè petiolata, elongato-linearia, obtusa, basi attenuata, 3–5-pollicaria; *inferiora* grossè sinuato-dentata; *superiora* plerumque integerrima, densè glandulosa. *Flores* violacei, paniculati. *Perianthium* tomentosum, copiosè glandulosum, pollicare: *faux* dilatata, in tubum gradatim attenuata: *limbus* fauce longior; *laciniis exterioribus* elliptico-oblongis, obtusis, trinerviis, reticulato-venosissimis; *interioribus* ovatis, acutiusculis, basi angustatâ subunguiculatis, venosis, brevioribus: *Coronâ* simplici, brevissimâ, tenuissimè membranaceâ, integerrimâ! *Filamenta* complanata, glabra, basi in columnam elongatam connata. *Ovarium* globosum, tomentosum, columnæ staminalis longioris apici insidens. *Styli* 3, terminales! longissimi, capillares. *Stigmata* paullò dilatata.

PLEUROPHORA.

Syst. Linn. HEPTANDRIA MONOGYNIA.

Ord. Nat. SALICARIÆ, *Juss.*

Calyx tubulosus, angulatus, bibracteatus: *limbo* plicato, 10–14-dentato: *dentibus* semi-ovatis, erectis, conniventibus, mucronatis; *alternis* spinosis, patentibus. *Petala* 5 v. 7, ligulata, ungue brevissimo, dentibus calycinis propriis alterna, fauci inserta. *Stamina* 7, rarius 5 v. 8, basi tubi calycini inserta: *filamenta* capillaria, glabra, calyce longiora: *antheræ* cordatæ, biloculares, suturâ marginali ferè undique dehiscentes. *Pistillum* 1: *ovarum* ovato-oblongum, compressum, pedicellatum, lateri inferiori baseos calycis insertum! uniloculare: *stylus* filiformis, glaber: *stigma* simplicissimum. *Placenta* ovarii parieti omninò adnata! *ovula* pauca, obovata, compressa, erecta. Cætera ignota.

Fruticulus *spithamæus, ramosissimus, rigidus:* ramis *tetragonis, angulis denticulato-scabris.* Folia *opposita, sessilia, lineari-lanceolata, acuminata, integerrima, coriacea, glabra, margine colorato, scabro, pollicaria.* Flores *in apice ramulorum axillares, sessiles, conferti, subspicati.* Bracteæ 2, *calyci utrinque adnatæ, lineari-lanceolatæ, mucronato-spinosæ.* Petala *parva, punicea.* Antheræ *violaceæ.*

1. P. *pungens.*

Hab. In Chili ad Coquimbo. *Macrae, Cuming.* ♄ (V. s. sp. in Herb. Lamb.)

This remarkable genus must be placed next to *Cuphea*, but from which, as well as from every other genus of the order, it is essentially distinguished by its pedicellate fruit, and by the placenta being attached along its whole length to the upper side of the ovarium. The stamina are also fewer in number, and the calyx is furnished with two bracteæ. The plant is a native of Chile, where it was discovered by my late friend Mr James Macrae, and more recently by Mr H. Cuming, in whose extensive collection there are abundance of fine specimens of it.

LAPAGERIA ROSEA, No. 22. p. 279.

Add the following synonym.

Vochi, Liliaceo amplissimoque flore cramesino. *Feuill. Peruv.* p. 69. t. 49.

The figure is an indifferent one, the leaves being erroneously represented as ternate, and the flower as tetraphyllous, but the description, as is usual with this accurate author, is excellent, except in regard to the leaves, which he states to be ternate.

Biography of the late DUGALD CARMICHAEL, *Esq. Captain 72d Regiment, Fellow of Linnæan Society, &c.* (Continued from preceding volume, page 103.)

THUS we see that neither the hurry of military movements, nor the proximity of the enemy, could hinder Capt. Carmichael from entering immediately upon his scientific researches, or availing himself of the hours which might justly be devoted to sleep or recreation, in order to become acquainted with the productions of the country. From his journal we transcribe the following notes on the animals of the Cape.

"The *African Rhinoceros* (*Rhinoceros bicornis*) differs from that of Asia, in having two horns instead of one. Its hide is smooth, likewise, and free from wrinkles. Of the hide of the *Rhinoceros* and *Hippopotamus*, the boors manufacture a sort of horsewhip, known by the name of *Shambok*." "The horns of the *Rhinoceros* are solid. When turned in the lathe, and fashioned into drinking-cups, the article is held in high repute among the colonists as an infallible detector of poison. They firmly believe, according to the ancient creed, that if any noxious fluid were poured into a cup of this description, it would instantly *foam and boil over the brim.*

"Of all the quadrupeds that prey upon birds, the *Ratel* (*Viverra mellivora*), a species of *Ursus*, according to Mr Burchell, is perhaps the most destructive. When I was at Algoa Bay, Capt. Lawrence and Dr Ingham, my next-door neighbours, amused themselves with breeding poultry. As their hen-roosts happened to stand contiguous, the fowls used to lay their eggs indiscriminately in that which was most convenient. This introduced frequent altercations between the owners, respecting the property of the eggs, each of them pretending to discover, by infallible marks, the produce of his own fowls. The scene of these disputes was usually at my door, which was regarded as a sort of neutral ground; and as their arguments were usually long and loud, my situation as a listener, and often a referee, was rather an unpleasant one. Hints or entreaties on my part could never prevail on them to move an inch from my threshold, and the subject was becoming every day more harassing, when my good genius, in the shape of a *Ratel*, came and took up its residence in our neighbourhood. In the course of one night, this destructive vermin put an end to all disputes, by cutting the throats of all the fowls, to the number of two dozen and a-half, most of which were found next morning weltering in their blood. It carried off two or three to its burrow, to which we traced it by means of their feathers, and after a great deal of labour, succeeded in destroying it.

"The *Ratel* is also exceedingly fond of honey, and securely plunders the hive, whilst the bees exhaust their fury on its impenetrable hide. It is, of all animals, perhaps, the most tenacious of life; the skin being so thick and so loosely attached to the carcass, that it is proof against every species of violence."

"The Boors and Hottentots in the vicinity of Algoa Bay, collect vast quantities of wild honey, which they find in the hollow trunks of decayed trees, in the deserted nest of the *Termes* (or white ants), in the crevices of rocks, and in holes burrowed in the ground by the chacals and hyænas. The hive is usually revealed to them by a bird, called, on this account, the *Honey-Guide* (*Cuculus Indicator*). This feathered informant, though particularly fond of honey, cannot procure it but by the aid of others. It therefore watches the appearance of those from whom it expects the gratification of its appetite, and advertising them by a peculiar and well-known note, leads the way, flitting from bush to bush, to the spot where the hoard is deposited. There is an inconvenience of some moment, however, that attends implicit reliance on the call of this extraordinary caterer, which is said to amuse itself in leading its unwary follower across the haunt of a lion, tiger, rhinceros, or other natural curiosity of that stamp, which he feels, perhaps, no particular anxiety to study. This is universally believed by the Boors, and may be true enough. But though we admit the fact, I should think we may safely reject the inference. The nature of the country where bees and *Indicators* are met with, is such, that the latter, in conducting you to the stores of the former, may occasionally cross the path of one or all of those animals; but it can hardly be credited that the bird, which, in alluring you, seeks only its own gratification, would designedly lead you to the disappointment of both.

" The *Swallows* are migratory at the Cape as well as in Europe; and appear at Algoa Bay in the month of September. Of the three species which I observed there, one is the *Hirundo capensis*. A pair of these built their nest on the outside of the house wherein I lodged, against the angle formed by the wall, and the board which supported the eaves. The whole of this nest was covered in, and it was furnished with a long neck or passage, through which the birds passed in and out. It resembled a longitudinal section of a Florence oil-flask. This nest having crumbled away after the young birds had quitted it, the same pair, or another of the same species, built on the old foundation again in the month of February. But at this time, I remarked an improvement in the plan of it, that can hardly be referred to the dictates of mere instinct. The body of the nest was of the same shape as before, but instead of a single passage, it was furnished with one at each side, running along the angle of the roof; and on watching the birds, I observed they invariably went in at one passage, and came out at the other. Besides saving themselves the trouble of turning in the nest, and disturbing, perhaps, its interior arrangement, they were guarded by this contrivance against a surprise by serpents, which frequently creep up along the wall, or descend from the thatch, and devour both the mother and her brood."

"One evening, it was, I think, about the middle of May, as we sat enjoying ourselves after dinner, we observed a number of flies, of an uncommon aspect, flitting past the tent. We started up and endeavoured to catch one of them, but without effect. Some Hottentot children, who were standing on an opposite bank, remarking our anxiety, came and offered us whole handfuls of them; and directing us to the spot where they had caught them, our astonishment is not to be expressed, when we beheld millions of winged insects, issuing into daylight through fissures in the earth, and through the pores, as it were, of the ground, where no opening was perceptible. Near these outlets, the children had posted themselves, and collecting the insects as they emerged, greedily devoured them. Such of them as escaped the Hottentots, were snapped up as they flew along by the small birds, and by the *Libellulæ* and other predatory flies. The body of these tiny insects is so small, and the wings are so large and unwieldy, that they could hardly support themselves in the air, as they floated along at the humour of the breeze. They were the males of the *Termes capensis;* commonly known by the name of the *White Ant.*

"No country in the world is more infested with ants than the Cape. These insects vary in size, from the red *Nigar,* scarcely visible to the naked eye, to the *Black Ant,* measuring nearly an inch in length. Their habitations are as various as their species. The smaller tribes excavate the ground, removing the soil, and depositing it as a rampart round the entrance, to keep off the water. The large black ants content themselves with enlarging such cavities as they find ready formed, under flat stones, thus providing themselves with an impenetrable roof. A smaller species of the same colour, constructs its nest on the top of a bush, enclosing such parts of the branches as come within the sphere of the external covering, which is as thin as paper, yet proof against the heaviest rain. But the most numerous and interesting insects are the *Termites,* of which the Cape furnishes several kinds. Of these, one species builds its nests on the surface of the ground. These are fabricated of loam, of an hemispherical shape, four or five feet high, and as much in diameter. In some districts, these nests cover the surface of the ground in immense numbers, standing within a few yards of each other, and resembling so many boulders of granite."

We shall here introduce Capt. Carmichael's observations, made on his return to Africa from the Mauritius.

"Some time after the regiment returned from the Mauritius to the Cape, in 1815, I made a short excursion into the country, in company with a party of sportsmen, who wished to retreat for a few weeks from the dust and the South-Easters of Capetown. We left town on the morning of the 3d of January, and directed our course across the Isthmus which connects the Cape Peninsula with the mainland. Though it was about the middle of the dry season, we had the benefit of several heavy showers from the westward during our ride, with which we felt the less annoyed, though drenched to the skin, as they fixed the moving sand, and tempered the scorching heat of the atmosphere. In the rainy season, the whole of this plain is a series of marshes, intersected by ridges of sand. At the time we crossed it, these swamps were mostly dried up; but wherever the surface was in the least depressed, there were still manifest indications of the existence of water. There can be no doubt that abundance of this element might be procured in every part of the Isthmus by digging to the depth of a few feet: at all events, by digging to the level of the sea, which is not much more, we are taught by experience, as well as by the laws of Hydrostatics, that not here alone, but in every region of the globe, a supply of water can be depended on. With such a resource, skilfully applied, this barren waste might be converted into fertile gardens; from which the capital could be supplied with an abundant supply of vegetables, and an end put to the present monopoly of these articles, by a few farmers in the immediate vicinity of the town.

"A great part of the plain is covered with a fine quartz sand, furnished by the disintegration of the sandstone mountains which surround it. It shifts perpetually from place to place at the humour of the breeze, forming a succession of banks, or ridges, white as driven snow. This periodical motion has a singular effect on the shrubby plants which are scattered over its surface. When suddenly overwhelmed by the sand, they push up their tops until they emerge into daylight; but the lower branches are all suffocated, and the trunk now converted into a root, sends off a new system of branches, which direct their course downward through the drift. In proportion as the sand accumulates, the plants grow up, keeping their heads above the surface; but without any apparent stem. A squall comes on, the bank is dispersed; and the shrubs, now laid bare to the original level of the soil, exhibit the grotesque appearance of so many *Mangrove-trees*.

"Though the flowering season was pretty nearly over, I observed a variety of plants still in blossom; among others, a large blue-flowered *Aristea*, a *Dianthus*, and several species of *Passerina*, particularly the *P. grandiflora* and *uniflora*. The greater part of the Isthmus is covered with shrubs of this last genus, which are in much request in Capetown, as the material usually employed to heat the bakers' ovens. The genus *Restio* is likewise abundant, and communicates somewhat of a glassy appearance to the surface; but these plants, except during the earliest stage of their growth, are rejected by cattle.

"The diagonal extent of the Isthmus from Capetown to Brinksfarm on the Eerste River, is about twenty-four miles. Throughout this dreary expanse, not a house is to be seen, nor an object to relieve the eye, or divert the mind from its own reflections, except here and there a waggon in its progress to or from Capetown, halted at the road-side, and its team of oxen browsing amongst the shrubs. In their intercourse with the capital, the boors are under the necessity of arranging their affairs so as to remain there only a few hours, or, at least, to send off their waggons, the sterility of its immediate environs rendering it impossible to find subsistence for their cattle there for a single night.

"From Brinksfarm, the road winds round the base of the mountain of Stellenbosch, and commands a fine view of the whole Cape Peninsula and the adjacent bays. Several neat plantations are scattered over each side of the road, as far as Hottentot-Holland Kloof. As we rode along, it was not without interest we remarked the country people actively employed in their various occupations; some collecting the juicy produce of the vineyard; some cutting down the corn, conveying it home in waggon-loads, piling it up in huge stacks, or guiding the horses which were trotting over it, to disengage the grain from the straw. To these succeeded another set, who, availing themselves of a favourable breeze, tossed the broken corn up in the air with long wooden forks, to separate the grain from its impurities. This animated scene, on which we dwelt with delight, formed a striking contrast to the early part of our day's journey.

"There is an inn at the bottom of the Kloof, where we tarried the whole of the next day, to get some repairs done to our travelling cart. On the morning of the 5th, we pursued our journey; and, after passing through a turnpike-gate, the only one in the Colony, at which half a rix-dollar is levied on every waggon, we ascended the Kloof. The pass is rugged and abrupt, but might be made comparatively easy by a moderate share of labour, judiciously exerted: and if the public welfare had any influence over those who administer the affairs of the Colony, they would employ a part of the garrison in works of this kind; instead of letting soldiers out to work in detail, to such individuals as have sufficient interest to procure them for their private use.

"The south-east wind blew in impetuous gusts as we ascended the Kloof; but from the time we gained the summit it became comparatively moderate. It is seldom, indeed, known to blow with much violence beyond the first chain of mountains. The country on the other side is high, barren, and covered with hard rushy plants, among which the genus *Restio* predominates. A few miles beyond the Kloof, we crossed a branch of the Palmeit River, and keeping to the left, followed a path recently made over the Nieuberg, which led us to the farm of Stephanus Leroex, where we proposed to halt for some days. This farm is situated in a fine amphitheatre, enclosed on one side by a bend of the great chain of mountains that commences at Hangklip Point, and on the other by the Nieuberg. The area is about ten miles across, and forms a gentle slop from the circumference to the centre, with a smooth verdant surface, regularly undulated, and watered by numerous mountain-streamlets, which meet in the middle of the valley, and form the swampy source of the River Sonderend. The channel of this river, as well as its tributary streams, is encumbered with the *Palmiet*, a gigantie species of bog-rush (*Juncus serratus*), that spreads and interlaces its creeping stem over the surface, forming a strong elastic network, upon which a man may walk without the least risk of sinking. The leaves of this plant bear a strong resemblance in figure and disposition to those of the smaller species of *Pandanus.* The stems, stripped of the foliage, are used by the wine-farmers as padding to fix the leggers against the sides of the waggons, when they send their wine to the market. After serving this purpose, they are flung out on the streets, and being of a black colour, very heavy, and much of the same size, gave rise to the ludicrous mistake of a certain English traveller, who has informed the public that the streets of Capetown are paved with bullocks' tails.

" Though the surface of the ground here, as well as in most other parts of the Colony, appears at a distance abundantly verdant, the produce is mostly of an useless, if not noxious quality, such as cattle invariably reject. A few straggling tufts of *Aristida*, *Holcus*, *Ehrhærta*, and *Anthistirea*, spring up here and there among a profusion of bulbous-rooted plants, and *Syngenesious shrubs.* In the vicinity of the farm-houses, you meet with patches of *Agrostis linearis*, a sweet grass, always cropped close to the ground; but no where with a grassy turf of any extent. This is a remarkable circumstance in a country so much favoured in point of climate; and where the variety of indigenous grasses is as great as in any other portion of the world of equal extent. Several causes it is probable, contribute to produce this uncommon sterility. The high winds, so prevalent for the greater part of the year, but more especially about the period when the grasses are in flower, either damage the whole plant, prevent the fecundation of the germ, or shake out the grain before it arrives at maturity. At this season, likewise, the periodical rains cease; and such of the seeds as had escaped the effects of the wind, fall on a parched soil, where they must remain in a torpid state until the next rainy season sets in, after a lapse of six or seven months. They lie, in the mean time, exposed to the depredations of an infinite variety of birds and insects, particularly the ants and termites, with which the surface of the ground is absolutely animated. These destructive insects retain their activity throughout the year, and are constantly in motion, day and night; nothing therefore in the shape of food escapes them. They never attack any part of a living plant; but seeds of all sorts are devoured by them on the spot, or carried off to their magazines.

"It is owing, perhaps, to this interruption in their natural progress to maturity and decay, that these grasses almost invariably throw out branches from the joints, after the main stalk has failed. These branches succeed each other after each successive miscarriage, and it is not uncommon even to find secondary branches issuing from the joints of the primary ones. Thus their existence appears to be protracted beyond the natural period, in efforts to fulfil the end of their creation. Notwithstanding these efforts, however, the greater part of them must have ceased long to exist, were it not that they possess the faculty of propagating themselves by the root; which they accomplish either by pushing out long creeping shoots, sometimes over, at others underneath the surface of the soil; or by forming a regular succession of bulbs, which retain the vital principle during the dry season, and shoot up into new plants on the return of the rain.

"The surrounding mountains are overrun with that singular plant, the *Lunaria plumosa*, which gives them a hoary aspect, distinguishable at a great distance. They consist of sandstone, the strata of which dip at an angle more or less acute to the eastward. The whole chain, from Hangklip Point, to the extremity of the Karroo, exhibits the same conformation; by which the valley on the east side of the chain are enriched with numberless streams, while the supply on the opposite side is comparatively scanty. The soil in the valley consists of gravel, cemented by an argillaceous earth. In summer it is as hard as stone, but absorbs moisture greedily, and after a copious fall of rain, becomes penetrable to the plough.

"As this valley is noted for game, we pitched our tent as soon as the cart arrived, having agreed to remain here some days. We had provided ourselves with a canteen, cooking utensils, and liquors. Our sportsmen were to furnish the table with game, and Leroex the produce of his farm and garden. It was soon remarked, however, by one of our party, who had been here some years before, that the farmer made a most enormous charge for his share of the contribution. Being challenged on the subject, he candidly acknowledged it, and stated that he considered his old charges sufficiently high, but that an English sportsman having once stopped for a few days with him, laughed at the modesty of his charge, and paid him double the amount. To avoid being ridiculed by the English, he had from that time modified his prices, with a view to acquire their good opinion. This liberal Englishman proved to be a ship-chandler from Capetown, who had contrived to escape for a week from behind the counter.

(To be continued.)

The Ohio. By J. J. Audubon, Esq.

To render more pleasant the task, says Mr Audubon in his Ornithological Biography, which you have imposed upon yourself, of following an author through the mazes of descriptive ornithology, permit me, kind reader, to relieve the tedium which may be apt now and then to come upon you, by presenting you with occasional descriptions of the scenery and manners of the land which has furnished the objects that engage your attention. The natural features of that land are not less remarkable than the moral characters of her inhabitants; and I cannot find a better subject with which to begin, than one of those magnificent rivers that roll the collected waters of her extensive territories to the ocean.

When my wife, my eldest son (then an infant), and myself, were returning from Pennsylvania to Kentucky, we found it expedient, the waters being unusually low, to provide ourselves with a skiff, to enable us to proceed to our abode at Henderson. I purchased a large, commodious, and light boat of that denomination. We procured a mattress, and our friends furnished us with ready prepared viands. We had two stout Negro rowers, and in this trim we left the village of Shippingport, in expectation of reaching the place of our destination in a very few days. It was in the month of October. The autumnal tints already decorated the shores of that queen of rivers, the

Ohio. Every tree was hung with long and flowing festoons of different species of vines, many loaded with clustered fruits of varied brilliancy, their rich bronzed carmine mingling beautifully with the yellow foliage, which now predominated over the yet green leaves, reflecting more lively tints from the clear stream than ever landscape-painter portrayed or poet imagined.

The days were yet warm. The sun had assumed the rich and glowing hue, which at that season produces the singular phenomenon, called there the "Indian Summer." The moon had rather passed the meridian of her grandeur. We glided down the river, meeting no other ripple of the water than that formed by the propulsion of our boat. Leizurely we moved along, gazing all day on the grandeur and beauty of the wild scenery around us.

Now and then a large cat-fish rose to the surface of the water, in pursuit of a shoal of fry, which starting simultaneously from the liquid element, like so many silvery arrows, produced a shower of light, while the pursuer, with open jaws, seized the stragglers, and, with a splash of his tail, disappeared from our view. Other fishes we heard uttering beneath our bark a rumbling noise, the strange sounds of which we discovered to proceed from the white perch, for on casting our net from the bow, we caught several of that species, when the noise ceased for a time.

Nature, in her varied arrangements, seems to have felt a partiality towards this portion of our country. As the traveller ascends or descends the Ohio, he cannot help remarking, that, alternately, nearly the whole length of the river, the margin, on one side, is bounded by lofty hills, and a rolling surface, while, on the other, extensive plains of the richest alluvial land are seen as far as the eye can command the view. Islands of varied size and form rise here and there from the bosom of the water, and the winding course of the stream frequently brings you to places, where the idea of being on a river of great length, changes to that of floating on a lake of moderate extent. Some of these islands are of considerable size and value; while others, small and insignificant, seem as if intended for contrast, and as serving to enhance the general interest of the scenery. These little islands are frequently overflowed, during great freshets or floods, and receive at their heads prodigious heaps of drifted timber. We foresaw, with great concern, the alterations that cultivation would soon produce along those delightful banks.

As night came, sinking in darkness the broader portions of the river, our minds became affected by strong emotions, and wandered far beyond the present moment. The tinkling of bells told us, that the cattle which bore them were gently roving from valley to valley in search of food, or returning to their distant homes. The hooting of the great owl, or the muffled noise of its wings, as it sailed smoothly over the stream, were matters of interest to us; so was the sound of the boatsman's horn, as it came winding more and more softly from afar. When daylight returned, many songsters burst forth with echoing notes, more and more mellow to the listening ear. Here and there the lonely cabin of a squatter struck the eye, giving note of commencing civilization. The crossing of a stream by a deer, foretold how soon the hills would be covered with snow.

Many sluggish flat-boats we overtook and passed; some laden with produce from the different head-waters of the small rivers that pour their tributary streams into the Ohio; others, of less dimensions, crowded with emigrants from distant parts, in search of a new home. Purer pleasures I never felt; nor have you, reader, I ween, unless indeed you have felt the like, and in such company.

The margins of the shores and of the rivers were at this season amply supplied with game. A wild turkey, a grouse, or a blue-winged teal, could be procured in a few moments; and we fared well, for, whenever we pleased, we landed, struck up a fire, and, provided as we were with the necessary utensils, procured a good repast.

Several of these happy days passed, and we neared our home, when, one evening, not far from Pigeon Creek (a small stream which runs into the Ohio, from the state of Indiana), a loud and strange noise was heard, so like the yells of Indian warfare, that we pulled at our oars, and made for the opposite side as fast and as quietly as possible. The sounds increased,—we imagined we heard cries of "murder;" and, as we knew that some depredations had lately been committed in the country by dissatisfied parties of aborigines, we felt for a while extremely uncomfortable. Ere long, however, our minds became more calmed, and we plainly discovered that the singular uproar was produced by an enthusiastic set of Methodists, who had wandered thus far out of the common way, for the purpose of holding one of their annual camp-meetings, under the shade of a beech forest. Without meeting with any other interruption, we reached Henderson, distant from Shipping-port by water about 200 miles.

When I think of these times, and call back to my mind the grandeur and beauty of those almost uninhabited shores; when I picture to myself the dense and lofty summits of the forests, that everywhere spread along the hills, and overhung the margins of the stream, unmolested by the axe of the settler; when I know how dearly-purchased the safe navigation of that river has been by the blood of many worthy Virginians; when I see that no longer any aborigines are to be found there, and that the vast herds of elks, deer, and buffaloes, which once pastured on these hills and in these valleys, making to themselves great roads to the several salt-springs, have ceased to exist; when I reflect that all this grand portion of our Union, instead of being in a state of nature, is now more or less covered with villages, farms, and towns, where the din of hammers and machinery is constantly heard; that the woods are fast disappearing under the axe by day, and the fire by night; that hundreds of steam-boats are gliding to and fro, over the whole length of the majestic river, forcing commerce to take root and to prosper at every spot; when I see the surplus population of Europe coming to assist in the destruction of the forest, and transplanting civilization into its darkest recesses;—when I remember that these extraordinary changes have all taken place in the short period of twenty years, I pause, wonder, and, although I know all to be fact, can scarcely believe its reality.

Whether these changes are for the better or for the worse, I shall not pretend to say; but in whatever way my conclusions may incline, I feel with regret, that there are on record no satisfactory accounts of the state of that portion of the country, from the time when our people first settled in it. This has not been because no one in America is able to accomplish such an undertaking. Our Irvings and our Coopers have proved themselves fully competent for the task. It has more probably been because the changes have succeeded each other with such rapidity as almost to rival the movements of the pen. However, it is not too late yet; and I sincerely hope that either or both of them will ere long furnish the generations to come with those delightful descriptions, which they are so well qualified to give, of the original state of a country that has been so rapidly forced to change her form and attire, under the influence of increasing population. Yes; I hope to read, ere I close my earthly career, accounts from those delightful writers of the progress of civilization in our western country. They will speak of the Clarks, the Croghans, the Boons, and many other men of great and daring enterprise. They will analyze, as it were, into each component part, the country as it once existed, and will render the picture, as it ought to be, immortal.

On the Guano or Modern Coprolite.

There are districts in England, of many miles in extent, where strata of considerable thickness occur, in which one-fourth part of the whole mass is made up of the fœcal matter, or excrement, of the former inhabitants of the ocean. This fact is certainly astonishing, but loses all its incredibility when compared with the *Guano*, a substance the excremental nature of which has been indubitably established by the chemical analysis of Klaproth *, Fourcroy, and Vauquelin †. This substance, nevertheless, forms on the coasts of Peru deposits of such extent, that, at first sight, we have some difficulty in admitting it to be the dung of sea birds, which once rested here at night, although upon considering all its relations, this can alone be its true nature.

* Beiträge, part iv. p. 199. gives the following as its composition: In 100 parts, 16 ammoniacal uric acid, 10 phosphate of lime, 12·75 oxalate of lime, 4 silica, 0·5 common salt, 28 arenaceous impurities, and 28·75 water and combustible animal remains. The French chemists found even 25 per cent. of uric acid.

† Gehlen's Journal, vol. vi. p. 679.

The term *Huana* (Europeans constantly substitute *hua* for *gua*, and *u* for *o*, according to Humboldt (Klaproth's Beiträgen, u. s.) signifies in the language of the Incas *dung*, the substance used for manure. The verb to manure is *huanuschani*. All the aborigines of Peru believe the guano to be the dung of birds; it is only doubted by some of the Spaniards. The guano is only found on the coast, and on islands and crags between latitude 13° and 21° S.; and it there forms beds 50 or 60 feet in thickness, which are wrought in the same way as ochre pits. It is not found to the north or south of this space, although the numbers of the cormorants, flamingos, and cranes seem to suffer no diminution. The little *Isla di Guano*, in the vicinity of the town of *Arica*, exhales such an intolerable odour, that, as Pere Feuillé long ago remarked, vessels never venture to come close up to the town. In Arica, large warehouses were built all along the shore, in which the guano is laid up.

When we consider, that, at the least, ever since the 12th and 13th centuries, it has been the constant custom to manure the land with the guano, for which purpose many millions of cubic feet have been scattered over the sandy deserts of Peru (the possibility of cultivation along the sea-coast depends entirely on this precious substance), and that it has been constantly abstracted in the same quantity, and that now, from repeated experiments, it *appears* the birds of a whole island cannot produce a few ships' cargoes; what must be our astonishment at the long succession of centuries, or the prodigious multitude of birds which must have been requisite to accumulate these guano deposits. It is evident, however, from the observations of Frezier, of feathers having been found at a considerable depth in the mass, that its formation is entirely to be attributed to birds.

Under the empire of the Incas, the guano was regarded as an important branch of state economy. It was forbidden on pain of death to kill the young birds on the Guano Islands. Each island had its own inspector, and was assigned to a certain province. The whole district between *Arica* and *Chaucay*, a distance of 200 nautical miles, was manured exclusively with guano *. In consequence of such precautions, we can easily understand its prodigious accumulation. Not a vestige now remains of all this excellent organization.

This is completely established by M. Marians de Riviero, who, in a Spanish treatise, a short extract of which is given in Ferussac's Bulletin, sect. i. t. xi. p. 84, mentions, that the Spaniards have entirely forgotten the wise provisions of the Incas, to secure the preservation of the precious manure. The Peruvians begin now to discover their error, and look forward with anxiety to the period when the guano will no longer suffice for the wants of husbandry. In fact, the discovery of new beds of the brown guano, which is of oldest formation, daily diminishes in frequency, and the production of the white guano, that which is still forming, has suddenly decreased, since the unlimited freedom of trade has attracted so many vessels to the coast, which scare away the flocks of birds which used formerly to roost upon the rocks and islands.

Notwithstanding all these disadvantages, very lately the annual product of brown and white guano, amounted to about 6300 tons, for which the duty has been about £40,000 Sterling per annum, paid at the different ports from which it is transported into the interior.

M. Buckland prefers for the *Guano* the name of *Ornithocoprus.*

On the Changes the Animal Secretions undergo during Cholera Morbus. By Mr R. Hermann, of Moscow.

We make the following extract of a paper by Mr R. Hermann of Moscow, upon the changes which the secretions of the human body undergo during cholera, from the 6th number of the *Annalen der Physik und Chemie*, 1831, as very few minute investigations of this nature have been recorded in the many works on this subject of cholera, which have been published in this and other countries; and it is of the highest importance that every information should be made public concerning the nature

* Near Villacori the ancient Peruvians also used as manure the pilchards (*Clupea Sardina*), thrown up by the sea.

of the disease, which seems now without doubt to have gained an entrance into England.

Having been commissioned by the constituted authorities at Moscow to institute chemical investigations into the nature of cholera, Mr Hermann made analyses of the blood, urine, and bile obtained from patients in different stages of the disease, as also of the vomited fluid and of the excrement.

At the commencement of his analysis of the blood of a cholera patient, he was surprised by finding that the clot contained a *free acid.* This he at first conceived to be a peculiarity in the blood of cholera patients, but he very soon found that his own blood, at a time when he was in perfect health, possessed the same, or rather stronger, acid properties than that of the cholera patient. Aware that chemists in general describe the blood as alcaline, he was induced to make an analysis of healthy blood, with a view of ascertaining the nature and quantity of the free acid which it contains.

Healthy Blood.—Mr Hermann's own blood, allowed to stand for twenty-four hours, until it separated completely into serum and clot, contained 57 of serum and 43 of moist clot in 100 parts. He found that the serum of this blood slightly reddened litmus, but not so powerfully as the clot did; and this he could not attribute simply to the colouring matter of the clot, as pure water did not receive a colour from it so soon as the blue litmus solution was changed to red. By boiling the serum and clot with carbonate of baryta, in a vessel connected with a mercurial pneumatic apparatus, he found there were disengaged from 100 volumes of serum, 18.1 volumes, and from the clot 21.2 volumes of gaseous carbonic acid. 100 parts of the same clot were then boiled without carbonate of baryta, and there were disengaged from them 10.4 volumes of gaseous carbonic acid: 10.4 volumes, therefore, of the free acid in the clot, consisted of carbonic acid; the other 10.8 volumes he found to be acetic acid.

The blood of a healthy pregnant woman was analyzed, with very nearly the same results *.

* It must be obvious that a much more extensive series of experiments than that adduced by Mr Hermann will be necessary to establish the accuracy of this result, differing so materially from that obtained by most chemists.

Blood during Cholera.—In this disease the blood is known to be of a very dark colour, and thick consistence. Mr Hermann obtained the blood of a patient who had laboured under a very severe attack of cholera for a few hours. The blood was drawn four hours before death, after violent vomiting.

In 100 parts of blood there were forty of serum, and 60 of clot; consequently 17 more of clot than in the healthy condition. The specific gravity of the serum was 1.036, and this fluid was decidedly *alcaline.* The clot was acid. 100 parts boiled with the carbonate of baryta, as before, evolved 21.2 of gaseous carbonic acid, exactly the same quantity as was obtained from the clot of healthy blood.

Mr Hermann conceives that this separation of the blood into an acid clot and alcaline serum, is owing to the property which the fibrine has of absorbing a certain quantity of acid; and he considers it as a phenomenon analogous to the change which weak acids undergo, when wood is immersed in them; the wood absorbing a considerable quantity of the acid. Should, then, the whole quantity of acid in the blood be diminished, the fibrine still retains a certain portion of it; and, if the diminution be very great, the whole of the acid of the serum may be removed, and this fluid will consequently exhibit alcaline properties, in consequence of the presence of subphosphate of soda in it.

The alcaline reaction of the serum in blood of those affected with cholera, is a very constant appearance. It only begins immediately after the patients have had evacuations by vomiting; and it again disappears when the patient survives the attack.

The following Table exhibits the differences observed by Mr Hermann in the composition and properties of healthy and diseased blood.

	Clot in 100 parts of Blood.	Serum in 100 parts of Blood.	Action of Clot on Litmus.	Action of Serum on Litmus.	Specific Gravity of Serum.
Blood of a healthy young man, .	43.	57.	Acid.	Acid.	1027
Blood of a healthy pregnant woman,	44.75	55.25	Acid.	Acid.	1023
Blood taken from a girl in the first stage of cholera, before the occurrence of watery evacuations,	50.	50.	Acid.	Acid.	1027
Blood from men who had the cholera, but recovered, . Blood taken after watery evacuations, ... *a*	55.	45.	Acid.	Alcaline.	1028
b	60.3	39.7	Acid.	Alcaline.	1032
c	62.5	37.5	Acid.	Alcaline.	1028
Blood of a man labouring under cholera, four hours before his death, ...	60.0	40.	Acid.	Alcaline.	1036
Blood of a woman who survived the cholera, but had afterwards an attack of inflammatory fever, .	46.25	53,75	Acid.	Neutral.	1028

Mr Hermann states, that he found blood taken from the right ventricle of the heart of a patient dying of cholera, very firmly coagulated. When shaken a little, this blood became fluid, and quite homogeneous. Viewed in the microscope, no globules could be perceived in it.

Mr Hermann sought for urea in the blood of cholera patients, but in vain. No trace of it was discoverable.

Analysis of Watery Fluid vomited by Cholera Patients.—This fluid is described by Mr Hermann as thick, of a dirty slightly yellow colour, and a sour smell. Its specific gravity varied in different patients, as 1.0060, 1.0055, and 1.0035.

When allowed to rest tranquil for some days, it becomes clear, while a grey-coloured mucus is deposited in variable quantity. By an analysis detailed by Mr Hermann, the different steps of which we do not think it necessary to mention, he found that this fluid consisted of the following ingredients:

Water and mucus, ...	990.
Osmazomelike substance, . . , .	6.51
Salivine, ...	1.04
Acetate of soda, muriate of soda, with small quantity of phosphate of lime and magnesia, . . .	1.56
Anhydrous acetic acid, ...	0.89
	1000.

A little butyric acid was afterwards discovered.

In the three specimens of the fluid which were examined, the quantity of acetic acid varied considerably. In 1000 parts of the fluid, of specific gravity 1.006, there were 1.204 parts of acetic acid; in that of specific gravity 1.0055, 0.942 parts; and in that of specific gravity 1.0035, 0.513 parts.

A very superficial glance at the results of this analysis of the vomited fluid, is sufficient, according to Mr Hermann, to shew its analogy with gastric juice.

Analysis of the Watery Excrement of Cholera Patients.—The fluid excrement passed by cholera patients, Mr Hermann describes as turbid, slightly and dirtily coloured, and possessing a peculiar fetid odour, derived from the large intestines. When the fluid stands for some time, it does not become wholly clear, like that passed by vomiting. It is generally *acid*, both in its chemical properties and taste, as ascertained by Dr Reuss.

The fluid passed by stool resembles much in its chemical constitution that which is vomited. It contains a free acid, in some instances in considerable quantity, which is acetic; also butyric acid. The chief animal principles which it contains are mucus, albumen, salivine, osmazome-like substance, and a small quantity of picromel and resin of bile.

In the body of a man who died after having been affected twenty-four hours with cholera, and who had been purged without vomiting, the fluid in the stomach was found to be exactly the same as that vomited by other patients. In the duodenum the fluid resembled much that in the stomach, though it was not so sour. In the large intestine the fluid had the fetid smell of excrement, and was darker in colour, and more acid than the fluid in the stomach or duodenum.

Analysis of the Urine of Cholera Patients.—Mr Hermann states, that, as the urine is generally very much suppressed during cholera, he had no opportunity of examining this fluid at the time when the disease was at its greatest height.

The urine which he analyzed was procured from a person who survived the attack of cholera. It was the first passed after the suppression. It formed a turbid yellowish fluid, which gave no precipitate by standing, and was quite neutral in its relation to litmus. Its composition was very analogous to that of healthy urine, though the solid ingredients were in a much smaller proportion. It contained muriatic, phosphatic, and ammoniacal salts, as well as urea. Its specific gravity was 1.006; Now, taking the quantity of solid matter in urine of the natural specific gravity 1.020 to be 6.7 proc., the fluid of specific gravity 1.006 can only contain about 2 proc. less than a third of the natural quantity. Mr Hermann is of opinion that, whilst the suppression of urine takes place, the formation of urea, believed by many to be one of the chief modes by which nitrogen is separated from the living body, is entirely stopped, as no trace of this substance was to be found either in the blood or any other fluids of the body.

Analysis of the Bile of Cholera Patients.—The gall-bladder of patients affected with cholera, is known to be in general unusually full and distended with bile.

Mr Hermann obtained three gall-bladders, which contained respectively 14, 15 and 16 drachms of bile, of specific gravity 1.043. The usual quantity of bile found in the gall-bladder is, according to John, 1 ounce, and its specific gravity 1.026; there is, therefore, during cholera, nearly double the quantity of bile in the gall-bladder, and its specific gravity is considerably greater.

The three specimens of bile which Mr Hermann analyzed, were all of nearly the same colour as ox's bile, of a thready consistence, like thick syrup. Its chemical constituents were, a large quantity of mucus, some albumen, colouring matter, resin of bile, picromel, cholesterine, and oleic acid, &c. In comparing this analysis with that given by Tiedemann and Gmelin, of healthy bile, the only apparent difference, besides the greater consistence and specific gravity of cholera bile, is probably in the greater quantity of resin of bile, as indicated by the copious precipitate thrown down by acetate of lead.

From these experiments it appears that, during cholera, the change in the composition of the blood consists in its being deprived of a large quantity of water, and some acetic acid, which, taking the quantity of blood in the adult person at 30 lb. amounts to nearly 8.5 lb. water, and 47 grains of acetic acid.

Mr Hermann conceives that it is principally in consequence of the removal of acetic acid from the blood, that the fibrinous polypous concretions arise in the cavities of the heart. In the healthy condition of the blood, he says that the acetic acid acts as a solvent to the fibrine; but, when a large proportion of it is removed, along with the vomited and purged matter, there arise these polypous concretions, which Dr Jähnichen invariably found in the cavities of the heart, in fifty bodies of cholera patients, which he dissected.

He also states, in confirmation of this opinion, that the alteration in the composition of the blood, does not occur till after there have been watery evacuations by vomiting or stool; and that the concretions of fibrine are much firmer, and more compact in those patients who linger for some time, than in those who die suddenly.

At the conclusion of his paper, Mr Hermann brings forward a theory of nervous excitement to account for the production of the changes previously mentioned to take place in the fluids and secretions of the body during cholera, and ends with a proposal for treatment founded on the chemical views given,—the injection of water into the veins being one of the remedies which he proposes.

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*Description of Pelokonite.** By G. F. Richter, in Freyberg.

Form, unknown; *cleavage*, none; *fracture*, conchoidal; *colour*, bluish-black; *streak*, liver-brown; *opaque; lustre*, vitreous, feeble, almost dull; *tenacity*, not great; *hardness*, 3.0 (that of calc spar); *specific gravity*, 2.509, and a larger fragment 2.567. The pelokonite is found in the Tierra Amarilla, and the Remolinos in Chili, along with copper-green, malachite, and another unknown blackish-brown mineral with a yellow streak.

This mineral is not noticed in the mineralogical manuals. In Dr A. Breithaupt's "Characteristik des Mineral Systems,"

* From πελος brown, and κονις dust, the powder of the streak, to distinguish it from copper and manganese ore.

in the notice on *copper and manganese ore*, mention is made of a mineral from the Tierra Amarilla in Chili, but which cannot be the *pelokonite*.

Pelokonite is very soluble in muriatic acid, less so in nitric. The muriatic solution has a pistachio green colour, and reacts on iron, manganese, copper, and phosphoric acid.

This mineral agrees in many of its properties with those substances which M. Haidinger has collected together into one order, that of the "Terene."

Poggendorf's Annalen for 1831.

Some Preliminary Experiments upon the Pod of Cæsalpinia coriaria, or Dividivi. By Mr RODSEY. Communicated by Captain MACADAM, Royal Marines.

1. ONE portion of dividivi, as I received it, on being slightly bruised in a mortar, and sifted, was divided into eight parts powder and seven gruff. Eighteen ounces being more bruised, gave as follows:—

Seed $\frac{1}{8}$ oz., husks or gruff $4\frac{4}{8}$ oz. = $4\frac{5}{8}$ oz.; powder $12\frac{7}{8}$ oz.; loss in fine powder $\frac{4}{8}$ oz. = $13\frac{3}{8}$ oz., which is the same as three parts powder and one gruff. A very large portion of the pulverizable substance appeared to have been bruised off, in extracting the seeds before it reached me, and hence I am of opinion, that it bears to the husky part a much larger proportion than what is above stated. As the great lightness of the article adds so much to its freight, it seems desirable that the gruff residuum should be separated by a mill, on the spot where it is grown; by this means one-half at least may be saved in the freight. Considering, therefore, that the powder will become the commercial article, I have confined my experiments to that portion; but it is probable an analysis of the interior or husky part of the pod may lead to its recommendation for some useful purpose where it grows, as it will be a refuse, if too weak for the tanner's use.

2. In conducting these experiments upon dividivi, it was my object to compare it with some other articles of the materia medica, that I might the better be enabled to judge of its probable utility. The articles I selected were oak-bark, kino terra japo-

nica, nutgalls, tormentilla, pomegranate rind, and sumach. I regret that I have not yet had time to compare it with many others, which a future opportunity may enable me to do. As these experiments, if repeated, might be expected to vary in the result from many causes, such as the season of gathering the fruit; the temperature of drying the powder and the precipitates; the degree of comminution; the difference of weights and errors of scales; the time of maceration, and temperature at which it is conducted; the care in decanting; the fineness of the filter; the caution used to collect all the precipitate, and the waste in transference from paper to paper; and, as the substances submitted to experiment are not crystalline, or naturally of an invariable composition, I have not used much precaution or great nicety in weighing, my object being rather to form an idea of the use of dividivi, than to analyse all the substances with accuracy.

3. One drachm, or 60 grains of each of the substances before mentioned, and in the state of powder, was macerated for forty-eight hours, in 5 oz., or forty times its weight, of cold distilled *water*. The first elutriation, the colour of which is seen in column 1, was used in the subsequent experiments; the sediments were afterwards repeatedly remacerated in more water, and, when dried in a gentle heat, weighed as in column 2, the water having dissolved as many grains, expressed in column 3, as complete the original drachm.

4. The first substance, the action of which I made upon these astringents, I made trial of was *lime-water*. To three ounces of fresh prepared lime-water I added half an ounce, or one-tenth of each infusion, containing the virtue of six grains of its basis; the result is contained in columns 4, 5, and 6. The first shews the colour, and the second the weight of each precipitate; the liquors decanted from the above precipitates having the colours mentioned in column 6, as well as

5. The original infusions were tested with *muriate of iron*, the result appears in columns 7 and 8; and, in order to see whether the lime-water had been used in sufficient quantity, I tried with the original infusions the different lime-water elutriations with the result indicated in column 9. The result of these experiments is, that the lime-water was used in excess, but did

not effectually precipitate all the gallic acid from the catechu, which therefore appears to contain a principle having a superior affinity for the gallic acid.

6. *Subcarbonate of potash* was the next test used. It precipitated only sumach and galls, and with both likewise produced a black cream, which, by the action of air, dissolved, and rendered the upper part of the solution very dark; column 10.

7. *Sulphuric acid*, in a diluted state, was next tried, column 11, and this occasions precipitates in the infusion of kino and pomegranate a little, which tended to subside in that of catechu, no effect at all on the infusions of sumach and tormentilla root, and almost none upon the rest. Whether the substances precipitated by the *acid* be of *an* acid nature, and those precipitated by the alkali alkaline, I leave for a future opportunity of trying.

8. One part of *isinglass* dissolved in 32 of water, was the next substance which I experimented upon. Sir H. Davy considers that it combines with the tanning principle in the proportion of 54 to 46 of tannin. Half an ounce of each infusion was added to half an ounce of the solution of isinglass, and the results are given in columns 12 and 13. The leather precipitated immediately like a resin, from the infusions of dividivi and galls, but the sumach was rendered milky, and so continued for more than a week without precipitating. The infusion of galls continued also milky, but in a less degree than the sumach, not precipitating at once so completely as the dividivi: at length one-eighth of a grain was obtained from the sumach. It is probable that a stronger infusion of sumach would have afforded a more copious and more precipitable substance: that from catechu formed a tenaceous ring of leather at the bottom of the phial, while all the rest were flocculent, and very different in colour and appearance from these. The other precipitates, except those from dividivi, galls, and sumach, melted in the gentle heat to which they were exposed in drying, and, as they thus became inseparable from the paper, they were not weighed. I, however, wished to determine the weight of the precipitate from oak-bark, and therefore repeated the experiment, drying the precipitate with more care, and then weighing it. Upon the elutriation of gelatine, tincture of muriate of iron produced an ef-

fect, but lime-water but very little. The decoction of isinglass produced no effect with the elutriation of lime, not even with that of catechu.

9. *Infusion of quassia* produced no effect upon any of the astringent infusions above mentioned.

10. *Sugar of lead* turned the different infusions, as in column 14; with the infusions of oak and sumach it was not tried.

11. I next tried *sulphates of copper*. I perceived but little effect, and sometimes none, with the persulphate, but the protosulphate gave very curious results, see columns 15 and 16. The precipitates, however, were not weighed nor preserved.

12. *Muriate of tin* was the next test used. The comparative copiousness of the precipitates, after twelve hours' standing, may be seen in column 17, which contains the depths of precipitate, in the infusion. Column 18 contains the weight of each. After the action of the muriate of tin, muriate of iron affected some infusions, and not others, according to column 19; but muriate of tin itself produced no effect, shewing it had been used in excess: this likewise appeared from adding more infusion, as indicated in column 20; when the elutriation from muriate of tin was tried with isinglass, no effect was produced. I observed ammonia to turn violet, the elutriation from muriate of tin and galls.

13. Emetic tartar produced no effect upon any of the infusions.

14. From columns 4, 8, 12, 16, and 19, dividivi appears more to resemble, in its properties, gall and sumach, than the other astringents; but, from columns 6, 9, 11, 13, 15, 18, and 20, it seems to differ more from sumach than from galls. It entirely resembles galls, except in the effect of subcarbonate of potash and isinglass, apparent from the galls, containing another principle common to them and sumach: see columns 10 and 12. From column 18 it would appear to be equal in strength to nut-galls, and, from columns 5 and 13, considerably stronger.

15. I next proceed to prepare, from both dividivi and galls, some ink-powder, according to Mr Gray's formula, and the writing from each was indistinguishable the one from the other. It has been asserted, and probably with truth, that the durability of ink bears some ratio to the proportionate quantity of nut-

galls it contains; therefore, as dividivi seems to be the stronger of the two, it is probable that its ink is more durable, and not less intense in its colour. I may here mention, that the powder of galls was very fine, and intended for sale, but the powder of dividivi was coarse. For the purpose of the dyer, also, it would appear that the use of dividivi would be as beneficial as the use of galls in the black dye, which might slightly differ in its hue and tint, but not at all be inferior to the galls in the depth of colour.

16. Sixty grains of dividivi, macerated repeatedly in alcohol, left 16¾ residuum, and afforded, by evaporating the different tinctures, 41¼ grains, indicating a loss in excessive drying, of 2 grains.

17. Sixty grains, treated in the same manner with sulphuric ether, left in one instance 19, and in the other 18 grains of residuum, indicating 41 and 42 grains of soluble matter, of which 28 and 33¾ grains only were obtained by evaporation, the remaining 13 and 8¼ grains being driven off in evaporation. The etherial extract was soluble in water, and became intensely black with muriate of iron.

18. Half an ounce of galls, and as much dividivi, treated with alumina fresh precipitated, left of extracts, the former 30½ grains, the latter 36, continuing soft, and not hardening or crystallizing, by gradual evaporation in a gentle heat. Where my experiments were repeated, two figures appear in the following table, as in columns 2, 3, 5, and 13.

It is remarked by Captain Macadam, who communicated the above notice of Mr Rodsey's experiments, that one day the pods of the Cæsalpinia may become in general use with the tanner, the leather made from them being better than that from oak bark.

TABLE of the Experiments made with Dividivi, and other Astringents.

	Cold Infusions.	Undissolved in Water.	Dissolved in Water.	Colour of Precipitate with Lime-water.	Weight of ditto in grains from 6 grains of basis.	Colour of Lime-water after precipitation.	Ditto with Muriate of Iron.	Muriate of Iron with the original infusions.	Lime-water Elutriation with the original infusions.	Action of Subcarb. of Potash.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
DIVIDIVI, ...	Light Brown,	14 $14\frac{1}{2}$	46 $45\frac{1}{2}$	Whitish-Green,	$4\frac{2}{8}$ $4\frac{1}{2}$	None.	0	Black.	White Precip.	0
NUTGALLS, . . .	Brown,	25 24	35 36	Whitish-Green,	$3\frac{7}{8}$ $4\frac{1}{4}$	None.	0	Black.	White Precip.	Cream & Precip.
SUMACH, ...	Greenish-Brown,	35 37	25 23	Whitish-Green,	$1\frac{4}{8}$ $1\frac{1}{2}$	Yellowish.	0	Black.	Green Precip.	Cream & Precip.
KINO, ...	Purple,	33 $33\frac{1}{2}$	22 $26\frac{1}{2}$	Very dark Brown-red,	$1\frac{6}{8}$ $2\frac{1}{8}$	Pinkish.	0	Green.	Turbid.	0
CATECHU, ...	Cinnamon,	20 $19\frac{1}{2}$	40 $40\frac{1}{2}$	Dark Brown.	$1\frac{5}{8}$ $3\frac{3}{4}$	Reddish-brown, Turbid.	Greenish-black.	Greenish-black.	Turbid.	0
OAK BARK, . . .	Brown,	41 43	19 17	Dark Brown.	$\frac{2}{8}$ $\frac{7}{8}$	Yellowish-brown.	0	Greenish-black.	Brown Turbid.	0
POMEGRANATE, . .	Yellowish-Brown,	39 39	21 21	Lighter Brown.	$1\frac{2}{8}$ $1\frac{2}{8}$	None.	0	Greenish-black.	Reddish-brown Precip.	0
TORMENTILLA, . .	Wine Brown.	43 45	17 15	Dark Brown.	$\frac{3}{8}$ $\frac{1}{2}$	Yellowish-brown.	0	Greenish.	Turbid.	0

TABLE *of the Experiments, &c.—continued.*

	Action of Sulphuric Acid.	Action of Isinglass.	Weight of Leather obtained.	Sugar of Lead.	Persulphate of Copper.	Proto-sulphate of Copper.	Depth of precipitate from Muriate of Tin.	Weight of precipitate from Muriate of Tin.	Muriate of Iron after Muriate of Tin.	Infusion after the Muriate of Tin had acted.
1.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
DIVIDIVI, ...	Slight Precip.	White Precip.	$7\frac{1}{2}$ gr. $5\frac{3}{4}$ Resin-like.	White.	Turbid.	Violet.	$\frac{1}{2}$	$3\frac{2}{8}$	Black.	Milky.
NUTGALLS, . . .	Slight Precip.	Yellowish-white Precip. turbid.	4 gr. $5\frac{1}{4}$ Resin-like.	White.	Turbid.	Violet.	$\frac{1}{2}$	$3\frac{2}{8}$	Black.	Milky.
SUMACH, ...	0	White Turbid.	$\frac{1}{8}$ gr.		0	Violet.	$\frac{1}{8}$	$\frac{3}{8}$	Black.	Turbid.
KINO, ...	Precip. $\frac{1}{2}$ gr.	Purple Precip.	Melted.	Thick.	0	Thick and Dark.	$\frac{1}{3}$	$1\frac{1}{8}$	0	Turbid.
CATECHU, ...	Little Precip.	Brown Precip.	Melted.	Thick Whitish.	Turbid.	Dark Olive.	$\frac{1}{8}$	$\frac{5}{8}$	Green.	Turbid.
OAK BARK, . . .	Slight Precip.	Leather-coloured Precip.	$1\frac{3}{4}$ gr.				$\frac{1}{4}$	$1\frac{1}{8}$	0	Turbid.
POMEGRANATE, . .	Precip. $\frac{1}{3}$ gr.	Brown Precip.	Melted.	Thick.	Turbid.	Dark Olive.	$\frac{1}{4}$	1	0	Very Turbid.
TORMENTILLA, . .	0	White Precip.	Melted.	Turbid.	0	Violet.	$\frac{1}{8}$	$\frac{4}{3}$	0	Turbid.

Analysis of a New Mineral found in the Paramo Rico, near Pamplona, South America. By M. J. B. Boussingault.

At a small distance from the village *Montuosa-Baja*, in the Paramo Rico, 3800 metres (12,467 English feet) above the level of the sea, there is found, in a decomposed syenite, a yellow heavy substance, which, from my analysis, seems to form a new mineral species.

This mineral occurs in small concretions, has a yellow colour, verging towards green, and a specific gravity = 6.00, that of water at the temperature of 24° C. (75° F.) being taken as unity. Before the blowpipe, on charcoal, it melts with ease into a dark coloured globule. With soda we obtain a particle of lead, but which is immediately changed into an infusible slag. After a new addition of soda, the slag sinks into the charcoal. On the mass being pulverized and washed, we obtain a grey, heavy, metallic powder, which has the aspect of regular molybdenum. This is also proved *via humida*, by which we get a considerable quantity of molybdic acid. This mineral is soluble with effervescence in nitric acid; and the solution is precipitated by nitrate of silver. It is quickly acted on by hydrochloric acid; there is formed hydrochlorate of lead, and the solution becomes of a green colour; at the same time is disengaged an odour of chlorine.

When I had thus ascertained that the mineral of Pamplona consisted of lead in combination with molybdenum, carbonic, hydrochloric, and chromic acids, I proceeded as follows to its analysis. One hundred grains of the powdered mineral were at first brought to incipient red heat. This separated 2.9 grains of carbonic acid.

The roasted mineral was dissolved in nitric acid, diluted with six times its volume of water. The solution was dull yellow, and there remained undissolved 3.7 grains of silica.

The addition of sulphuric acid to the nitric solution precipitated sulphate of the oxide of lead, which, after a red heat, weighed 95.9 grains, corresponding to 76.6 grains of oxide of lead.

The solution, after the separation of the lead, was agitated with a small excess of the nitrate of silver. This precipitated 6.6 grains of chloride of silver, corresponding to 1.3 grains of hydrochloric acid. Ammonia was then added, after the excess of silver was precipitated by a few drops of hydrochloric acid, and the hydrochlorate removed by filtration; this produced a gelatinous deposit, which weighed 7.1 grains after a red heat. This deposit might contain oxide of lead. It was therefore treated with boiling hydrochloric acid. There was formed hydrochlorate of lead, which was separated, and alcohol then added to the acid solution. The hydrochlorate of lead weighed 4.0 grains, which corresponds to 3.2 grains of oxide; so that the total quantity of oxide of lead in the mineral amounted to 73.8 grains. The acid alcoholic solution was evaporated, and saturated with caustic potash, in order to dissolve the alumina. The alcaline solution, when saturated with nitric acid, and precipitated by ammonia, gave 2.2 grains of alumina.

The ammoniacal solution, which could only contain the molybdenum and chromic acid, was evaporated to dryness, during which it assumed a dark yellow colour. The salts of ammonia, principally its nitrate, were thus expelled, and there remained a pulverulent greenish-white residuum, which was a mixture of molybdic acid and oxide of chrome.

There adhered to the sides of the platinum capsule, in which the ammoniacal salts were volatilized, a fusible, extremely acid substance, which possessed all the characters of phosphoric acid. This acid was taken up by alcohol, the solution diluted with water, and the alcohol expelled by boiling. It was then saturated with ammonia, and precipitated by nitrate of barytes, which yielded 4.0 grains of phosphate of barytes, which of course contained 1.3 grains of phosphoric acid. The mixture of molybdic acid and oxide of chrome, which weighed 10.9 grains, was treated with caustic potassa; there remained undissolved 0.9 grains of oxide of chrome, corresponding to 1.2 of chromic acid.

From this analysis, the mineral of Pamplona contains:

Oxide of lead,	73.8
Oxide of molybdenum,	10.0
Carbonic acid,	2.9
Hydrochloric acid,	1.3
Phosphoric acid,	1.3
Chromic acid,	1.2
Oxide of iron,	1.7
Alumina,	2.2
Silica,	3.7
	98.1

We must necessarily suppose that, of the oxide of lead,

14.6	are combined with	Carbonic acid;
5.3	....	Hydrochloric acid;
4.1	....	Phosphoric acid;
2.4	....	Chromic acid.
26.4		

Which leaves 47.4 in combination with the molybdic acid.

In the neutral molybdate of the oxide of lead ($\dot{P}b\,\dddot{M}o$) 10 of molybdic acid will take up 15.2 of the oxide of lead. But here the 10 grains of acid are united with almost three times that quantity of base. The mineral under consideration, therefore, seems to be a new molybdate of the oxide of lead, with three times the quantity of oxide assigned by Hatchett to the neutral salt. In the molybdate of lead of Pamplona, the oxygen of the acid is almost exactly equal to that of the base; it is, therefore, a *molybas triplumbicus*, and is expressed by the formula $\dot{P}b^3\,\ddot{M}o$. We may, therefore, consider the mineral of Pamplona as consisting of:

Molybdate of oxide of lead ($\dot{P}b^3\,\dddot{M}o$),	56.7
Carbonate of ditto,	17.5
Hydrochlorate of ditto,	6.6
Phosphate,	5.4
Chromate,	3.6
Matrix,	7.6
Uncombined oxide of lead,	0.7
	98.1

On the Chains of Mountains and Volcanoes of Central Asia. By Baron A. Von Humboldt. (Concluded from preceding Volume, p. 240.)

Such are the principal features of a geognostical description of Central Asia, which I have drawn up with the aid of numerous materials accumulated by me during a long series of years. Of these materials, the portion for which we are indebted to modern European travellers is of small importance, in comparison with the prodigious space which is occupied by the chain of the Altaï, the Himalaya mountains, the transverse ridges of the Bolor and the Kingkan. Those who, at the present day, have published the most important and complete details on these subjects are the learned persons who are conversant with Chinese, Manchoo, and Mongol literature. The more general the cultivation of the Asiatic dialects shall become, the better shall we appreciate the utility of these so-long-neglected sources, for the study of the geognostic constitution of Central Asia. Until M. Klaproth diffuses a new light upon this study by a special work of his own, the picture which I have here exhibited of the four systems of mountains which run from east to west, the materials for which were, in a great part furnished by the learned person whom I have just named, will not be without its use. In order to ascertain the characteristic properties which are to be found in the inequalities of the globe's surface, and to discover the laws which regulate the local disposition of the masses of mountains, and the depressions, we may have recourse to the analogy which other continents may offer. If once the grand forms and predominating courses of the chains are well determined, we shall see connected with this fundamental principle, as with a common type, whatever appeared at first isolated in these phenomena, and at variance with rules, proclaiming another date of formation. This method, which I followed in my geognostic description of South America, I have endeavoured to apply here to the limits of the grand masses of Central Asia.

In taking a last view of the four systems of mountains which divide the continent of Asia from east to west, we observe that the southern has the greatest extent, and the fullest development in respect of length. The Altaï hardly attains, with its elevated summits, the 78th degree; the Tëen-shan, the chain at whose foot are situated Hami, Aksu, and Cashgar, reaches at least to the meridian of 69° 45′; provided we place Cashgar, according to the authority of the missionaries, in 71° 37′ east of Paris*. The third and fourth systems are, as it were, blended in the grand clusters of Badakshan, Little Tibet, and Cashgar. Beyond the 69th and 70th meridians there is but one chain, that of the Hindu-Kho, which is depressed towards Herat, but which afterwards, to the southward of Asterabad, rises to a considerable height towards the volcanic and snowy mountain of Demavend. The table-land of Iran, which, in its greatest extension, from Tehran to Shiraz, appears to attain the average height of 650 toises (4265 feet), throws off, towards India and Tibet, two branches, the Himalaya and the Kwan-lun chain, and forms a bifurcation of the rent from which the mountainous masses arose. Thus the Kwan-lun may be considered as a saliant branch of the Himalaya. The intermediate space, comprising Tibet and Katchi, is intersected by numerous rents in all directions. This analogy with the most common phenomena of the formation of veins is manifested in a very striking manner, as I have elsewhere shewn, in the long and narrow line of the Cordilleras of the New World.

We may trace beyond the Caspian Sea, to the 45th meridian (of Paris) the systems of the Himalaya and the Kwan-lun, which are prolonged till they join in the group situated between Cashmer and Fyzabad. Thus the chain of the Himalaya remains to the south of the Bolor, the Ak-tag, the Mingboolak, and the Ala-tau, between Badakshan, Samerkand, and Turkestan; to the east of the Caucasus it joins the table-land of Azerbidjan, and bounds to the south the *great depression*, of which the Caspian Sea and lake Aral † occupies the lowest basin, and in which a considerable portion of the land whose surface is probably 18,000

* The astronomical geography of Inner Asia is still very confused, because the elements of the observations are not known, merely the results.

† A series of barometrical levels continued throughout a very severe winter, during the expedition of Colonel Berg, from the Caspian Sea to the western shore of Lake Aral, at the Bay Mertvoy Kultuk, by Captains Duhamel and Anjou, has demonstrated that the level of Lake Aral is 117 English feet above that of the Caspian Sea.

square leagues, and which lies between the Kooma, the Don, the Volga, the Yak, the Obsheysyrt, lake Aksakal, the Lower Sihon, and the Khanat of Khiva, upon the shores of the Amoo-daria, is situated below the level of the ocean. The existence of this singular depression has been the object of laborious barometrical observations of levels between the Caspian Sea and the Black Sea, by MM. Parrot and Engelhardt; between Orenburg and Gouriev at the mouth of the Yaik, by MM. Helmersen and Hoffmann. This very low country is abundant in tertiary formations, whence proceeds melaphyre, and *debris* of scorified rocks, and offers to the geognostic inquirer, from the constitution of its soil, a phenomena hitherto unique in our planet. To the south of Baku, and in the Gulf of Balkan, this aspect is materially modified by volcanic forces. The Academy of Sciences of St Petersburgh has recently complied with my solicitations to get determined by a series of stations of barometric levels upon north-eastern edge of this basin, upon the Volga between Kamyshin and Saratov, upon the Yaik between the Obsheysyrt, Orenburg, and the Uralsk, upon the Yemba and beyond the hills of Mougojar, by which the Ural extends itself towards the south on the side of lake Aksakal and towards Sarasu, the position of a geodœsic line, uniting all the points at the level of the surface of the ocean.

I have referred already to the hypothesis, according to which this great depression of the land of Western Asia was formerly continued as far as the mouth of the Ob and the Frozen Sea, by a valley traversing the desert of Kara-koum and the numerous groups of oases in the steppes of the Kirghiz and Baraba. Its origin appears to me to be more ancient than that of the Ural mountains, the southern prolongation of which may be traced in an uninterrupted course from the table-land of Gaberlinsk to Oustoort, between lake Aral and the Caspian Sea. Would not a chain, whose height is so inconsiderable, have entirely disappeared if the great rent of the Ural had not been formed subsequently to this depression? Consequently, the period of the sinking of Western Asia coincides rather with that of the rising of the table-land of Iran, that of Central Asia, the Himalaya, the Kwan-lun, the Tëen-shan, and all the old systems of mountains running from east to west; perhaps also with the period of the upraising of the Caucasus and the cluster of mountains of Armenia and Erzeroum. No part of the earth, not even excepting South Africa, presents a mass of land so extensive, and elevated to so great a height, as that in Central Asia. The principal axis of this upraising, which probably preceded the eruption of the chains from the rents running from east to west, as in the direction of S. W. and N. E., from the group of mountains between Cashmer, Badakshan, and the Tsung-ling in Tibet, where are situated the Caïlasa, and the sacred lakes*, as far as the snowy summits of the Inshan and Khingkan†. The elevation from below of so enormous a mass would suffice to produce a sinking or hollow which, even at the present day, is perhaps not half filled with water, and which, since it was formed, has been so modified by the action of subterranean forces, that, according to the traditions of Tartars, collected by Professor Eichwald, the promontory of Absheron was formerly united by an isthmus with the opposite coast of the Caspian Sea in Turcomania. The great lakes, which have been formed in Europe

* The lakes Manasa and Ravan Hrad. *Manasa*, in Sanscrit, signifies "spirit." Manasa-vara is the easternmost of these two lakes: its name means literally "the most perfect of honourable lakes." The westernmost lake is named *Ravanah Hrad*, or "Lake of Ravana," after the celebrated hero of the *Ramayana*.—Bopp.

† This direction of the axis of elevation from the S. W. to the N. E. is again found beyond the 55th degree of latitude, in the space comprised between Western Siberia, a low country, and Eastern Siberia, a country full of chains of mountains: this space is bounded by the meridian of Irkutsk, the Frozen Sea, and the Sea of Okotsk. Dr Erdman has discovered among the Aldan mountains, at Allakh-yuma, a peak 5000 feet high. To the north of the Kwan-lun, the chain of Northern Tibet, and to the west of the meridian of Peking, the portions of elevated land most important in respect to the extent and height, are the following:—1. To the east of the cluster of the Kookoonoor, the space between Toorfan, Tangut, the great sinuosity of the Hoang-ho, Garjan, and the chain of the Khing-khan, a space which comprehends the great desert of Gobi. 2. The table-land between the snowy mountains of Khangai and Tangnu, and between the sources of the Yeniseï, the Selengga and the Amoor. 3. To the west of the district watered by the upper course of the Oxus (Amou), and of the Jaxartes (Sihoon); between Fyzabad, Balkh, Samarkand and the Ala-tau near Turkestan, to the westward of the Bolor (Beloot-tag). The upraising of this transverse ridge has produced in the soil of the great longitudinal valley of the Tëen-shan-nar-lu, between the second and third systems of mountains from east to west, or between the Tëen-shan and the Kwanlun, a counter-slope from west to east, whilst in the longitudinal valley of the Tëenshan-pe-lu in Zungaria, between the Tëen-shan and the Altaï, a general declivity is observable from east to west.

at the foot of the Alps, are a phenomenon analogous to the cavity in which the Caspian Sea is situated, and owe in the same manner their origin to a sinking of the land. We shall soon see that it is principally in the compass of this hollow, consequently in the space where the resistance was least, that recent traces of volcanic action are apparent.

The position of mount Aral-toube, which formerly emitted fire, of the existence of which I became aware from the itineraries of Colonel Gens, becomes more interesting when we compare it with that of the volcanoes of Pechan and Ho-tcheou, on the northern and southern sides of the Tëen-shan, with that of the *solfatara* of Ouroumtsi, and with that of the adjoining chasm of lake Darlai, which exhales ammoniacal vapours. The researches of MM. Klaproth and Rémusat acquainted us with this last fact upwards of six years ago.

The volcano situated in about the latitude of 42° 25′ or 42° 35′, between Korgos, on the banks of the Ele, and Kouche, in Little Bucharia, belongs to the chain of the Tëen-shan: perhaps it may be on the northern face, three degrees to the eastward of lake Yssi-kul or Tremoortu. Chinese authors call it Pĭh-shan ("White Mountain"), Ho-shan, and Aghi ("Fiery Mountain")*. It is not known with certainty whether the name of *Pĭh-shan* implies that its summit reaches the line of perpetual snow, which the height of this mountain would determine, at least the minimum; or whether it merely denotes the glittering hue of a

* The details given M. Klaproth (*Tabl. Hist. de l'Asie*, p. 110; *Mem.* relatifs à l'Asie, t. ii. p. 358) are the most complete, and derived principally from the history of the Ming dynasty. M. Abel-Rémusat (*Journ. Asiat.* t. v. p. 45; *Descrip. de Khotan*, t. ii. p. 9), has added more in the Japanese translation of the grand Chinese Encyclopedia. The root *ag*, which is found in the word *Aghi*, according to M. Klaproth, signifies "fire" in Hindustani. To the south of Pih-shan, in the neighbourhood of Khoten, belonging to the Tëen-shan-nar-lu, there can be no doubt that, prior to our era, Sanscrit was spoken, or a language possessing a strong analogy with it: but in Sanscrit a flaming mountain is called Agni-ghri. According to M. Bopp, *Aghi* is not a Sancrit word.—Humboldt

The root *ag*, which is found in the word *Aghi*, signifies "fire" in all the dialects of Hindustan; this element is *ag* in Hindustani, *agh* in Mahratta, and the form of *agi* is still preserved in the dialect of the Punjab. The word *agni*, by which "fire" is commonly designated in Sanscrit, belongs to the same root, as well as *agun* in Bengalee, *ogun* in Russian, and the *ignis* of the Latins.—Klaproth.

peak covered with saline substances, pumice-stone, and volcanic ashes in decomposition. A Chinese author of the seventh century says: At 200 *le*, or fifteen leagues, to the north of the city of Kwei-chow (now Koutche), in about the latitude of 41° 37 and longitude 80° 35′ E., according to the astronomical determination of the missionaries made in the country of the Eleuths, rises the Pechan, which emits fire and smoke without interruption. It is from thence sal ammoniac is brought; upon one of the declivities of the Fiery Mountain (Ho-tcheou), all the stones burn, melt, and flow to a distance of some tens of *le*. The fused mass * hardens as it becomes cold. The natives use it in disorders † as a medicine: sulphur is also found there.

M. Klaproth observes, that this mountain is now called Khalar ‡, and that, conformably to the account given by the Bokhars, who bring to Siberia sal-ammoniac (called *nao-sha* in Chinese, and *nōshāder* in Persian), the mountains to the south of Korgos is so abundant in this species of salt, that the natives frequently employ it as a means of paying their tribute to the Emperor of China. In a recent *Description of Central Asia*,

* The history of the Chinese dynasty Tang, speaking of the lava from the Pih-shan, states that it ran like liquid fat.—KLAPROTH.

† This is not lava, but the saline particles which appear in the form of an efflorescence on its surface.

‡ The Pih-shan of the ancient Chinese, at present has the Turk name of Eshik-bosh; *Eshik* is a species of goat, and *bash* signifies "head." Sulphur is produced there in abundance. The Eshik-bash belongs to the elevated mountains, which, in the time of the Wei dynasty (the third century) bounded, to the north-west, the kingdom of Kwei-tsu (Ku-cha); it is the Aghi-shan under the Suy dynasty (in the early moiety of the seventh century). The history of this dynasty relates that this mountain always shewed fire and smoke, and that sal-ammoniac was obtained there. In the description of the western country, which forms a part of the history of the Tang dynasty, we find that the mountain in question was then called Aghi-teen-shan (which may be translated "mountain of fields of fire"), or Pih-shan ("white mountain"), that it was to the north of the city of Ilolo, and that it emitted perpetual fire. Ilolo (or perhaps Irolo, Ilor, or Irol) was then the residence of the King of Kwei-tsu.

The Eshik-bash is to the north of Ku-cha, and 200 leagues to the west of the Kan-tengri, which forms part of the chain of the Teen-chan. The Eshik-bash is very large, and much sulphur and sal-ammoniac is even now collected there. It gives birth to the river Eshik-bash-gol, which flows to the south of the city of Kucha, and falls, after a course of 200 *le*, into the Erghew.

published at Peking in 1777, we find the following statement: —" The province of Ku-cha produces copper, saltpetre, sulphur, and sal-ammoniac. The latter article comes from an ammoniac mountain to the north of the city of Koutche, which is full of chasms and caverns. These apertures in spring, summer, and autumn, are filled to such a degree, that, during the night, the mountain appears illuminated by thousands of lamps. No one is then able to approach it. In winter alone, when the vast quantity of snow has extinguished the fire, the natives are able to labour in collecting the sal-ammoniac, for which purpose they strip themselves quite naked. The salt is found in caverns, in the form of stalactites, which renders it difficult to be detached." The name of Tartarian salt, formerly given in commerce to this salt, ought to have long ago directed attention to the volcanic phenomena of Central Asia.

M. Cordier, in his letter to M. Abel Rémusat, " on the existence of two burning volcanoes in Central Asia," calls Pechan a *solfatara* like that of Puzzuoli. In the state in which it is described in the work cited farther back, the Pechan might well deserve only the name of an extinct volcano, although the igneous phenomena are wanting in the solfataras I have seen: such as those of Puzzuoli, the crater of the Peak of Teneriffe, the Rucu-pichincha, and the volcano of Jorullo; but passages in more ancient Chinese historians, who relate the march of the army of the Heung-nus, in the first century of our era, speak of masses of rocks in fusion flowing to the distance of some miles: so that it is impossible, in these expressions, not to understand eruptions of lava. The ammoniac mountain between Koutche and Korgos has also been a volcano, in activity, in the strictest sense of the word: a volcano which emitted torrents of lava in the centre of Asia, 400 geographical leagues from the Caspian Sea to the west, 433 from the Frozen Sea to the north, 504 from the Great Ocean to the east, and 440 from the Indian Ocean to the south. This is not the place to discuss the question relative to the influence of the proximity of the sea on the action of volcanoes; I merely solicit attention to the geographical position of the volcanoes of Inner Asia, and their reciprocal relations. The Pechan is distant from 300 to 400 leagues from all the seas. When I returned from Mexico, some celebrated mineralogists expressed their astonishment when they heard me speak of the volcanic eruption of the plain of Jorullo, and of the volcano of Popocatepetl, as still in activity: although the former is only thirty leagues from the sea, and the latter forty-three leagues. Gebel Koldaghi, a conical and smoking mountain of Kordofan, of which Mr Rüppel was told at Dongola, is 150 leagues from the Red Sea, and this distance is but a third of that at which the Pechan, which for 1700 years has emitted torrents of lava, is situated from the Indian Ocean. The hypothesis, conformably to which the Andes present no volcano in activity in those parts where the chain recedes from the sea, is without foundation. The system of mountains of the Caraccas, which run from east to west, or the chain of the coast of Venezuela, is shaken by violent earthquakes, but has no longer apertures which are in permanent communication with the interior of the earth, and which discharge lava, than the chain of the Himalaya, which is little more than 100 leagues from the Gulf of Bengal, or the Ghauts, which may almost be termed a coast-chain. Where trachyte has been unable to penetrate across the chains when they have been elevated, they discover no rents; no channels are opened, whereby the subterranean forces can act in a permanent manner at the surface. The remarkable fact of the proximity of the sea wherever volcanoes are still in activity,—a fact which, in general, is not to be denied,—seems to be accounted for less by the chemical agency of the water, than by the configuration of the crust of the globe, and the deficiency of resistance, which, in the vicinity of maritime basins, the upraised masses of the Continent oppose to elastic fluids, and to the efflux of matters in fusion in the interior of our planet. Real volcanic phenomena may occur, as in the old country of the Eleuths, and at Toorfan, to the south of the Tëen-shan, wherever, owing to ancient resolutions, a fissure is opened in the crust of the globe at a distance from the sea. The reason why volcanoes in activity are not more rarely remote from the sea, is merely because, wherever an eruption has been unable to force itself through the declivity of continental masses towards a maritime basin, a very unusual concurrence of circumstances is requisite to permit a permanent communication between the interior of the globe and the atmosphere, and to form apertures, which, like intermittent warm springs, effuse, instead of water, gases and oxidized earths in fusion, in other words, lava.

To the eastward of Pechan, the "White Mountain" of the Eleuths, the whole northern slope of the Tëen-shan presents volcanic phenomena: "lava and pumice-stone are seen there, and even considerable solfataras, which are called 'fiery places.' The solfatara of Ouroumtsi is five leagues in circumference; in winter it is not covered with snow; it is supposed to be full of ashes. If a stone be thrown into this basin, flames issue forth, as well as a black smoke, which continues some time. Birds dare not fly over these fiery places." Eastward, sixty leagues from Pechan, is a lake of very considerable extent, the different names of which in the Chinese, Kirghiz, and Calmuc languages, signify, "warm salt and ferruginous water."

If we cross the volcanic chain of the Tëen-shan, we find E. S. E. of lake Issikoul (so often mentioned in the itineraries which I have collected), and of the volcano of the Pechan, the volcano of Toorfan, which may also be called the volcano of Ho-chow ("City of Fire"), for it is very near that city *. M. Abel Rémusat has made particular mention of this volcano in his *Histoire de Khoten,* and in his letter to M. Cordier †. No reference is made to stony masses in fusion (torrents of lava), there, as at Pechan; but "a column of smoke is seen continually to issue; this smoke gives place at night to a flame like that of a torch. Birds and other animals upon which the light falls, appear of a red colour. The natives, when they go thither to collect the *nao-sha*, or sal-ammoniac, put on wooden shoes, for leather soles would be very soon burned." Sal-ammoniac is procured at the volcano of Ho-tcheou, not only in the form of a crust or sediment, according as it is deposited by the vapours which exhale it; but Chinese books likewise make mention "of a greenish liquor collected in cavities, which is boiled and evapo-

* Ho-chow, a city, now destroyed, was a league and a half to the east of Toorfan.

† M. Rémusat calls the volcano of Pechan, to the north of Koutche, the volcano of Bishbalik. From the time of the Mongols in China, all the country between the northern slope of the Téen-shan and the little chain of the Tarbagatay has been called Bishbalik.

rated, and from it sal-ammoniac is obtained in the form of small lumps like sugar, of extreme whiteness, and perfect purity."

Pechan and the volcano of Ho-tcheou or Tufan are 140 leagues apart, in the direction of east and west. About forty leagues westward of the meridian of Ho-tcheou, at the foot of the gigantic Bokhda-ula, is the great solfatara of Ouroumtsi. At 140 leagues north-west of this, in a plain adjoining the banks of the Kobok, which flows into the small lake of Darlai, rises a hill, "the clefts of which are very warm, though they do not exhale smoke (visible vapours): the sal-ammoniac, in these crevices is sublimed into so solid a coating, that the stone is obliged to be broken in order to get it."

These four places hitherto known, namely, Pechan, Ho-tcheou, Ouroumtsi, and Kobok, which exhibit evident volcanic phenomena, in the interior of Asia, are 130 or 140 leagues to the south of the point of Chinese Zungaria, where I was at the beginning of 1829. Aral-toube, the conical and insular mountain of Lake Ala-kul, which has been in a state of ignition in historical times, and which is mentioned in the itineraries collected at Semipolatinsk, is in the volcanic territory of Bishbalik. This insular mountain is situated to the west of the ammoniac-cavern of Kobok, and to the north of Pechan, which still emits light, and which formerly discharged lava, and at a distance of sixty leagues from each of these two points. From Lake Ala-kul to Lake Zaisang, where the Russian Cossacks of the line of the Irtish, exercise the right of fishing, by connivance of the Mandarins, the distance is reckoned at fifty-one leagues. The Tarbagatai, at the foot of which is situated Choogonchak, a town of Chinese Mongolia, and where Dr Meyer, the learned and enterprising companion of M. Ledebour, fruitlessly essayed, in 1825, to prosecute his researches in natural history, extends to the south-west of Lake Zaisang towards the Ala-kul *. We are thus acquainted, in the interior

* I do not wish to express any doubt respecting the existence of the Ala-kul and the Alaktugul-noor lakes, in the vicinity of each other; but it appears singular to me, that the Tartars and Mongols, who traverse these parts so often, and who have been questioned at Semipolatinsk, should only know the Ala-kul, and assert that the Alaktugul-noor owes its existence to a confusion of names. M. Pansner, in his Russian map of Inner Asia, which may be implicitly relied on with regard to the country north of the course of the

of Asia, with a volcanic territory, the surface of which is upwards of 2500 square leagues, and which is distant 300 or 400 leagues from the sea: it occupies a moiety of the longitudinal valley situated between the first and second systems of mountains. The chief seat of volcanic action seems to be in the Teen-shan. Perhaps the colossal Bokhda-ula is a trachytic mountain like Chimborazo. On the side north of the Tarbagatai and of Lake Darlai, the action becomes weaker; yet Mr Rose and I found white trachyte along the south-western declivity of the Altaï, upon a bell-shaped hill at Ridderski, near the village of Butachchikha.

On both sides of the Tëen-shan, north and south, violent earthquakes are felt. The town of Aksou was entirely destroyed by a convulsion of this kind at the beginning of the eighteenth century. Professor Eversman, of Casan, whose repeated travels have made us acquainted with Bokhara, was told by a Tartar, who was a servant of his, well acquainted with the country between Lakes Balkashi and Ala-kul, that earthquakes were very common there. In eastern Siberia, to the north of the fiftieth parallel, the centre of the circle of shocks appears to be at Irktusk, and in the deep basin of Lake Baikal, where, on the Kiachta road, especially on the banks of the Jeda, and the

Ele, makes the Ala-kul (properly Ala-ghul, or "party-coloured lake") communicate with the Alaktugul by five channels. Possibly the isthmus which separates these lakes, may be marshy, which causes them to be considered as one. Casim Bek, a professor at Casan, and who is a Persian by birth, insists that *tugul* is a Tartaro-Turkish negation, and that therefore, *Altatugul* signifies "the lake not variegated," as Ala-tau-ghul implies "the lake of the variegated mountain." Perhaps the names of Ala-kul and Ala-tugul mean merely "lake near the Ala-tau mountain," which stretches from Turkestan to Zungaria. The small map published by the English missionaries of the Caucasus, does not contain the Ala-kul; there appears only a group of three lakes, the Balkashi, the Alak-tugul, and the Koorgeh. The hypothesis, however, according to which the vicinity of large lakes produces, in the interior of Asia, the same effect upon volcanoes remote from the sea, as the ocean, is without foundation. The volcano of Toorfan is surrounded only by insignificant lakes; and, as it has been already remarked, Lake Temoortu or Ysal-kul, which is less than double the extent of the Lake of Geneva, is thirty-three leagues from the volcano of Pih-shan.—HUMBOLDT.

The Chinese maps represent the two lakes as one, having a mountain in the midst. This lake is called Ala-kul, its eastern portion bears the name of Alak-tugul nor, and its western gulf that of She-bartu-kholay.—KLAPROTH.

Chekoy, basalt is found with olivine, cellular amygdaloid, chabasie, and apophyllite *. In the month of February 1829, Irktusk suffered greatly from violent earthquakes; and in the month of April following, convulsions were also felt at Ridderski, which were perceived at the bottom of the mines, where they were very severe. But this part of the Altaï is the extreme limit of the circle of shocks; farther to the west, in the plains of Siberia, between the Altaï and the Ural, as well as along the entire chain of the latter, no motion has hitherto been observed. The volcano of Pechan, the Aral-toube, to the westward of the caverns of sal-ammoniac of Kobok, Ridderski, and the portion of the Altaï which abounds in metals, are situated for the most part in a direction which but slightly deviates from that of the meridian. Perhaps the Altaï may be comprehended within the circle of the convulsions of the Tëen-shan, and the shocks of the Altaï, instead of coming only from the east, or from the basin of the Baikal, may also come from the volcanic country of Bishbalik. In many parts of the new continent, it is clear, that the circles of shocks intersect each other, that is, the same country receives terrestrial convulsions periodically on two different quarters.

The volcanic territory of Bishbalik is to the eastward of the great depression of the old world. Travellers who have journeyed from Orenburg to Bokhara, relate that at Sussak in the Kara-tau, which forms with the Ala-tau a promontory to the north of the town of Taraz in Turkestan, on the edge of the depression, warm springs spout up. On the south and on the west of the inner basin we find two volcanoes still in activity; Demavend, which is visible from Tehran, and the Seyban of Ararat, † which is covered with vitrified lava. The trachytes, porphyries, and thermal springs of the Caucasus are well known. On both sides of the isthmus between the Caspian and Black Seas, naphtha springs and volcanoes of mud are numerous. The mud volcano of Taman, of which Pallas and Messrs Engelhard and Parrot have

* Dr Hess, associate of the Academy of Sciences of St Petersburgh, who resided on the borders of the Balkal, and to the south of the lake, from 1826 to 1828, gives us reason to expect a geological description of a portion of the remarkable country which he traversed. He frequently observed at Verkhnei-Oudinsk granite alternating several times with conglomerate.

† The height of Ararat, according to Parrot, is 2700 toises (17,718 feet); that of Elbourz, according to Kuppfer, 2560 (16,800 feet) above the level of the ocean.

described the last fiery eruption, in 1794, from the reports of Tartars, is, according to the very sensible remark of Mr Eichwald, " a dependency of Baku, and of the whole peninsula of Absheron." Eruptions take place where the volcanic forces encounter least opposition. On the 27th November 1827, crackings and tremblings of the earth, of a violent character, were succeeded, at the village of Gokmali, in the province of Baku, three leagues from the western shore of the Caspian Sea, by an eruption of flames and stones. A space of ground, 200 toises long and 150 wide, burned for twenty-seven hours without intermission, and rose above the level of the neighbouring soil. After the flame became extinct, columns of water were ejected, which continue to flow till the present hour. I am gratified at being enabled to state here, that Mr Eichwald's periplus of the Caspian Sea, which will soon appear, will contain some very important physical and geological observations, more particularly upon the connexion of fiery eruptions with the appearance of naphtha-springs and strata of rock-salt, on the blocks of calcareous rock hurled to considerable distances, on the elevation and depression of the bed of the Caspian Sea, which still continue; on the passing of black porphyry, partly vitrified and containing garnets (*melapyres*), through granite, red quartzose porphyry, very dark calcareous syenite, in the Krasnovodsk mountains washed by the bay of the Balkan, to the northward of the ancient mouth of the Oxus (Amoo-doria). We shall learn from the geognostic description of the eastern shore of the Caspian Sea, where the island of Chabekan discovers naphtha-springs the same as Baku and the isles between this town and Salian, what species of crystallized rocks are hidden beneath the rocks in horizontal strata in the peninsula of Absheron, where the action of subterranean fire is always felt, and where it has not yet been able to reach the open air. The porphyries of the Caucasus, which run from W. N. W. to E. S. E., a position and a direction which I have already mentioned as the reason of the presumed connexion of this chain with the rent of the Tëen-shan, discover themselves again, traversing all the rocks nearly to the centre of the great depression of the old world, to the east of the Caspian Sea, in the mountains of Krasnovodsk and Kurreh. Recent researches and the traditions of the Tartars inform us, that the existence of naphtha springs has always been preceded by fiery eruptions. Several salt lakes on the two opposite shores of the Caspian Sea have a very elevated temperature; and blocks of rock-salt, traversed by asphaltum, are formed, as Mr Eichwald remarks with much shrewdness, " by the effect of a sudden volcanic action, as at Vesuvius,* in the Cordilleras of South America and in Azirbidjan, or even under our own observation by the slow but continued action of heat." M. L. de Buch has long directed his attention to the connexion of the volcanic forces with the masses of anhydrous rock-salt, which traverse so often and so many formations of horizontal strata.

We have already seen that the circles of the terrestrial convulsions, of which Lake Baikal or the volcanoes of Tëen-shan are the centre, do not extend in western Siberia beyond the western declivity of the Altaï, and do not pass the Irtish or the meridian of Semipolantinsk. In the chain of the Ural, earthquakes are not felt, nor, notwithstanding the rocks abound in metals, do we find there basalt or olivine, nor trachytes, properly so called, nor mineral springs. The circle of the phenomena of Azerbidajan, which includes the peninsula of Absheron, or the Caucasus, often extends as far as Kizlar and Astrakhan.

It is the same on the border of the great depression in the west. If we direct our observation from the Caucasian isthmus to the north and north-west, we come to the country of grand formations in horizontal and tertiary strata, which occupy southern Russia and Poland. In this region, the rocks of pyroxene pierce the red free-stone of Yekaterinoslav, whilst asphaltum and springs impregnated with sulphurous gas denote other masses hid under the sedimentary deposits. It may also be mentioned as an important fact, that in the chain of the Ural, which abounds so much in serpentine and hornblende, and which serves as a boundary between Europe and Asia, a true amygdaloidal formation appear at Griasnushinskaia, towards its southern extremity.

We shall content ourselves here with observing, with reference to the ingenious opinions recently promulgated by M. Elie de Beaumont, respecting the relative age and the parallelism of

* In an eruption of this volcano in 1805, M. Guy Lussac and I found small fragments of rock-salt in the lava as it cooled. My Tartar itineraries likewise speak of rock-salt in the neighbourhood of a volcanic mountain of the Tëen-shan, north of Aksou, between the station of Turpa-gad and Mount Arbab.

systems of contemporary mountains, that, in the interior of Asia likewise, the four grand chains which run from east to west are of a totally different origin from the chains which lie in a direction north and south, or N. 30° W., and S. 30° E. The chain of the Ural, the Bolor, or Beloor-tag, the Ghauts of Malabar, and the Kingkhan, are probably more modern than the chains of the Himalaya and the Tëen-shan. The systems of different epochs are not always separated from each other by considerable spaces, as in Germany, and in the greater part of the new continent. Frequently, chains of mountains, or axes of upraising, of dissimilar directions, and belonging to epochs totally different, are nearly approximated by nature; resembling so far the characters on a monument which, crossing different ways, were engraved at different periods, and carry intrinsic marks of their own date. Thus, in the south of France, are seen chains and undulated swellings, some of which are parallel to the Pyrenees and others to the western Alps. The same diversity of geological phenomena is apparent in the high land of Central Asia, where isolated portions appear as it were surrounded and enclosed by subdivisions, in parallel lines, of the systems of mountain.

Critical Observations on the Ideas of M. Alexander Brongniart, relating to the Classification and probable Origin of Tertiary Deposits. By A. Boue', M. D. Communicated by the Author.

The "Tableau des Terrains" of M. Brongniart is well known, and has been gratefully received by the scientific world. Far from being disposed to remain stationary in his ideas, this founder of the true doctrine of tertiary deposits has recognised the advances made in our knowledge of these formations, and has, consequently, modified some of his theoretical deductions, and even some of his former classifications. We are now to inquire if he has carried his modifications sufficiently far, to what extent his new doctrines can be admitted; and if he is always, in his reasoning, in harmony with his principles.

The plastic clay not a distinct formation, only a subordinate bed.

One of the most important points in which our author has given the victory to his opponents is, the separation of the *plastic clay*, or his *terrain argilo-sableux*, from the other numerous tertiary deposits of clay with lignites. He does not enumerate any organic bodies as occurring in his plastic clay.—(*Vide Tableau des Terrains*, p. 182.) " Les debris organiques qu'on a attribues à l'argile plastique, appartiennent ordinairement aux argiles figulines;" nor even any trace of lignite, so that if the last mentioned mineral occur in it, it is only in so small a quantity as to be omitted in a general view. He further acknowledges, that the plastic clay is only a small deposit, " d'amas conches sur des surfaces de roches ou dans les cavités qui peuvent presenter ces surfaces,"—p. 181. He still admits, in opposition to his former opinion, not only that there is true plastic clay under the chalk (p. 183.), but also that the potter's clay (argile figuline) associated with tertiary lignite differs but little from the plastic clay, " ne differ que tres peu de l'argile plastique,"—p. 177. After this distinct statement and candid agreement with opinions expressed by others long ago, we cannot help thinking that our learned author has inserted, merely by mistake in the same work, the remark, " qu'il y a entre le calcaire grossier et la craie un terrain composé d'argile pure et de bois bitumineux, accompagné de corps organises terrestres ou fluviatiles,"—p. 185; and that, at page 194, he speaks of " argile plastique et ses debris organiques d'eau douce." This theoretical part of his work is probably of older date than the rest; besides, we only mention this apparent contradiction to put in a stronger point of view M. Brongniart's latest and most correct classification.

On the other hand, if he separates the plastic clay from the deposits of tertiary clay with lignite, we may ask him the proofs of the lignite clay of Cologne, and the plastic clay of Gross Almerode, in Hessia, being still parts of his argillo-arenacious group. Indeed both localities present characters in opposition to those assigned to that group; for at Cologne there are fossil-shells, the fishes of the Dusodile are well known there, and even teeth of the mastodon have been described by Noggerath as imbedded in that clay. We have then, on the contrary, the zoological characters of his *proteique* group, or of the upper tertiary soil, as given by M. Brongniart himself. In regard to the situation of the Gros Almeroda deposit, the classification rests on a purely mineralogical resemblance, which may deceive M. Brongniart in this case, as it has done in that of the plastic clay in the greensand. No certain indication proves the justness of this parallelism; in the mean time, the association of this clay with lignite, as well as in the Meissner, is contrary to the characters assigned to plastic clay by M. Brongniart. Further, as he admits in his plastic clay only an extremely fine mechanical deposit, upon which chemical action has had some influence (p. 181.); it results, from our limited observations, that plastic clay, or potter's clay, differing but little from the first, occurs in other formations besides those in which M. Brongniart is now willing to admit its presence. Thus, the lignite of the uppermost tertiary soil, his proteique group, sometimes contains true plastic clay, as is the case at Wolfsegg, in Upper Austria, in Bohemia, and Hungary, and it forms also beds in the sandstone of the lias marls at Kyfendorf, in Southern Coburg. We may even inquire whether or not plastic clay does not exist in more than one other formation, and especially in the old alluvial ones at Hamburgh? Plastic clay, according to our view of its mode of formation seems to be a deposit of very minute fragments derived from granitic, syenitic, and felspathic districts. When these rocks were not in the neighbourhood, the clay was not deposited, but in its place other mineralogical compounds, as sand, loam, &c. were deposited. Would it be rational to call in the aid of mineral waters in a deposit of this kind, notwithstanding its arenaceous characters?

The *terrain marno-charboneux* of M. Brongniart is merely a subordinate deposit at various heights in the tertiary soil, or, if we choose, only in the Paris coarse marine limestone. This fact no one denies, so that we regret M. Brongniart calls it a *terrain* (p. 176.), and the more so as he puts this denomination as parallel with great formation (grand formation, p. 4.). Farther, he acknowledges that he places in that deposit various beds (assises), for he tells us that his *terrain* is sometimes subordinate to the coarse marine limestone, sometimes totally independent, and that it exists as well in the inferior part of the limestone as amongst its beds (p. 177.). Now, I ask, if the greywacke or the variegated sandstone were called a great formation, it would be allowable to classify under the same head, as great formations, small beds of so subordinate a nature as those beds, or large elliptical nests, of *marno-charboneux* rocks. These, then, are to be viewed as only a simple dependence or appendix to the Parisian *calcaire grossiere* or *tritonien*, of which the first member is the plastic clay, which is only a small local deposit even in the Paris basin, for in the north-western part, as near Beauvois, the *calcaire grossiere* is separated from the chalk by marly sands with green particles.

This classification will at first view appear rather heretical, although it is very simple, and in accordance with other facts of the same kind. Thus, the sub-apennine clay-marl is covered by sand and shelly limestones. In these last, especially in their under part, there are some argillaceous beds, resembling the micaceous sub-apennine clay. No one ever thought of separating these subordinate beds from the sands and the limestone, and forming them into a separate group or *terrain*. On the contrary, it is generally acknowledged that these alternations are, as is the case between other deposits, the places of transition or union of one deposit with the other, and that the uppermost argillaceous beds bore less resemblance to the true sub-apennine clay, and became more mixed with sandy and calcareous particles, and *vice versa*. Now, is it not exactly the same case with the plastic clay and the argillaceous beds of the Paris limestone, which are sometimes arenaceous and carboniferous? Is it not natural to suppose that the purest deposit, of clay was followed afterwards at intervals by a more loamy deposit with more calcareous matter, and entangling lignite, fresh-water shells, &c., while these bodies were accidentally carried into the sea along with the mud of rivers? Does not M. Brongniart himself confess that "la distinction de cette argile (plastique) d'avec son terrain marno-charboneux est quelquefois presq' impossible"—p. 199.); that, besides the mineralogical difference between both is trifling (p. 177.), and that they contain the same minerals, the selenite, pyrites, &c.? Lastly, does he not expressly say, that "son terrain marno-charboneux est quelquefois tout fait au-dessous des calcaire tritonien?"—P. 177. But this is the sole place assigned to the plastic clay, so that the conclusion is, *that both clays are but one single deposit.*

On the other hand, if M. Brongniart had not thought proper to give to the plastic clay the rank of a formation, who ever, in England, would have thought of separating the London clay from the plastic clay? An argillaceous deposit from top to bottom, but more plastic or sandy in the inferior than in the superior part, has it ever been divided elsewhere into two distinct formations? Besides, what is artificially called the plastic clay in the London basin, contains marine or even fresh-water shells, so that the parallelism of that clay with the clay of Paris, could only be maintained, when M. Brongniart erroneously united into one mass all the known tertiary lignites.

Lastly, If the English plastic clay is acknowledged to be identical with that of Paris, we dare defy M. Brongniart to name any place in Europe, beyond the Paris basin, where that clay undoubtedly exists. If he had known other localities besides the two formerly mentioned, and which we proved to be erroneous, certainly he would have done so. We then consider ourselves entitled, and without the risk of being considered innovators, to infer that the plastic clay, as well as the marno-charboneux group of M. Brongniart, does not exist as a *formation* or *terrain*, but that it is only in the Paris basin, the first member (but not always present) of a marine principally calcareous deposit, which contains subordinate beds of a clay not very unlike the preceding, and not unfrequently lignites or fresh-water shells, or even mixtures of marine and fresh-water shells. In classifying the Parisian clays in this manner, I follow the classical geological doctrines taught me by my old master Professor Jameson. A grand merit of the Wernerian school is teaching the true principles of the science, under which are included, amongst other considerations of the first importance, the distinction of what is termed a formation, a deposit, a bed, &c. The zoological school of geology can adorn the science, but never act in opposition to geognostical axioms, without falling into errors.

The Calcaire grossiere or Paris Coarse Marine Limestone and Gypsum are Marine Deposits.

The Parisian coarse marine limestone seems to be confined in Europe to the Paris basin, to the foot of the Southern Alps, and perhaps to some extremely limited localities in Northern Germany, as Eversen and Lemgo. The limestone which has been compared with it in other parts of Germany, covers a lignite deposit, which circumstance, according to M. Brongniart's own views, places it higher in the series. As far as I have seen and read, it appears that the Paris limestone, said by Brongniart to extend from the western part of France towards the eastern extremity of Europe (p. 185.), belongs to the upper tertiary soil. We think that he himself already acknowledges his mistake in the localities mentioned for Britanny, La Vendee, Montpellier, Bavaria, Austria and Hungary (p. 190). Those geologists who have visited and described the three last mentioned countries, have lately acknowledged that there they could find only subapennine deposits, so that probably M. Brongniart will give his assent to this statement. We do not know any thing which can induce us with Brongniart (p. 190.), to place as parallel with the Paris limestone the *red molasse* of Switzerland. That deposit is a mass of indurated greyish or reddish coloured marls, without fossil organic remains, with a few beds of sandstone impregnated with mineral pitch, and covered in an unconformable and overlying position by the molasse, with lignite, selenite, and fresh-water shells, as at Nant de Verni, near Geneva. These marls, according to the observations of Necker, pass under the fucoidal alpine sandstone of the Voirons, at the same time that they cover the greensand rocks of the Perte du Rhone. As we believe we found in the Carpathians a system of similar beds in the recent secondary arenaceous soil, we are disposed to look upon this as a dependent of the fucoidal secondary sandstone, until other observations of M. Brongniart shall prove the contrary.

If M. Brongniart has extended too widely the geographical distribution of the Paris limestone, he seems also to have fallen into a similar mistake in regard to other deposits, when he says that " Les quatre alternatives de terrain tritonien, paleotherien, proteique, et epilymnique, peuvent se suivre depuis le basin de

Paris jusqu'en Hongrie"* (p. 190.) ; and he is equally at fault when he attempts to apply the *accidens* of the peculiar Paris basin to those of different basins, as those of the Aar, of Ulm, of Bavaria, Hungary, and Lombardy. (P. 190.) We would even contest with him the proposition, that out of the Paris basin there are many known spots where the tritonian limestone is covered with his paleotherian formation (p. 186.) ; we at least know no place out of the Paris basin where such a thing is to be seen, for even in England the superpositions are not quite identical. Besides, since the bones of the gypsum of Montmartre have been found in the *tritonian* limestone, there remain only the mineralogical characters to enable us to join together the gypsums of Paris and of the Puy en Velay. For the Aix one, the zoological characters are already not identical, and the tritonian limestone is wanting at Puy. In Lombardy we are not acquainted with any fresh-water deposit, and fresh-water and terrestrial shells are rare. In Hungary and Bavaria there is only a fresh-water deposit deposited in ancient tertiary lakes, of which the borders are still more or less visible. There are a good many beds of marine and fresh-water shells mixed together, but these last are only small *accidens* in the upper tertiary soil. Lastly, The valley of the Aar seems to us to be only occupied by these last formations.

The four alternations of the Paris deposits are thus only exceptions to a general rule, and not the case upon which the classifications of the tertiary deposits of all the basins must be modelled. Paris has had many observers, which is the cause of this error, in the same manner as the minute study of the German *zechstein* has so long retarded the progress of geological classification. (P. 175.) All the facts go to prove that the upper tertiary soil predominates in the greater number of the tertiary basins distributed throughout Europe. The *epilymnique* formation is but seldom met with beyond the Paris basin, or at least when it does appear, it is without the *buhrstone* or *meuliere*. If the *paleotherian* or gypsum rocks may be compared,

* The calcaire grossier and London clay belong to the *tritonien ;* certain lignites, Paris gypsum, and calcaire siliceux belong to the *paleotherien ;* the crag of English geologists, nagelflu, and calcaire moellen, belong to the *proteique ;* and certain travertines, certain marls of the Isle of Wight, Paris basin, and Hungary, &c. and mill or buhrstone, belong to the *epilymnique* group.

to a certain extent, with portions of the tertiary soil in central France, and with the gypseous and muriatiferous inferior parts of the *proteique* system in the Mediterranean basin, this deposit, as described by Brongniart, does not occur elsewhere than at Paris. Lastly, the *tritonian* limestone is nearly peculiar to Paris, and the important assertion of Brongniart, that "Dans les colleries subapennines le terrain tritonien se confond avec le terrain proteique," (p. 171.), seems to rest entirely on his description of the Superga Hill near Turin. Now, the public can judge if that memoir puts the question at rest, and if a confirmation of it would not still be desirable.

In the chapter on the upper tertiary soil, M. Brongniart, always too much occupied with the under part of his edifice, seems, in our opinion, to have proposed various false classifications. Thus he arranges as parallel deposits the Rigi and Salzburg nagelfluh with that of the molasse, two deposits which we, along with Studer and Keferstein, consider to be very different from each other. The molasse contains beds of conglomerate, but the old nagelfluh of the Rigi shews its age, by occurring in rolled masses in the more ancient nagelfluh of the molasse. We even believe that the Rigi nagelfluh is secondary, and that at Salzburg there is an alluvial nagelfluh or conglomerate, a cretaceous or Rigi-like nagefluh, and a third belonging perhaps to the molasse.

If this is a point not easily determined, we do not see how M. Brongniart can with propriety place the various lignites of the molasse only in the inferior part of his deposit, or of his *Proteique System* (pages 158 and 188); and how he can recognise in these masses his paleotherian or gypsum formation of Paris (p. 146.)

In Switzerland the lignites are found at very different heights of the molasse deposit, as is proved by the different beds contained in the Albis, and by the Jet of Kapfnach, when compared with the bituminous wood of Usnach. In Bavaria, lignite is found in three or four different positions; and in Upper Austria it is easily observed amongst the uppermost part of the molasse. Lastly, in the northern part of the tertiary basin in Bavaria, in Lower Austria, as at St Polten, &c., at Sarisap and other parts in Hungary, in Stiria and Carinthia, lignite occurs in the upper sand above the molasse. That of Sienna has nearly the same position. All these having been enumerated in our Synoptical Table of Formations, published in 1828, M. Brongniart should not have omitted these deposits. Instead of admitting with M. Brongniart only four or five deposits of lignite (p. 158), we find that inflammable substance at various heights in the three tertiary groups, viz. the upper tertiary sands, the subapennine clay-marl, and the Paris limestone, as well as in five or six secondary formations, viz. in greensand, Kimmeridge clay, nummulite limestone of Istria, Oxford clay, lias marl, and even in the under part of the Keuper. We are aware of the fact that, in the last mentioned deposits, the coal exhibits characters intermediate between those of jet and slate coal (houille grasse), and that it is named by M. Brongniart *Stipite*, but yet they are also sometimes associated with true lignite.

The comparison of the inferior molasse with the gypsum deposit at Paris appears to be theoretically true, if we conceive that both deposits took place at nearly the same period of time; but the contrary if we are disposed to infer the resemblance from zoological or mineralogical characters. M. Brongniart expresses our opinion when he says, " qu'il ne s'agit nullement question d'etablir le moindre rapprochement entre la molasse et le gypse de Montmartre." (Page 160.)

On the other hand, it is astonishing that M. Brongniart should say that the lignite in the molasse or the *terrain proteique* are lacustrine deposits; and that he further declares, that, if such is the case, " la succession des generations d'animaux comme le moyen le plus sur et peut-étre le seul pour determiner les epoques geognostiques. (P. 159 & 290.) Yet he has well stated, in another place, the characters of the various fresh-water deposits. (P. 166.) He acknowledges that the fœtid limestone associated with the lignite of Switzerland has no sinuous tubes (tubulures) (p. 165, 168), that it is a mechanical deposit which " s'il ne renforme en general que des debris de corps organisés terrestres ou d'eau, peut aussi avoir enveloppé quelques debris d'un autre origine,"—p. 169. In the same article he explains very clearly how such deposits can be placed amongst beds formed in sea-bays, or at the mouths of rivers. He speaks explicitly of those mixtures of marine and fresh-water shells (p. 169, 186, 188); and he finds that some marine limestones with fresh-water shells, as that of Mayence (p. 170, 174, 185), form the passage between the deposits entirely marine and those of fresh-water formation.

Notwithstanding he has given in this way all the elements for resolving the problem, M. Brongniart, always thinking of the Paris basin, says, that " on a cru reconnoitre sous les lignites Suisses d'abord un terrain lacustre plus ou moins epais, et ensuite un terrain de calcaire Parisien,"—p. 159. These facts, if proved, would indeed decide the question; but where are the proofs? First, the *tritonian* limestone is unknown in all the countries of molasse or subapennine clay-marl; and if a portion of the molasse, that, namely, around the Lake of Geneva, contains fresh-water shells, these deposits exist not only near to lignite beds, but also in some argillaceous beds, as at Pressy, near Geneva, and Cologny: this being the case, one cannot say, " qu'il n'y a point de coquilles lacustres au milieu meme de la mollasse,"—p. 148. These shells have been carried by the fluviatile waters, as M. Brongniart acknowledges to have been the case with the *palm-tree* of Lausanne (p. 148); but, from these facts, it does not follow that the molasse, even in the basin of Geneva, is lacustrine, for the shells are not sufficiently numerous, and are not imbedded in the same way there as in true lacustrine deposits. These fossils, the lignite as well as the fresh-water and terrestrial shells, which are found so often in the upper tertiary soil of Southern France, of Austria, Hungary, Transylvania, and Gallicia, or as in some *greensand* beds, are accidental. Lastly, in considering, in a large marine formation like the molasse, every bed of lignite, or every stratum of fresh-water shells, as lacustrine deposits, we obtain so complex and singular a supposition, that, even if we had not a more simple and satisfactory opinion to offer, it would fall to be rejected.

M. Brongniart's idea is entirely founded on his theory of the formation of the deposit of gypsum at Paris. He classes it in the second group of his first division of the lacustrine rocks, viz. that where the mass does not present any *sinuous pores (tubulures)*,—a fact so remarkable, that, if true, would change almost entirely the question. He acknowledges that, at the points of contact with the marine deposits, there is an intermixture of fresh-water with marine shells (p. 188); but he lays much stress on some very scarce lymnea found in gypsum (p. 186), and especially in marls, with fresh-water and marine shells, at St Ouen and St Pantin. Now, it so happens that these shells are not more, nay, even not so abundant, as in the Mayence limestone, which he classifies as we do, that is, amongst the marine rocks. Assuredly, if a saline solution like that which deposited gypsum and strontianite at Paris, possessed the property of killing or removing marine animals, it must also have acted on the fresh-water shells; but some shells, carried down accidentally by rivers, may have been able to remain preserved in the marly beds formed during the moments when the solution was feebly acidulated, or had precipitated all its salts. A particular accident can be even conceived by which a fluviatile shell may have remained entire enveloped in marly gypsum, and even in pure gypsum. Dead animals floated down may have left their skeletons in the gypsum. The short period during which the solution was feebly impregnated with saline matter, would naturally prevent the marine animals taking possession again of their old stations; so that the presence of fresh-water shells in the marls below, above, or in the gypsum, seems to be a mere accident, occasioned by the carrying down of a river, a fact easily understood, and explaining why these shells are found not in continuous beds, but in short beds or nodules. The existence of beds of marine shells in the same position would be more difficultly explained, at least we would be obliged to suppose a succession of deposits formed during very unequal spaces of time.

Let us leave this subject, let us not attach too much importance to a few fresh-water shells, and admit only those deposits to be of fresh-water formation, which are characterized so well by M. Brongniart at page 166 of his Tableau.

It may occasion surprise that we have not taken into consideration the bones met with in gypsum; but the truth is, their occurrence in the gypsum is, zoologically considered, of no importance for geology, as they have been found not only in the clayey marly beds of the marine limestone (p. 172), but also imbedded in that rock itself: now the first, according to Brongniart, are accidental (p. 170). If this be admitted, what reason can be given for refusing to include the bones found in gypsum n the same category? Further, *La presence du terrain paleo-*

therien dans le calcaire moellon des terrains proteiques de Montpellier, n' est pas une anomalie aux generalités reconnues dans les formations, et elle ne detruit aucune idée reçu ni oter aucune valeur aux characteres zoologiques, (p. 203).—Without asking whether that assertion is in accordance with another, where it is said, that *La succession des generations est le moyen le plus sur et peut-etre le seul pour determines les epoques geognostiques* (p. 159), we shall take the statement as offered to us, and as a sufficient proof that the bodies of animals, or bones, have been carried down by rivers, without interruption, during the whole tertiary period, and that the same species lived during that time on the surface of the earth. It seems, then, we must abandon that hypothesis of a gypsiferous lake, surrounded by beaches inhabited by animals, which did not exist before the paleotherian period. The theory was ingenious, but facts overturned it.

Although we are not disposed to admit a favourite hypothesis of Brongniart, we are ready to range ourselves under his banners, when he finds it more rational to bring the gypsum and strontianite from the bowels of the earth (p. 196), than from a distance through the agency of water, as is the opinion of Prevost. During some of the great eruptions that took place in Auvergne, or nearly about that time, we can easily conceive, that aqueous and acidulous emanations may have found their way to the surface by great rents, indicated partly by the beds of the Loire and Allier, also by the Channel. These phenomena were only a repetition of what formerly took place after every extensive eruptions; and volcanoes still act in the same way. It was such an irregular emanation of acids which produced the irregular interlacing of the paleotherian rocks, a fact on which Brongniart lays much stress (p. 156).

We may add, that our explanation of the marine formation of the gypsum, resolves all the difficulties which M. Brongniart finds, when speculating on the return of the sea into a fresh water basin, and explains also the deposit of the superior tertiary sandstone near Paris, a deposit which did require a long time, as is shewn by its containing balanites, &c. This basin must have been a salt-water lake, until the period of the beginning of the upper fresh water limestone, the only one which has the proper characters assigned to such deposits by Brongniart. When the marine limestone was depositing, the rivers were conveying into the basin mud, vegetable and animal matter, and some fresh water shells; the mud and sand were mixed with the fragments of shells and various marine bodies, and have thus formed the coarse marine limestone in the spots where we find it; while there were formed elsewhere, either alone or mixed up with gypsum, strontianite and silex, in the localities where these matters were forming, and where no marine animals were living; or they accumulated where the currents carried them, and were precipitated nearly alone, when they did not advance far into the basin. In this way was formed, in the inferior part of the Parisian deposits, not an alternation of marine and fresh water deposits, but a marine deposit of many beds, where we find fresh water shells, mixed or not mixed, in some localities, with marine shells. The number of these can only be determined approximately; it is a local accident; we know already two or three instances of the first kind, in the marine limestone, one in the Gres de Beauchamp and d'Eranville, one in the upper gypsum; and for the second case, we have the marly beds, with paludines, below and above the Gres de Beauchamp, in the high road of Maffiers, and below the gypsum, the shelly rocks of St Ouen, the shelly marls of the gypsum, small beds with paludines among the oyster beds of Montmartre, and the siliceous limestone above gypsum, and not below, as M. Brongniart conceived,—a fact well known, since the fortifications were made upon the heights near Nogent sur Marne and Fontaine aux Bois. Perhaps even the Cytheria bed is a case of fresh water fossil. According to our explanation, the singular mixture and entangling of the gypsum and marine limestone, observed by Prevost, is a natural thing; fresh water shells were isolated in some marine limestone, as, for instance, the cyrene at Passy; some others were entangled in marls or gypsum; beds of clay, with lignite, were formed in the marine limestone, and would as the gypsum envelope particular vegetables and animals. Lastly, silica being distributed irregularly, by means of mineral water, was precipitated in particular localities, and produced in one part of the basin, more exposed to the afflux of river water, the well known siliceous limestone, in which fresh water fossils are not so great a rarity as is commonly believed. After the cessation of the saline and lime formation, by the obstruction or cessation of the mineral springs, the deposits again began to partake every where of nearly the same nature; marly oyster beds and sands completed the tertiary soil of Paris, and afterwards the basin became a fresh water lake, and then only it began to be the Paris basin, for before that period the extent of the basin was much larger, and it communicated with the present basins of the Tourraine, or the Loire, of the Calvados, of England, and probably even of Belgium and the north of Europe.

(To be concluded in next Number.)

On Humanity to Animals. By James L. Drummond, M. D. Professor of Anatomy and Physiology in the Belfast Academical Institution, &c.

[In a very agreeably written volume by the author of a popular work, the "First Steps to Botany," occur the following excellent observations on an interesting topic, viz. *Humanity to Animals*, which we have much pleasure in laying before our readers.]

I will now occupy your attention for a little in making some remarks on a theme which, I fear, has seldom been submitted to your consideration, or impressed on your mind as being of any moment; I mean humanity to animals,—a subject to which I have several times alluded before, but which I shall now more particularly press upon your notice. That there are men in the world whose dispositions are diabolically cruel, we have but too many proofs. The newspapers contain weekly accounts of outrages committed against every feeling of humanity, both as regards our own species and other animals, and which are too often committed without any motive save the wanton indulgence of a bad and cruel mind; though I regret to say, that if any end is to be gained, however slight, and that even by the exercise of the most severe cruelty, the latter forms, too often, no bar whatever in the way: hence it was once, and I fear still is, the practice, in some places, to whip pigs to death, because their flesh was thought to be improved by it. In these countries, calves are drained of their blood, and made to feel, by repeated operations, all the miseries of exhaustion, merely to make the veal of a whiter colour. Lobsters are brought to market with pegs of wood thrust into one of their claw-joints to keep them from opening, which, though it must produce continued and dreadful pain, saves the slight trouble of tying them with a bit of cord ; and that is enough.

Your own recollection will recall but too many other examples of cruelty ; but if you have not read of the experiments made by anatomists on living animals, you will still have an imperfect idea of the horrible excesses which are committed. The slightest matter of the merest curiosity is made the pretext for mangling living animals in the most dreadful way that can be imagined. It is not always, I must observe, in consequence of a theory being formed, and a belief that if proved true it might be of importance to our species, that experiments are made to determine its correctness or fallacy. In France, especially, the most barbarous cutting up of living animals is pursued with a savage and reckless enthusiasm, not for the purpose of verifying a probable, and, if true, important conjecture, but to ascertain what effects are produced by such butchery ;—I hesitate not to use the word, for it is the fittest that could be selected. Experiments of this description are unhallowed in their nature, and they will, almost always, be unsatisfactory in their result to a rigid investigator of truth ; for a conclusion can seldom be depended on, which is derived from observation of a mangled suffering creature bleeding under the dissecting-knife.

That experiments have sometimes led to a little increase of certain knowledge, I know ; but their frequent repetition, after all has been proved by them that is necessary, every humane man must deprecate ; and still more is it to be regretted, that the prosecution of experiments on living animals is recommended to students, to boys, as a useful mode of employing their time and improving their minds. I can find no excuse for any man, who will dissect living dogs, rip up their bellies (or, as the softened phrase is, lay open their abdomen), cut out their stomach, or spleen, or kidneys, or perform other dreadful mutilations, merely to satisfy a feeling of curiosity ; and still less do I think that he can be excused for recommending such practices to his pupils.

One would suppose that the determining such a question, as whether, in vomiting, the stomach acts alone, or is assisted by the diaphragm and abdominal muscles, or is altogether passive, would scarcely be thought worth the sacrifice even of one dog—by any man, at least, who had ever himself felt what pain is, were it but that from the prick of a needle, or of a thorn lodged in the finger. Yet this unimportant matter, this subject of curiosity alone, which is not of the slightest consequence, whatever way it might be settled, has been the cause of innumerable living dissections, the very least of which is sufficient to make one's blood run cold. Let any one who has ever experienced nausea and sickness for ten minutes, think what must be the sufferings of a creature whose belly is ripped open, and emetics injected into its stomach; or what must be the agony produced by cutting away its stomach altogether, and sewing a bladder in its place—thereby substituting, for the purpose of experiment, an artificial stomach. These, and similar barbarous, but really useless, experiments, have been repeated over and over, with a perseverance which is perfectly disgusting. Think of a dog being tied down to a table, the whole fleshy walls of its belly being cut away with a knife, and experiments made on it in that dreadful and pitiable state, for the purpose merely of ascertaining whether it will vomit or not. "An animal," Magendie observes, "still vomits, though the diaphragm has been rendered immoveable by cutting the diaphragmatic nerves; it vomits in the same manner, *though the whole abdominal muscles have been taken away by the knife*, with the precaution of leaving the linea alba and the peritoneum untouched." *

Now, you will observe, that I do not mean to inculcate the positive abstinence from experiments on any account whatever, for there may be circumstances which will fairly warrant their adoption, though a humane or just man will never have recourse to them, either for the purpose of determining a question of mere curiosity, or of light importance; neither will he repeat them unnecessarily. But the practice, especially of the French physiologists, is very different. They torture animals innumerable, almost without end or aim, farther than *hoping* to get at something, like a child who breaks a watch in pieces, thinking to obtain thereby a knowledge of the reason why it ticks. Many

* Magendie's Physiology, translated by Dr Milligan, ed. 3. p. 287.

hundred dogs have been dissected alive, to prove whether the stomach is active or passive in vomiting; but I would ask, When an animal is writhing in agony, struck with dismay and astonishment, with its belly opened, and its bowels exposed to the atmosphere, are we to expect that, in all the horrors of this situation, the stomach will exhibit itself, or perform its functions just as if nothing had happened? I cannot believe it; and if ten thousand such experiments as this were made, there still will, and must be, a want of proof. The stomach may, in such circumstances, be passive, though in the natural state of the animal, it may be active in vomiting; and, in fact, after all the cruelties which have been practised by physiologists, we do not at this moment know whether, in the natural and unmutilated state of an animal, the stomach contracts in vomiting or not; and, fortunately, this of not one straw's consequence *.

I believe, also, that little or no confidence is to be placed in the accuracy of conclusions respecting the natural functions of viscera drawn from observation of what occurs in animals labouring under extreme suffering and terror. The pancreas, for example, has always been considered as a gland similar to those

* Since writing the above, I have noticed the following very satisfactory remarks on this subject, in the seventh edition of C. Bell's Anatomy and Physiology of the Human Body, vol. iii. p. 275.

"There is a very curious experiment by M. Magendie, which has much puzzled physiologists. He cut out the stomach of a large dog, and substituted in its place a bladder, which he fastened to the œsophagus, and having excited *vomiting*, by pouring emetic solution into the veins, the contents of this bladder were discharged as from the natural stomach. The conclusion has been too hastily formed, that the stomach has therefore nothing to do with the action of vomiting. But it ought to be recollected, that the bladder represents a relaxed stomach, whereas the stomach is muscular and active, and capable of resisting the action of the abdominal muscles and diaphragm, unless there be a consent of the action of the stomach, and the action of the muscles of respiration. Thus, if we could suppose that a man had a distended bladder for a stomach, whilst he exerted himself forcibly and retained his breath, the contents would be discharged. So would they, if he lay with his belly over a yard-arm. But no such discharge takes place from the natural body, because the upper orifice of the stomach resists! This resistance does not take place in vomiting; and, therefore, I say, the stomach has to do with vomiting, in spite of all the cruelties which have been committed. The lower orifice is contracted, the coats of the stomach are contracted, and the upper orifice is relaxed in the act of vomiting, while the power of ejecting the contents is very principally owing to the violent throws and contractions of the abdominal muscles and diaphragm."

which produce the saliva, but whether its secretion were exactly the same or different, its large size is a pretty good presumptive proof that the quantity of fluid it prepares is not very small. The duct or tube through which the pancreas empties its secreted fluid, opens into the first of the small intestines; now, if a dog be tied down, and his abdomen be laid open, or, as I have already remarked, if, in vulgar phrase, his belly be ripped up, the hands introduced among his bowels, and the portion of intestine to which the pancreatic duct goes be slit open, can I, in fairness and truth, trust to any result in this case which may be obtained from observation of the quantity of fluid secreted by the gland during so horrible a process? I say, it would be unphilosophical to have any such trust, and I would look on almost all opinions formed on data so unnatural, as unsatisfactory and valueless. Magendie thus describes his mode of collecting this fluid:—"I lay bare the orifice of the canal in a dog, I wipe the surrounding mucous membrane with a very fine cloth, and I wait until a drop of liquid passes out; as soon as it appears, I suck it up with a *pipette*, an instrument used in chemistry. In this manner I have succeeded in collecting some drops of pancreatic juice, but never enough to analyse it according to rule." He also says, "What I have been most struck with in endeavouring to procure pancreatic juice, is the smallness of the quantity which it forms; a drop scarcely passes out in half an hour, and I have sometimes waited longer for it. It does not flow more rapidly during digestion; but, on the contrary, it seems slower. I think it is generally more copious in young animals." * At page 212, however, of the same work, the account of the quantity secreted is a little different. "Sometimes," he says, "a *quarter* of an hour passes before a drop of the fluid springs from the orifice of the canal which pours it into the intestine;" and in the next paragraph, he observes, that he has seen "the flowing of the pancreatic fluid take place in certain cases with considerable rapidity." The term *considerable rapidity* is very vague; but it shows that the secretion was in some cases much more copious than in others, and is a farther proof of the great uncertainty that always must and will attach to experiments of this character.

But it may be objected, that a similar exposure of the bile-

* Magendie's Physiology, translated by Milligan, ed. 3. p. 457.

duct shows, that the bile is constantly pouring from *it* into the intestine. But if we suppose, as has been generally done, that the pancreas is in truth a salivary gland, we may readily conceive that, as in those of the mouth, the effect of terror and acute pain will be to suspend its action; for every one knows that both of these cause a great decrease or suspension of the flow of the salivary secretion, and an ardent desire to take drink. This is very obvious in tedious surgical operations. If, therefore, pain and terror suspend the action of the salivary glands in the mouth, we may well suppose that the same causes will suspend the secretion of the pancreas.

I believe myself to be amongst the last persons who would be inclined to throw any impediment in the way of improvement or knowledge; but I most conscientiously believe, that in attempting to excite your detestation of such cruelties, I am speaking the language of truth, as well as of mercy. What, again, is to be expected of a young medical man who acquires a taste for dissecting living animals? Is that the way to pursue his studies with advantage? Is it not most likely to draw him from the legitimate study of his profession? In place of storing his mind with a knowledge of chemistry, materia medica, human anatomy, and the other fundamental branches of medicine and surgery, he is employing his time in cutting up living cats and dogs, in the hope, perhaps, that he too may become a discoverer; or as likely, it may be, from mere idleness. I am sorry that, in our own islands, it is common among teachers of anatomy to recommend the practice of vivisection to their students; but then, this recommendation is merely to "make experiments on the lower animals." Yes; but this making of experiments includes every species of cruelty that the most savage ingenuity can invent: it includes sawing off portions of the skull, and paring away the brain in slices, to see what effect is produced by wounding one part more than another: it includes the starving of animals to death, for the purpose of ascertaining the appearance of their stomach: it includes the tying of ligatures on the bile-duct, the thoracic-duct, the pylorus, and other parts, all which is accompanied with excruciating torture to the victim operated on: it includes the laying bare of the heart, to observe the strength of its action, dividing nerves, cutting away viscera, and many other operations, which are accompanied with the direst cruelty, and nine-tenths of which, after all, relate to matters of curiosity alone, and lead to no practical benefit of any kind.

It may be curious enough that, when a particular part of the brain is wounded, the animal has a tendency to move forward; when another, to move backward; and when a third and a fourth, to turn round; but I cannot think the knowledge of these circumstances by any means worth the price it has cost; and, after all, it merely shows what takes place when the brain is denuded, and wounded, and, consequently, its *natural* function deranged, if not destroyed. Putting aside the sufferings of the thousands of animals which have been sacrificed in experimenting and exhibiting these phenomena in lectures and demonstrations, I cannot but think that the witnessing of such cruelties must have a very demoralizing effect. I cannot conceive how a person can become cooly reconciled to the sight, let alone the practice, of such murderous acts, and continue to retain proper feelings of humanity for his own species. In this I may be wrong; but whether or not, I am satisfied, that to recommend to students the pursuit, or even to exhibit to them the view of such dissections as I have adverted to, is to run the risk of making them at once cruel and speculative, and at the same time neglectful of those branches of solid knowledge which will qualify them to be truly useful in their profession.

I know it is often urged, that medical knowledge has been greatly improved by experimenting in this way on animals. That it has been a little, I will grant, but only a little, for the phenomena which take place in animals will often not apply to ourselves in the practice or treatment of either wounds or diseases. Experiments to determine the action of poisons, and ascertain their antidotes, are, perhaps, or at least were, more allowable than any others; but the discovery of the stomach-pump is of more value than all that ever have or could have been made. And yet, so differently do poisons act on differet animals, that no observation drawn from their action can be applied to man. Hemlock, as every one knows, is a wholesome food for the goat, but it poisoned Socrates; while, on the other hand, a dog will be destroyed by a quantity of nux vomica, which a man can swallow with impunity.

That experiments on animals may sometimes be accounted necessary or desirable, I have already admitted; and I refer you to Mr Bell's most admirable book on the Natural System of the Nerves *, for an example of the true principles on which such experiments ought to be conducted;—an example where the end was legitimate, and where the humanity and good sense of the operator were such as not to lead him either to put the animal to extreme suffering, in which state little can be depended on, nor to any unnecessary repetition of his experiments.

From what I have now written, you will, perhaps, account me morbidly compassionate; and, indeed, there is so little feeling among mankind for the sufferings of animals, that I should be rather surprised if you thought otherwise. But the true evil is, that humanity is neglected to a most culpable degree. It is a virtue that is inculcated neither on youth, nor age, nor sect, nor party; and, from custom, we every day see, without emotion, acts of cruelty which, only that we have been long used to them, would excite our deepest indignation. Look, for example, at the treatment of the horse. That poor slave, so useful to man, is subjected to hardship, pain, and suffering, to a degree that would seem utterly incredible, were we not, all our lives, accustomed to the sight.

The horse's skin is remarkably sensible, and it is only after the daily or hourly infliction of the whip for years, that it at last becomes comparatively callous. Pampered, perhaps, in his better days, he passes successively from hand to hand, every new change of his condition being a change for the worse, from one step of misery and hardship to another, till curtailed of more than half his days, he at last gets freed from the brutal unfeeling tyrants under whom he dragged out his weary existence. The *wanton* infliction of pain, too, on the horse, is exercised in a most shameful manner. One might suppose, to observe the conduct even of many well educated men, that they thought him merely intended by nature to undergo a life of flogging, buffet-

* An Exposition of the Natural System of the Nerves of the Human Body, &c. By Charles Bell.

ing, and fatigue. Then look at the merciless rate of travelling, and the inhuman loads which have to be dragged along under the perpetual torture of the whip. Lift up the collar, and see the red raw flesh, which, at every step, receives a new wound from the pressure and friction of that part of the harness. Recollect the pain produced by the slightest touch on your own skin, when rendered raw by a blister or other means, and try to conceive what must be the sufferings of thousands of stage-coach and other horses, under the united miseries arising from abraded skin, excessive fatigue, daily cutting with the whip, and often, what is equally bad, the wanton brutality of ostlers and stable-boys!

If an animal were tied to a stake, and flogged regularly four hours a day, who would not exclaim against the brutality of the act? Yet the horse, in innumerable instances, suffers far worse, and no one cares. Besides a much longer infliction of the whip, in many cases, there is the excessive fatigue, a feeling even worse than pain; it is suffering of a very intolerable kind: yet so little is our humanity, that driving a horse to death, if he be old at least, and his strength gone, so that the pecuniary sacrifice is not great, is a matter of almost perfect indifference; and in stage-coaches, generally speaking, the horses are driven with calculating nicety so far as nature will hold out, without actually giving way altogether under the accumulated suffering and exhaustion.

The want of humanity to animals, which is every where so glaring, cannot, I think, be a natural defect of the human mind, but is the offspring of a wrong education, and an unjust and arrogant conceit that man is the only being of any consequence in this world; and that it matters not what becomes of others, or what they may suffer, provided he reap the slightest benefit. Some anatomists even hold out as one reason for making experiments on animals, their not being destined to immortality. But if they be indeed "the beasts which perish," should not justice teach us to render their temporary lot as easy as possible? Man may persecute man, but hope will still lie in the bitter cup, and visions of brighter times will illumine the present gloom of misery. The slave, writhing under the whip of a savage master, may indulge in the inspiring thought of being at length released by death from the cruelty of his persecutor, and of enjoying for ever the happiness which he in vain had prayed for here. The prisoner, chained in fetters, and languishing out his life in a dungeon, lives in expectation, that should he not be restored to freedom, death will at length strike off his bonds, and usher him to eternal bliss. But what counterbalance to its misery has the poor brute, whose life is one continued unbroken series of suffering? It has no heaven to look to, no bright anticipation of a period when misery shall cease, and happiness be enjoyed. Its life is its little all, and *that* the general tyrant renders a curse to it while it lasts, or takes from it by an infliction of the severest torments. But the lower animals are "the beasts which perish," and, therefore, not to be cared for further than they can be useful to us. I will not attempt to argue the question, whether death annihilates them or not, but there are very wise men in the world who think, that as much proof lies on the one side as on the other; and, at all events, a benevolent mind will pity their sufferings, and attempt to relieve them, whether they perish or not.

I hope that what I have said respecting the exercise of humanity to animals, will awaken your attention to that virtue. Neither punishment, indeed, nor reward, are any where held out as inducements to its practice; but it is therefore not less a virtue, and you will have the satisfaction, at any rate, of *doing good for its own sake*, a thing, I fear, of not common occurrence in the present constitution of things. The brutal sports, which were formerly so frequent, especially bull-baiting, bear-baiting, badger-hunting, and cock-fighting, have been greatly lessened, which, I suppose, is owing to the more general diffusion of useful knowledge among all classes, especially the better. The lower orders have not the same encouragement in pursuing these detestable sports from their superiors in wealth and consequence as formerly, and hence their frequency has abated. The still more brutal practice of prize-fighting, I am glad to see, is also on the decrease; and I entertain some hope of yet seeing the time when one may express disapprobation of such inhuman brutalities, without being considered either foolish or ridiculous.

I exceedingly regret that so much more remains to be said on the subject of this letter; but it would be painful for you, as well as me, to dwell any longer upon it: it appears but too plain, that so much cruelty continuing still to be practised in this age of civilization and knowledge, shows that something generally and radically bad exists in the usual mode of forming the minds of youth *.

* The following note, attached, along with many others characterised by much learning and research, to a sermon by my brother, entitled, "Humanity to Animals, the Christian's duty, a Discourse by William Hamilton Drummond, D. D." published 1830, may be introduced here with advantage.

Many divines of distinguished reputation have advocated the cause of animals, but, strange to tell, not always with the approbation of their hearers. In 1772, the Rev. James Granger preached a sermon on this subject, in the parish church of Shiplake, in Oxfordshire. This sermon he published, for the singular reason that it had offended all who heard it, as he himself informs us in the following postscript:—"The foregoing discourse gave almost universal disgust to two considerable congregations. The mention of dogs and horses was considered as a prostitution of the dignity of the pulpit, and a proof of the author's growing insanity. * * * It is, with great humility, submitted to the judgment and candour of the public, and particularly to the cool consideration of those who were pleased to censure it, and by whose disapprobation, without any premeditated design of the author, it now sees the light." It was dictated, he says, by his heart; and, assuredly, it contains nothing offensive to good feeling or good taste, to morality or religion, much less to the *dignity of the pulpit.* It is prefaced by a dedication to *T. B. Drayman*, written in a strain of original caustic humour, on the principle, I suppose, of Horace:—

"ridiculum acri
Fortius et melius plerumque secat res."

As some may be gratified, and others benefited, by its perusal, it is here subjoined:—

"Neighbour Tom,

"Having seen thee exercise the lash with greater rage, and heard thee swear, at the same time, more roundly and forcibly than I ever saw any of thy brethren of the whip in London, I cannot help thinking that thou hast the best right to this discourse. But I am afraid, Tom, that I shall in some parts of it appear to thee to be as great a *barbarian* as thou seemest to me a savage. If thou findest any hard words in it, come to my vicarage-house, and I will endeavour to explain them to thee in as familiar language as thou talkest to thy horses. For God's sake and thy own, have some compassion upon those poor beasts, and especially to the fore-horse of thy team. He is as sensible of blows as thou art, and ought not to have been so outrageously punished for turning aside into a road to which he was long accustomed, when thou wast fast asleep upon thy dray. If thou breakest any more whips upon him, and repeatest thy horrid oaths, wishing thyself 'damned and doubly damned,' if thou art not revenged of him, I shall take care that thou be punished by a Justice of the Peace, as well as by thy own master in this world; and give thee fair warning, that a worse punishment waits for thee

With regard to the virtue of humanity as exercised towards your own species, I would wish you to have an ever-present conviction, that only for circumstances, you yourself might have had a very different lot from what you enjoy; that millions who are sunk in ignorance, and "steeped in poverty to the very lips," would, with your opportunities, have been your equals or superiors in usefulness and talent; that you should always curb with a strong hand the suggestions and workings of an overweening self-pride; and that, when you give charity or advice, or render your good offices in any shape to your less fortunate brethren of the human race, you should act on the pure and unadulterated principle of doing good for its own sake, and from a sympathy of feeling for the privations and misfortunes of your fellow men. An action, however good or charitable it may be in its effects, if it be performed either from a hope of reward, or through a fear of punishment, let us call it what we will, is not an act of virtue.

On the Employment of Heated Air in the Smelting of Iron.

Among the many discoveries that have of late been made in chemical science, there are perhaps few of more practical importance than the ingenious application of heated air in the smelting of iron-ore, either in the immediate benefit which it will confer on this important art, or in the various improvements which it is likely to lead to in other operations. The following is a very brief outline of the manner in which the heated air is

in the next, and that damnation will certainly come according to thy call. I, however, hope better things of thee, and that all thy punishment will be in this life. It is not likely that thy soul, when separated from thy body, will sleep till the day of judgment. According to the doctrine of a very sensible man, it may inhabit the fore-horse of a dray, and suffer all the pain that guilt and whip-cord can give. In a word, Tom, I advise thee to fall on thy knees, and ask God forgiveness for thy cruelty and thy oaths, and to be careful for the future not to sleep upon the road; to drink less ale, and no drams; so shalt thou save thy whips and thy horses, thy body and thy soul.

"I am, Tom, thy friend and well-wisher,

"James Granger."

applied in some of the iron-works where this method of working the ore has been introduced.

The air is blown by cylinder bellows in the usual manner, but before entering the smelting furnace it passes through pipes of cast-iron, heated to redness, which are altogether about thirty feet in length, and three feet in diameter. They are usually made in three or four pieces, joined together by apertures considerably less than three feet in diameter, and placed horizontally, or in whatever manner the local arrangements about the furnace may render most convenient. A brick arch is then thrown round the pipes, leaving a free space of about eight inches and upwards between it and them, and two or more furnaces constructed, so as to heat the pipes in the archway, the flues playing into it, and terminating in a common vent at the farther extremity. They may be considered, therefore, as placed on the floor of a long and narrow reverberatory furnace, about six feet high, and nearly of the same breadth, being at the same time protected by fire bricks when they might be injured by the direct flame of the furnaces.

The iron-ore is smelted according to this plan with little more than half the coal necessary when the furnaces are worked with air in the usual manner; the small coal which is sold at an inferior price is found quite sufficient for heating the pipes.

It has also been ascertained, that there is no difficulty in smelting the iron ore with common coal instead of coke, and in some furnaces at present in use, no coke whatever is employed, so that it is probable the trouble and expense attending its preparation will be unnecessary. It is likewise in contemplation to endeavour to reduce the iron-ore at once in the furnace, without any previous calcination, and the proprietors of some of the iron-works seem to entertain little doubt that they will be successful in their attempt.

The great effect produced by the heated air in these furnaces must be attributed to the circumstance that, according to this plan, a higher temperature can be more easily excited and maintained, than when the blast is supplied with air at the ordinary temperature of the atmosphere. And the great saving of fuel we would presume does not arise from a greater *quantity* of heat being evolved from a given quantity of coke or coal in the one case than the other, but from the greater *intensity* of temperature that prevails when the heated air is employed, insuring the more steady and certain action of the charcoal on the calcined ironstone, less or none being exhausted without any adequate return, *i. e.* consumed at an inferior temperature, without affecting the ore in contact with it. It is possible, however, that the absolute quantity of heat evolved may differ according to the temperature at which an inflammable substance is consumed, though no precise experiments have been made to determine this.

If we consider the quantity of air required for the combustion of common inflammable matter, we shall be better able to appreciate the important effects which must arise from the use of heated air. Let us suppose that coke alone is used in the smelting furnace, and that carbonic oxide is the sole product of the combustion in that part of the furnace where the blast takes effect upon the fuel, then, even according to this calculation, every six parts of charcoal require no less than thirty-six of atmospheric air for their combustion, this quantity containing only eight parts of oxygen. Accordingly, though the air may be so thin and attenuated that we are apt to overlook its cooling influence, every portion of combustible matter mixes with six times its weight of cold air (air at natural temperatures), all of which must be heated to a certain extent at the expense of the fuel already in a state of combustion, before it can give out any heat by its action on the inflammable matter of the coal. If, again, carbonic acid be the product of the combustion when the heat is most powerful, twice as much air (seventy-two parts) will be necessary for every six of charcoal, or each portion will require twelve times its weight of air. The first effect of the introduction of this large quantity of cold air, must be to diminish the actual temperature of the furnace, however much it may add to it immediately afterwards as it is consumed. If, then, the air be heated before it passes to the furnace, its temperature must be higher than when air is supplied in the usual manner, just in proportion to the degree of heat previously communicated to it.

The high temperature of the furnace not only enables the iron-ore to be smelted with less fuel than would otherwise be necessary, but by effecting a complete separation of the scoriæ from the melted iron, may contribute also to produce a purer and more perfect pig-iron; as it is possible, however, that under these circumstances the iron may receive a larger impregnation of the bases of the earths which are decomposed in small quantity during this operation, the quality of the product demands the most careful examination. The specimens we happened to see, so far as we could judge from bare inspection, appeared excellent.

Description of several New or Rare Plants which have lately flowered in the neighbourhood of Edinburgh, and chiefly in the Royal Botanic Garden. By Dr GRAHAM, Professor of Botany in the University of Edinburgh.

10*th Dec.* 1831.

Arthrostemma nitida.

A. *nitida;* caule suffruticoso, erecto, ramulisque patulis tetragono, alato, pilis coloratis patulis hirsutissimo; foliis ovatis, acutis, serrulatis, utrinque glabris, superne nitidis, nervis inferne glanduloso-hispidis; pedunculis versus apices ramorum collectis, axillaribus, petiolo longioribus, trifloris; petalis obovatis, retusis; antheris dissimilibus, connectivo, brevè biauriculato.

DESCRIPTION.—*Root* perennial. *Stem* erect, suffruticose, quadrangular, with a narrow wing at each angle, red near the bottom, green above, hispid, hairs red, harsh, glandular, tumid at the base, tufted longer and coarser in the same verticel with the leaves. *Branches* spreading, ascending. *Leaves* (3 inches long, 2 broad) decussating, ovate, acuminate, 5-ribbed, much veined and wrinkled, dark green and shining above, paler below, petioled, glabrous excepting on the lower surface of the nerves and veins, which is glanduloso-hispid; petioles short, suberect. *Flowers* collected at the extremities of the shoots, where they arise from the axils of diminished leaves, peduncled; peduncles in structure and form like minute branches, about twice as long as the petioles, 3-flowered, pedicels nearly awanting. *Bracteæ* single on the outside of each of the lateral pedicels, and two small, opposite, at the base of the calyx, showing a tendency to a farther subdivision of the inflorescence, ovato-elliptical, glabrous, ciliated, nerved. *Calyx* nearly cylindrical, glanduloso-hispid, indistinctly ribbed; limb 4-parted, segments spreading, deltoideo-acuminate, ciliated, ciliæ glandular. *Corolla* pale lilac, petals distant, obovato-elliptical, retuse, faintly nerved. *Stamens* 8, inserted alternately within and between the petals into the mouth of the calyx; filaments colourless, erect, glabrous, flattened, slightly declined, about half the length of the petals; anthers in the bud bent forward, compressed dorsally, the larger passing between the calyx and ovarium, and having their apices lodged in cavities on the outside of this, when expanded compressed laterally, and wrinkled in front, bent at an acute angle with the filaments, arched, their apices ascending, perforated with a single pore, connective with two short blunt auricles at the base, unequal, four large and brownish-yellow, four small yellow, more erect. *Stigma* minute, divided transversely, pubescent. *Style* rather longer than the filaments, declined, ascending at the apex. *Germen* free above, adhering below, having a few hairs upon its apex, tetralocular. *Ovules* numerous.

This plant was raised at Mr Neill's garden, Canonmills, from seeds sent to him, in 1829, by Mr John Tweedie, formerly head-gardener at Eglinton Castle, Ayrshire, and now of the Retiro, Buenos Ayres. The packet was marked in Mr Tweedie's handwriting, "Herbaceous Melastoma, from damp woods of the Banda Oriental." The plants came up freely in the summer of 1830; but none shewed flower till July 1831, when several flowered equally well in the cold frame and in the greenhouse.

Stylidium scandens.

"I. Capsula ventricosa, subovata, nunc sphærica vel oblonga.

"I. D. Folia scapi vel caulis verticillata. Calycis labia ($\frac{2}{3}$) partita.

"S. *scandens;* caule scandente, foliis linearibus apice spirali cirrhoso, "fauce coronata, labello appendiculato, columna superne pubescente." —*Brown,* Prodr. 570.

Description.—*Root* perennial. *Stem* (18 inches high) slender, shining, red, glabrous, branched. *Leaves* (3½ inches long) verticelled, crowded, linear, channelled, mucronate, rolled back at the apex in form of a cirrhus, throwing out long, filiform, single, unbranched, red and shining roots from their axils. *Bracteæ* green, adpressed, one below each pedicel, and two sub-opposite above its middle, the former small, ovato-acuminate, or larger and subulate, the latter very minute and scale-like. *Corymbose racemes* erect, clustered at the extremities of the branches. *Pedicels* (3–9 lines long) spreading, single-flowered, red, glabrous, filiform. *Calyx* superior, bilabiate, $\frac{2}{3}$-partite, green, glabrous, adpressed, segments elliptical, with paler edges, ciliated. *Corolla* (about 10 lines across) monopetalous; tube epigynous, nearly colourless, twice the length of the calyx; limb 5-partite; labellum pale, reflected, ovate, acute, fringed with glandular hairs, auricled, auricles spreading, very slender, subulato-filiform, rose-coloured, twice the length of the labellum, with a few glandular hairs near their bases, under a high magnifying power appearing rough and serrulate; other segments of the corolla lilac and imbricated in the bud, afterwards rose-coloured, paler below, darker in the throat, spreading or slightly reflected, obovate, sparingly ciliated, crenate at the apex, the two next the labellum crowned with an erect, generally emarginate subspathulate scale, the two others naked. *Column* terminal, reflected over the labellum, and irritable, flat, white at its base, lilac in the middle, yellow towards its extremity, and there especially, but slightly also on its upper surface, glanduloso-pubescent. *Anthers,* after bursting, brownish-yellow, surrounded by a tuft of shining, transparent, at length yellow pubescence, bilobular, lobes divaricating, elliptical, pointed at the lower extremity, bursting along the front. *Stigma* in the centre between the anthers, green, at first hidden and small, but afterwards much enlarged, capitate and raised upon a conical neck, pubescent. *Germen* green, becoming reddish-brown when ripe, ovate, glabrous, unilocular; ovules placed on a round central receptacle, having the mere rudiments of a dissepiment at its base.

This very pretty species of a singular and interesting genus, was raised at the Botanic Garden, Edinburgh, from seeds communicated by the late Lord Blantyre, a nobleman, whose melancholy death, in a period of undistinguishing popular tumult, was deplored far beyond the wide-spread circle which includes those who had a personal knowledge of his many virtues. They had been received by his Lordship from Colonel Lindsay, to whom, and to Mr Fraser, I owe the possession of excellent specimens collected at King George's Sound. The flowers were slowly developed, each remained long expanded, and appeared on one raceme in succession during the whole month of November. Other racemes are now beginning to appear, so that I doubt not the plant will be a great ornament to the greenhouse during the whole winter.

Celestial Phenomena from January 1. *to April* 1. 1832, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Astronomical Calculator, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight —The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

JANUARY.

D.	H.	′	″	
2.	5	3	53	☌ ☽ 1 μ ♐
2.	5	34	17	☌ ☽ 2 μ ♐
3.	3	4	0	● New Moon.
4.	8	2	–	☌ ☽ ☿
4.	20	53	–	☌ ♀ ϑ ♎
5.	15	6	33	☌ ☽ ϑ ♑
5.	17	32	22	☌ ☽ ♅
6.	14	43	40	☌ ☽ ♃
8.	19	45	–	☌ ♀ ν ♏
11.	0	45	30	☽ First Quarter.
11.	3	18	–	Inf. ☌ ☉ ☿
11.	6	24	28	☌ ☽ ν ♓
12.	3	52	13	☌ ☽ 2 ξ Ceti.
12.	11	18	36	☌ ☽ μ Ceti.
13.	7	8	7	☌ ☽ f ♉
13.	13	6	–	☌ ☿ d ♐
14.	3	12	46	☌ ☽ γ ♉
14.	4	25	29	☌ ☽ 1 δ ♉
14.	4	53	33	☌ ☽ 2 δ ♉
14.	9	37	58	☌ ☽ α ♉
15.	17	36	55	Em. I. sat. ♃
16.	4	41	26	☌ ☽ ν ♊
17.	15	51	6	○ Full Moon.
17.	17	44	25	☌ ☽ ζ ♊
18.	7	42	36	☌ ☽ δ ♋
19.	5	37	–	☌ ♂ B Oph.
19.	17	24	26	☌ ☽ α ♌
20.	22	9	34	☌ ☽ ♄
20.	23	27	35	☉ enters ♒
23.	7	4	–	☌ ♀ ρ Oph.
24.	17	3	6	☾ Last Quarter.
26.	5	59	10	☌ ☽ γ ♎
26.	17	23	0	☌ ☽ ψ ♎
27.	9	42	40	☌ ☽ φ Oph.
27.	17	22	–	☍ ☉ ⚶
28.	23	32	51	☌ ☽ ♀
29.	3	34	36	☌ ☽ ♂
29.	11	24	36	☌ ☿ 1 μ ♐
29.	12	7	5	☌ ☽ 2 μ ♐
30.	2	3	47	☌ ☽ π ♐
30.	15	44	–	☌ ☽ ☿
30.	17	15	22	☌ ☽ d ♐

FEBRUARY.

D.	H.	′	″	
1.	22	17	6	● New Moon.
2.	2	39	26	☌ ☽ ♅
2.	3	16	–	☌ ♀ ♂
2.	19	45	–	☌ ♀ 1 μ ♐
3.	3	40	–	☌ ☿ 2 μ ♐
3.	4	7	–	☿ greatest elong.
3.	8	33	30	☌ ☽ ♃
4.	5	36	–	☌ ☉ ♅
7.	12	9	23	☌ ☽ ν ♓
8.	10	2	4	☌ ☽ ξ Ceti.
8.	17	39	36	☌ ☽ μ Ceti.
9.	11	14	42	☽ First Quarter.
9.	14	4	40	☌ ☽ f ♉
10.	10	51	57	☌ ☽ γ ♉
10.	12	7	25	☌ ☽ 1 δ ♉
10.	12	36	32	☌ ☽ 2 δ ♉
10.	17	31	40	☌ ☽ α ♉
12.	14	12	24	☌ ☽ ν ♊
13.	3	41	1	☌ ☽ ζ ♊
13.	20	37	–	☌ ♀ π ♐
14.	18	31	37	☌ ☽ δ ♋
16.	3	20	42	○ Full Moon.
16.	4	25	14	☌ ☽ α ♌
17.	6	9	37	☌ ☽ ♄
17.	11	47	14	☌ ☽ σ ♌
19.	14	6	29	☉ enters ♓
21.	5	53	–	☌ ☿ ϑ ♑
22.	12	25	–	☍ ☉ ⚵
23.	13	52	44	☌ ☽ γ ♎
23.	1	6	31	☌ ☽ ψ ♎
23.	12	22	54	☾ Last Quarter.
23.	17	15	36	☌ ☽ φ Oph.
23.	23	56	–	☌ ☿ ♅
24.	14	0	–	☌ ☉ ♃
25.	18	45	23	☌ ☽ 1 μ ♐
25.	19	27	52	☌ ☽ 2 μ ♐
26.	21	25	43	☌ ☽ π ♐
27.	1	13	41	☌ ☽ d ♐
27.	6	43	18	☌ ☽ ♂
28.	8	16	34	☌ ☽ ♀
29.	4	44	9	☌ ♀ ϑ ♑
29.	13	26	6	☌ ☽ ♅

MARCH.

D.	H.	′	″	
1.	5	0	–	☍ ☉ ♄
1.	8	20	–	☌ ☽ ☿
2.	3	56	37	☌ ☽ ♃
2.	15	13	36	● New Moon.
5.	17	51	2	☌ ☽ ν ♓
6.	15	31	20	☌ ☽ 2 ξ Ceti.
6.	23	5	27	☌ ☽ μ Ceti.
7.	19	31	11	☌ ☽ f ♉
8.	0	4	–	☌ ♀ ϑ ♑
8.	10	22	–	☌ ☿ ♃
8.	16	28	15	☌ ☽ γ ♉
8.	17	44	36	☌ ☽ 1 δ ♉
8.	18	14	4	☌ ☽ 2 δ ♉
8.	23	13	19	☌ ☽ α ♉
9.	19	10	36	☽ First Quarter.
10.	20	54	45	☌ ☽ ν ♊
11.	10	48	4	☌ ☽ ζ ♊
12.	2	48	–	☌ ♃ λ ♒
12.	7	19	–	♀ near ♅
13.	2	51	58	☌ ☽ δ ♋
14.	13	43	31	☌ ☽ α ♌
15.	12	24	7	☌ ☽ ♄
15.	21	35	0	☌ ☽ σ ♌
16.	15	18	6	○ Full Moon.
19.	22	57	–	Sup. ☌ ☉ ☿
20.	14	6	2	☉ enters ♈
20.	22	44	54	☌ ☽ γ ♎
22.	1	42	7	☌ ☽ φ Oph.
24.	2	46	2	☌ ☽ 1 μ ♐
24.	3	28	21	☌ ☽ 2 μ ♐
24.	8	34	30	☾ Last Quarter.
25.	5	24	44	☌ ☽ π ♐
25.	9	13	10	☌ ☽ d ♐
27.	9	46	18	☌ ☽ ♂
27.	12	58	4	☌ ☽ ϑ ♑
27.	22	15	6	☌ ☽ ♅
29.	14	42	17	☌ ☽ ♀
29.	15	45	–	☌ ♂ ϑ ♑
30.	0	20	33	☌ ☽ ♃
30.	11	40	–	☌ ♀ λ ♒

Occultation of Planets and Stars of the First Magnitude by the Moon.

		H.	′		°
January 20. SATURN, *centre*,	Im.	21	1	at	340
	Em.	21	34	at	272
February 10. ALDEBARAN,	Im.	16	29	at	82
	Em.	17	37	at	265
February 16. REGULUS,	Im.	4	53	at	105
	Em.	5	49	at	288
February 28. VENUS, *centre*,	Im.	7	51	at	143
	Em.	8	6	at	177
March 1. MERCURY, *centre*,	Im.	6	39	at	61
	Em.	7	45	at	263
March 8. } ALDEBARAN,	Im.	23	43	at	111
...... 9. }	Em.	0	33	at	334

The *angle* denotes the point of the Moon's limb where the phenomenon will take place, reckoning from the *vertex* of the limb towards the right hand round the circumference, as seen with a telescope which inverts.

Times of the Planets passing th e Meridian, and their Declination.

JANUARY.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	13 14	20 32 S.	8 49	15 48 S.	9 41	21 33 S.	15 0	14 52 S.	4 29	7 40 N.	14 20	17 39 S.
5	12 51	19 36	8 51	16 52	9 38	22 2	14 47	14 35	4 13	7 43	14 4	17 35
10	12 8	19 6	8 54	18 4	9 34	22 34	14 32	14 13	3 52	7 46	13 47	17 30
15	11 24	19 15	8 57	19 10	9 30	23 0	14 17	13 51	3 33	7 51	13 28	17 25
20	10 51	19 47	9 1	20 6	9 25	23 21	14 1	13 28	3 12	7 57	13 9	17 20
25	10 35	20 31	9 8	20 50	9 20	23 36	13 46	13 4	2 52	8 4	12 50	17 16

FEBRUARY.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	10 28	21 20 S.	9 15	21 29 S.	9 15	23 48 S.	13 25	12 30 S.	2 24	8 14 N.	12 25	17 9 S.
5	10 29	21 30	9 19	21 39	9 11	23 51	13 12	12 10	2 7	8 20	12 9	17 5
10	10 35	21 24	9 24	21 39	9 7	23 48	12 57	11 45	1 46	8 29	11 50	17 0
15	10 45	20 28	9 31	21 22	9 3	23 39	12 42	11 19	1 25	8 38	11 34	16 55
20	10 54	19 29	9 36	20 52	9 0	23 24	12 27	10 53	1 3	8 48	11 15	16 49
25	11 5	17 22	9 42	20 5	8 56	23 4	12 11	10 26	0 42	8 57	10 56	16 45

MARCH.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	11 18	14 58 S.	9 48	19 5 S.	8 51	22 37 S.	11 58	10 0 S.	0 20	9 7 N.	10 38	16 40 S.
5	11 28	12 39	9 51	18 6	8 49	22 12	11 45	9 59	0 4	9 15	10 24	16 37
10	11 43	8 48	9 56	16 41	8 46	21 36	11 30	9 12	23 39	9 24	10 4	16 32
15	12 0	5 24	10 0	15 5	8 42	20 54	11 14	8 46	23 18	9 33	9 45	16 26
20	12 12	1 23 S.	10 4	13 18	8 37	20 8	10 59	8 19	22 57	9 42	9 27	16 23
25	12 28	3 41 N.	10 9	11 21	8 32	19 16	10 44	7 53	22 36	9 49	9 9	16 20

Proceedings of the Wernerian Natural History Society.
(Continued from the preceding Volume, p. 175.)

1831, *Dec.* 10.—The Society commenced its twenty-fifth Session, Robert Stevenson, Esq. V. P. in the Chair.

The Secretary read a letter, communicated by Dr Gillies, from the Lady of an Officer at Malta, containing a sketch of the new volcanic island, and also mentioning some remarkable particulars regarding the recent earthquake at Samos. Professor Jameson then communicated some interesting facts relative to the new volcanic island, contained in a letter from one of his correspondents.

The Professor then mentioned, 1. The occurrence of what was called a "shower of manna" in Persia, and exhibited specimens of the substance which fell, and which he stated to be a kind of lichen, which being loosely attached to rocks, trees, or the soil, had been carried up into the air by whirlwinds: 2. The discovery, by one of his pupils, of a very extensive bed of ligneous debris, no less than about 40 feet in thickness, near to the city of Rome, which, in primeval times, had constituted a forest there, and which had hitherto in a great measure escaped the notice of observers: 3. The ascertainment of the fact, that, in the mines of Freyberg, the temperature uniformly increases with the depth of the mine, proving that there is an internal source of heat: 4. The notice of a species of Cæsalpinia, the pods of which are fully equal to oak-bark, for the purposes of tanning. *Lastly*, The Professor gave an account, which he illustrated by sketches, of observations made by Dr Alex. Turnbull Christie, on the caves of Sicily. (See the present number of this Journal, p. 1. *et seq.*)

The Rev. Dr Scot of Corstorphine then read a learned essay on the Oreb, or Raven of the English Bible.

Dr Gillies read an extract from a Buenos Ayres newspaper, dated 2d April last, giving an account of the liberation and welfare of M. Bonpland, the botanical companion of Baron Humboldt in South America, and who had been a prisoner at large for the last fourteen years.

At this meeting, the following gentlemen were elected office-bearers for the year 1832:

ROBERT JAMESON, Esq. *President.*

VICE-PRESIDENTS.

Dr John Boggie.
Rev. Dr Brunton.
Dr Robert Graham.
Robert Stevenson, Esq.

Secretary, Pat. Neill, Esq.
Treasurer, A. G. Ellis, Esq.
Librarian, James Wilson, Esq.
Painter, P. Syme, Esq.

COUNCIL.

Sir Arthur Nicolson, Bart.
Dr John Gillies.
Rev. Dr Scot.
Dr C. Anderson.
W. C. Trevelyan, Esq.
Mark Watt, Esq.
Sir Patrick Walker.
W. A. Cadell, Esq.

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

1. *The Arabian Horse and the Camel.*—It is an erroneous opinion which believes Arabia to be very rich in horses. Many tribes are wholly unprovided with them, and Burckhardt supposes that there do not exist 50,000 of those animals between the extreme boundaries of the Euphrates and Syria, a much smaller number than the same extent of ground would furnish in any other part of Asia or Europe. The Syrian districts, especially Hauran, produce the best; but of pure Arabian blood of the choicest breeds, few have ever been exported. If a Bedouin wishes to express his admiration of the speed of another's mare, he blesses the animal copiously, and, addressing her master, says, "Go and wash your mare's feet and drink up the water." The best Arabian camel, after three whole days' abstinence from water, shows manifest signs of great distress; in case of absolute necessity, it might *possibly* go five days without drinking, but this trial can never be required, since there is no route across the Arabian Desert in which wells are farther

distant from each other than three days and a half. Burckhardt never heard an instance of a camel being slaughtered for the sake of the water in its stomach. The extremity of thirst, indeed, induces the traveller, unable to support the exertion of walking, to cling as a last resource to this serviceable animal; nor does its stomach, unless on the first day's watering, afford by any means a copious supply. The swiftness of the camel has been greatly exaggerated: 115 miles in eleven hours, during which occurred two passages over the Nile in a ferry-boat, each requiring twenty minutes, is the most extraordinary performance which Burckhardt ever heard authenticated; and this, probably, has been surpassed by an English trotting mare. He thinks, that, if left to its own free will, this animal would have travelled 200 miles in twenty-four hours; twelve miles an hour is the utmost trotting pace of a camel; it may gallop nine miles in half an hour, but it cannot support that pace, which is unnatural to it for a longer time. Nothing can be easier than its common amble of five and a half miles an hour, and if properly fed every evening, or in case of emergency once in two days, it will continue this pace uninterruptedly for five or even six days. While the hump continues full, the animal will endure considerable fatigue on a very short allowance—feeding, as the Arabs say, on the fat of its own hump. After a long journey the hump almost entirely subsides, and it is not until after three or four months' repose, and a considerable time after the rest of the carcass has acquired flesh, that it resumes its natural size, of one-fourth of the whole body. The full growth of the camel is attained at twelve years; he lives forty, but at about or under thirty his activity declines. In Egypt, camels are kept closely shorn, and are guided by a string attached to the nose-ring. Those of Arabia are seldom perforated in the nose, and readily obey the short stick of the rider. The camel-saddle of the Arabian women is gaudily fitted out, and a lady of Nadja considers it a degradation to mount any other than a *black camel*, while an Æzenian beauty prefers one which is *grey* or *white*. Cautery to the chest of the hump is usually applied when their broken-winded caravan-camel is exhausted by fatigue. Towards the close of a long journey, scarcely an evening passes without this operation, yet the load is replaced on the following morning on the part recently burned, and no degree of pain induces the patient animal to refuse or throw it off. If it once sinks, however, overpowered, either by hunger or toil, it cannot be compelled to rise again.

GEOLOGY.

2. *Subterranean Temperature.*—As you lately, in conversation, expressed a wish to obtain some details regarding the experiments upon subterranean temperature, which have been carried on for some time back in some of the Freyberg mines, under the direction of M. Reich, professor of physics in the Mining Academy, I send you a few of the facts which I was able to collect during my late visit to that highly interesting district.—The mine to which my observations were confined, and in which the most complete series of experiments are going on, is the *Kurprinz*, distant about five miles south-west from Freyberg. It is one of the three largest in the district. There are four thermometers in this mine, in the Treibschacht, third, fifth and eighth galleries; of the results of whose indications the following is a synoptic Table, for the twelve months which preceded the date of my visit on the 19th October 1830. They are observed three times a-week, on Monday, Wednesday, and Friday, either at 7 A. M. or 12 noon; and every observation is made and registered on the spot by Steiger Richter, the captain of the mine.

Stations.	Perpendicular depth in Leipzig feet	Lowest temperature.	Highest temperature.	Mean.	Range.
Treibschacht, ...	18	43°.92 F.	59°.67 F.	51°.79 F.	15°.75 F.
3d, Gezeugstrecke,	490	57 .94	61 .18	59 .56	3 .24
5th, Do...............	634	62 .42	62 .64	62 .53	0 .22
8th, Do...............	1300	67 .44	68 .45	67 .94	1 .01

During my visit to the mine, I observed two of the thermometers, that in the Treibschacht and third gallery. The temperature of the first was 59°.79 Fahr.; air of gallery being 64°;—that of the latter was 62°.49; air of gallery 62°.—In the fifth gezeugstrecke, at a depth of 634 feet, is a chalybeate spring, nearly pure, strongly impregnated with a large volume of free carbonic acid; I found its temperature 80°.25, from which, I was told by the captain of the mine, it never varied all the year round. Indeed, it had lately become more copious in quantity, which had been accompanied with a slight elevation of temperature. Air of gallery, in vicinity of spring, 77°.22, being heated by radiation from the water.—As the value of these observations is greatly enhanced by the precision and accuracy with which they are conducted, I shall briefly describe to you the thermometers with which, and the manner in which, they are made. The bulb, and more than 3 feet of the tube, which is altogether about 4 feet long, are enclosed in a brass cylinder about half an inch in diameter, and closed at the lower extremity. The upper part only of the tube, which projects scarcely a foot out of the cylinder, is graduated, but very delicately, so that $\frac{1}{10}$th of a degree of Reaumur is clearly distinguishable, and smaller fractions may be correctly estimated. The space between the non-graduated part of the tube and the brass case is filled with fine sand, so as to exclude completely the action of the external air. With these precautions, the brass tube is sunk its whole length into a hole bored obliquely into the solid gneiss rock, forming the walls of the galleries, (in which little chambers have been previously hewn, closed by a door, the key of which is only in the hands of the steiger), leaving only the graduated scale above the surface, on which the temperature may be observed. The bulb of the thermometer is thus sunk 3 feet into the solid rock, and completely excluded from the air, both by the sand between the tube of the thermometer and the inside of the brass cylinder, and another layer of sand with which the interval between the outside of the cylinder and the walls of the bore is filled up. These thermometers are so delicate, that, notwithstanding these precautions, they are affected momentarily by passing currents of air, and even by the too long proximity of the observer. M. Reich proposes publishing his observations when he has collected a sufficient number. He observed to me, on our conversing on the subject, that he suspected many of the observations published on subterranean temperature were very deficient in the precautions taken to ensure accurate results. He places very little reliance on the observations of Professor Kuppfer of Kasan, which, he says, are very superficial, and not carried on on a sufficient scale, or with sufficient precautions, to arrive at precise conclusions. I am not exactly aware of the mean annual temperature of Freyberg; its elevation, you know, was calculated by Charpentier at 1630 Leipzic feet. M. G.

3. *On the Fossil Deer of Ireland; by Mr Hart.*—In the autumn of 1828, while some workmen were employed in making preparations for planting the southern aspect of a hill of loam sand close to Enniskerry, they dug up several bones belonging to the fossil deer, *C. megaceros*, which lay buried in the loam at the depth of 3 or 4 feet below the surface, and at an elevation of about 40 feet above the level of the bed of the river which runs at the base of this hill. As the persons into whose hands these remains fell were not aware that any importance would be attached to their discovery, the occurrence attracted no particular notice at the time, in consequence of which the greater part of the bones were lost, or variously dispersed, when the above circumstances became known to the Rev. Robert Magee, who, after some search, recovered a few bones, and a fragment of an antler. This latter he presented to the Royal Dublin Society, in whose museum it is deposited. It consists of the root and part of the beam of the antler of the right side; its length is 11 inches, and its circumference at the base 10 inches; a portion only of the brow antler remains, and is much worn, apparently by attrition. The bones found in this place were not in that high state of preservation, for which the bones of this animal are so remarkable when found in marl; they had less specific gravity, were friable and powdery on the surface, and their projections or processes were generally worn off. Not being able to ascertain whether duplicates of any particular bone occurred in this instance, I have no means of determining whether these remains had belonged to one or to several individuals. The hill in which these bones were found is situated on the north bank of the river of Enniskerry, opposite the village; its height is about sixty or seventy feet above the river; it is one of a series of heaps of diluvial gravel, dispersed through an extensive valley, lying between primitive mountains. This gravel is composed principally of disintegrated granite, intermixed with clay, and contains round pieces of secondary limestone of various sizes,

which is occasionally met with in such quantity, that it is profitable to collect and burn them. Through most of the valleys separating these gravel hills, small streams or rivulets run over beds which often contain marl; such is particularly the case with respect to the river of Enniskerry, from the bed of which marl, containing a large proportion of carbonate of lime, is sometimes raised as manure. The presence of these bones in the gravel, would seem to warrant the inference, that the destruction of the animal to which they belong was owing to the same cause which conveyed those large heaps of sand and gravel to the situation which they at present occupy; and that this was the work of a vast inundation or deluge, by which the surface of this country was once submerged, appears to be sufficiently evident from the very striking resemblance which these gravel hills bear on a great scale, to the smaller heaps of sand and gravel left in the beds of mountain rivers after floods. The bodies of animals overtaken and drowned by this inundation, after remaining for a short time under water, would naturally run into a state of putrefaction; and having become inflated by the gaseous fluids disengaged in their interior during that process, they would rise and float on the surface until the soft parts were completely decomposed, when the bones, having their connecting media destroyed, would descend by their own gravity: and should the surface on which they come to rest at the bottom consist of a soft material, they would sink into this to a greater or less depth. It was thus, in all probability, that the bones of the fossil deer came to be deposited in their usual position in the marl, at a time coeval with, or immediately subsequent to, the formation of that substance; while the bones found in the sand would seem to owe their position there to the circumstance of the animal they belonged to happening to have been overwhelmed by the enormous masses of gravel and clay which the water rolled before it in the violence of its first irruption.—*From 2d edition of Description of the Fossil Deer of Ireland, by John Hart, Esq. M.R.I.A., &c.*

4. *New Volcanic Isle in the Mediterranean.*—In a letter purporting to be from Lieut. St Lamert, of the frigate Armide, to the Russian admiral, inserted in one of the newspapers, is a short account of this curious island. The following passage in

the notice is worthy of attention.—" A platform, nearly above the level of the water, surrounds the isle, and renders it very easy of access. It is, however, not prudent to approach on the ENE. and SW., on account of some detached portions of earth, over which the sea has begun to beat, at less than half a cable's length from the shore. The isle is free from shoals on every side; there is, however, on the NE. a *bank* which extends for a mile out; but after sounding repeatedly on those parts of the bank where the yellowish colour of the water appeared more prominent, we found a bottom at fifty fathoms; therefore the isle may with safety be closely surveyed. *Before the rising of this volcanic hill, this bank did not exist. It appears, then, that the volcano, before it made its explosion at the surface of the water, had raised up the earthy crust under which it roared, and has left behind it the long train of land which it had driven up.* On coming to the level of the sea, it has vomited a prodigious quantity of calcined matter, and it is thus that the new isle has arisen."—Now, should this statement turn out correct, it will go far to decide a much controverted point between Humboldt, Von Buch, Daubeny, and others, on one side, and Necker, Scrope, &c., on the other, since it is evident that this is a case of a *crater of elevation*, the existence of which the latter geologists entirely deny. Not that the converse of this would follow; for Dr Daubeny, for one, has never questioned that there is also such things as craters of *eruption*, of which kind this may be an example. D.

5. *Fossil Forest discovered at Rome.*—An interesting discovery has been made by a pedestrian tourist (a physician) in the immediate vicinity of Rome, namely, that of a fossil underground forest, above forty feet in thickness, and extending for several miles. The petrific matter is a calc-sinter, and from the layers of ligneous debris being freely intermixed with volcanic dust, the discoverer of this interesting circumstance thinks there can be little doubt but that this colossal phenomenon was occasioned by an earthquake, of which the memory is lost. The description of it is thus given in a letter:—" Facing the northern extremity of the Pincian Hill, on the left of the new road near the Porta del Popolo, I was struck with the peculiar appearance of the ground, and, on approaching it, I was surprised

to find it formed of a pile of petrified matter, eighteen or twenty feet in height by about forty in length, entirely composed at the lower part of the petrified trunks of very large trees, lying obliquely forward and outward; above which the whole rock consisted of petrified branches and typolithic leaves, intermixed in various places with volcanic sand and gravel. Some of the branches that lay in contact with the volcanic matter had a scorified appearance; the ligneous fibre is entirely consumed, but its texture is perfectly preserved. My surprise and joy at such a discovery, to which I believe I may lay claim, was not lessened by finding this fossil forest to extend up the Via Flaminia towards the Ponte Molle, forming, in fact, the entire range of precipitous high ground to the right of the road, now full forty feet in thickness. Before getting to the bridge it branches off still more to the right, and about a mile above it there is an interruption of this subterranean forest, where you perceive, under the petrifactions, the original aqueous formation of the country, consisting of cemented gravel, sand, and clay, before it was covered over by the volcanic dust, and the forest we have been describing. A quarter of a mile higher up the Tiber you come to a mineral spring, having a somewhat acid taste, which is frequented for its medicinal qualities. The petrified forest now crosses the Tiber, and you perceive detached parts of it ascending in the direction of the stream. The question naturally arises in the mind, What could have occasioned so singular a catastrophe? Is this the work of an earthquake, when this part of the country was the scene of the volcanic convulsions, which so many concomitant appearances confirm? The gigantic nature and extent of the phenomenon admit the probability of the conjecture; the admixture of volcanic dust among the trunks and branches of the forest strengthens the supposition; the overthrown position of the whole mass shews that the event was simultaneous; and the scorched impressions on the petrifactions point out the agency of fire. The petrifacient matter is calcareous, but of a peculiar nature, different from any I ever saw before. It is of a light brown colour, and very pulverulent. The upper parts of the petrifactions partake of the friable nature of the petrifacient, but, as it gets deeper, it becomes more and more indurated by the increase of the superincumbent pressure. The abrupt manner in which this extensive bed of petrified wood terminates is not one of its least singularities, and, altogether, it is perhaps one of the most curious facts of the kind yet discovered." G. H. W.

6. *Geognostical and Geographical Distribution of Minerals.* —Although it is a well-known but little regarded fact, the occurrence of one and the same crystalline form of a mineral in particular localities, it is also equally interesting that widely distant places exhibit the greatest agreement in their exterior and in their mineral contents. The latter is found to be the case, when we compare together the minerals of North America with the same species in Scandinavia, particularly of Norway and Finland. The same is the case with other districts. Thus there is not only a striking agreement between the varieties of gneiss in the Bohmerwald and those of Scandinavia, but also in the subordinate beds, veins, and imbedded masses of granite, and the same imbedded minerals occur in these distant countries. The red and green garnets, and black augite and coccolite of Norway occur again in the boundary between Moravia and Bohemia; but, in the eastern half of the Bohmerwald, there occur albite, triphane, petalite, tantalite, &c. The garnet, epidite, and hornblende of Schriesheim, in the Bergstrasse, often shew a striking resemblance to those of Arendal; and the wernerite, coccolite, colophonite, garnet, chondrodite, green spinel, triphane, petalite, black tourmaline, hornblende, &c. of Massachussets in North America, strikingly resemble the same minerals found at Arendal, Eger, and other places in Norway, and from Hermala, Pargas, and Ersby in Finland.

STATISTICS.

7. *Glasgow Statistics*, 1831.—Population, Births, Marriages, and Burials.—In 1821, the population was 147,043. In 1831, 202,426, viz. males 93,724, females 108,702; increase in ten years 55,383 souls. There are 137 occupations narrated, with the number of individuals employed in each. Ages under 5, 30,277; 5 to 10, 25,707; 10 to 15, 21,211; 15 to 20, 20,745; 20 to 30, 38,185; 30 to 40, 26,419; 40 to 50, 18,014; 50 to 60, 11,648; 60 to 70, 6,920; 70 to 80, 2,592; 80 to 90, 645; 90 to 100, 58; 100 and upwards, 5, viz. 1 male, 4 females.

Of what Country.—Scotch, 163,600; English, 2,919; Irish, 35,554; Foreigners, 353. Total, 202,426. There are many who consider the great influx of Irish as detrimental to this part of the country. This may hold true as regards weavers and indigent persons; but it is only justice to say, that but for the numerous industrious Irish labourers, the improvements of late years could not have been carried on with the same beneficial effect.

" *Pauperism.*—The number of paupers being 5,006, and the population 202,426, there is one pauper for every $40\frac{45}{100}$ persons. The number of paupers being 5,006, and the sum expended for their maintenance or relief, L.17,281 : 18 : 0½, gives L.3 : 9 : 0½ to each pauper. If the sum for the relief of paupers was paid equally by the whole non-recipient population, the proportion to each would be *one shilling and ninepence and a small fraction.*

" *Muslin Weaving.*—This city has long been conspicuous for its trade and manufactures, and latterly the weaving of muslin by power has been carried on to a great extent. In August 1831 four firms alone, viz. the Lancefield Spinning Company, Messrs Johnstone and Galbraith, James Finlay and Company, and William Dunn, employed 2,405 looms. These looms, on an average, weave 14 yards per day. Allowing each loom to work 300 days in a year, these four firms would throw off 10,101,000 yards of cloth, which, at the average price of 4½d. per yard, is L.189,393, 15s. per annum.

" *Post-Office.*—In 1709, the whole post office revenue in Scotland was under L.2,000. The revenue of the Glasgow office in 1781 was L.4341 : 4 : 9; in 1810, L.27,598 : 6 : 0; in 1815, L.34,784 : 16 : 0; in 1820, L.31,533 : 2 : 3; in 1825, L.34,190 : 1 : 7; and in 1830, L.34,978 : 9 : 0½. The London Mail-coach first came to Glasgow on 7th July 1788. Before that time the course of post from London to Glasgow was five days, the Glasgow letters being then brought round by Edinburgh, and even detained there twelve hours till the usual Edinburgh dispatch was made up in the evening.

" *Number of Steam-Engines in the City and suburbs.*—The first steam-engine used in Scotland for spinning cotton was put up at Springfield, opposite to what is now the Steam-Boat Quay, at the Broomielaw, in 1792, by Mr Robert Muir, for Messrs Scott, Stevenson, and Company, afterwards Tod and Stevenson. In 1831 there are 356 steam-engines in the city and suburbs applicable to manufactures, collieries, stone-quarries, and steam-boats. These engines combine a force equal to 7,366 horse power.

Stage-Coaches.—In 1763, with the exception of two coaches which ran between Edinburgh and Leith, there was only one stage-coach in Scotland. It set out once a month from Edinburgh to London, and was from twelve to sixteen days upon the road. About that time a heavy coach, drawn by four horses in good weather and by six in bad, commenced running between Edinburgh and Glasgow three times a-week. In a short time it ran every day, and was from eleven to twelve hours upon the road. At the time this carriage started, there was no other public conveyance from Glasgow. In April 1831 there were sixty-one public carriages which left Glasgow daily. These carriages were drawn by 183 horses, and 671 were kept for completing the journeys. The carriages accommodated 1,010 passengers.

Steam-Boats.—Till Henry Bell launched the Comet on the Clyde at Glasgow, in January 1812, there were no steam-boats plying on any river in Europe. In 1828 there were fifty-nine steam-boats on the Clyde; tonnage 8,283, average $140\frac{23}{59}$ Since 1828 several additional boats have plied on the Clyde, among others, in the Liverpool trade. The Glasgow, 286 tons, propelled by two engines of 50 horse-power each. The Liverpool, 315 tons, propelled by two engines of 75 horse-power each.

" Number of Persons estimated to depart from, and arrive in, Glasgow, by public conveyances, every lawful day,—viz.

Forty-six steam-boats carrying passengers, each averaging twenty passengers, ...	920
Coaches carrying 1010 passengers, from which deduct one-third, say	673
Canal tract-boats, per Annual Reports, ...	156
Number of persons departing from Glasgow every lawful day, .	1,749
Number of persons arriving in Glasgow every lawful day, .	1,749
Total arriving and departing daily, . .	3,498
Number of persons arriving in, or departing from, Glasgow in the course of the year by public conveyances, . .	1,094,874

It is unnecessary to say that the foregoing are not all distinct persons, many of those who depart from Glasgow return on the same day.

" *Sale of Bullocks, Sheep, and Lambs in the Live Cattle Market, Glasgow.*—Bullocks 17,840, Sheep and Lambs 144,900. Total, Bullocks, Sheep and Lambs, 162,740.

" *Value of Meat, Bread and Milk, sold in the City and Suburbs.*—Meat, L. 334,376 ; bread, L. 194,993 ; milk, L. 74,113. Total, Meat, Bread and Milk, L. 603,482.

" *Gas Company.*—During 24 hours in the winter months, the Company make upwards of 500,000 cubic feet of gas ; and during the same period in the summer months, about 120,000. The pipes extend to more than 100 miles through the streets. In generating the gas, 9,050 tons of coals are used. The first lamp which was lighted in the street with gas, was put up in the Trongate by the Company on 5th September 1818.

	Tons.
" *Supply of Coal in Glasgow.*—Total Coals brought into Glasgow,	561,049
" Exported from the Clyde at the Broomielaw and Bowling Bay, and from Port Eglinton by the Ardrossan Canal,	124,000
" Total Tons retained for the use of families and public works in the city and suburbs,	437,049

" Average price of Coals delivered in quantities in Glasgow in tons, during five years, viz. In 1826, 9s. 7d. to 10s. 7d. In 1827, 6s. 3d. to 7s. 3d. In 1828, 1829, and 1830, 5s. 10d. to 6s. 10d. Families who purchase their coals in small quantities, through coal agents or others, are charged somewhat higher.

8. *Russian Gold and Platina.*—During the second six months of 1829, from the Ural Mines, the following quantities of gold and platina have reached Petersburgh.

Gold from the Government Mines,	1783 lb.	
...... from Private Mines,	3025	
		4808
Platina from the Government Mines,	47 lb.	
.... from Private Mines,	1108	
		1155

The produce of the first half year of 1829, was 4688 lb. gold, and 1,041¼ lb. platina. The value of gold alone for the year above, is L. 650,000.

NEW PUBLICATIONS.

1. *Memoirs of Wernerian Natural History Society.*

The Sixth Volume of the Memoirs of the Wernerian Natural History Society, has just appeared, and contains the following interesting papers:

A Monograph of the Genus *Allium*. By Mr George Don, A. L. S.—On the Saphan of the Hebrew Scriptures. By the Rev. David Scot, M. D.—On the Structure of the Eye of the Swordfish. By Robert Edmond Grant, M. D., F. R. S. E., &c.—Notice regarding a Vein of Asphaltum, found imbedded in Gneiss, in the Hill of Castle Leod, near Dingwall. By Henry Witham, Esq. F. R. S. E. and M. W. S.—Description of a New Species of Ornithorynchus. By Mr William Macgillivray, M. W. S.—Observations on the Anatomy of the Paca of Brazil. By Dr Grant.—Sketches of the Comparative Anatomy of the Organ of Hearing, founded chiefly on the Ear of the Squalus. By Thomas Buchanan, C. M., M. W. S., with two Plates.—On the Fossil Remains of Quadrupeds, &c. discovered in the Cavern at Kirkdale, in Yorkshire, and in other Cavities in Limestone Rocks. By the Rev. George Young, A. M., M. W. S.—Observations on the Anatomy of of the *Parameles nasuta*. By Dr Grant.—Meteorological Journal from the Mouth of the Rio de la Plata to the Coast of Chili, 1822; with a Chart. By William Jameson, Esq. Surgeon.—Memoir on the Geology of the Snowdon Range of Mountains, as connected with its Scenery, Soil, and Productions. By James Stuart Menteath, Esq.—A Commentary on the Second Book of the Herbarium Amboinense. By Francis Hamilton, M. D.—On the Anatomical Peculiarities of the Sturgeon. By David Craigie, M. D. (with an engraving.) —Observations on the *Aranea geometrica*, *obtextrix*, *domestica*, and other Spiders. By Mark Watt, Esq. M. W. S. (with a Plate.)—Description of a Silurus, known in Demerara by the name of *Gilbacke*, more properly *Geelbuik*. By Dr T. S. Traill of Liverpool.—Description of a New Species of Cephalus, which it is proposed to name *Cephalus Cocherani*. By Dr Traill, (with a Plate).—Remarks on the Genus *Scissurella* of M. D'Orbigny, with a description of a recent British Species. By John

Fleming, D. D., F. R. S. E. &c.—Account of an Optical Illusion called the Fairy Islands, seen on the North Coast of Ireland. —On the Question, whether Domestic Poultry were bred among the ancient Jews. By the Rev. Dr Scot.—On the Origin of Domestic Poultry. By James Wilson, Esq. F. R. S. E. &c. —On the Okrub of the Ancient Hebrews, and Scorpion of the English Bible. By the Rev. Dr Scot.—Description of a Species of Arvicola common in Aberdeenshire. By Mr W. Macgillivray, M. W. S.—On the Mustard Plant mentioned in the Gospels. By the Rev. Dr Scot.—A Catalogue of Coleopterous Insects found in the neighbourhood of Edinburgh, with occasional reference to their Localities. By Mr James Duncan.—Remarks on the Phenogamic Vegetation of the River Dee, in Aberdeenshire. By W. Macgillivray, A. M.

2. *An Introduction to the Atomic Theory.* By Dr Daubeny. 8vo. Pp. 147. 1831.

Dr Thomson in his Chemistry, has detailed with sufficient minuteness the facts on which the atomic theory is based; while Dr Turner has given a popular summary of this important chemical doctrine. Professor Daubeny, in this learned and attractive volume, has, besides a view of the atomic system, laid before his readers a sketch of the opinions entertained by the most distinguished ancient and modern philosophers with respect to the constitution of matter. Although Dr Daubeny's "Introduction" is professedly chemical, it will be found to afford information and views highly interesting also to those who cultivate general science.

3. *A System of Chemistry of Inorganic Bodies.* By Professor Thomson of Glasgow. 2 vols. 8vo. 1831.

These volumes, independently of their containing the most complete account of the chemical properties of inorganic matter hitherto published in this or any other country, abound in new and important facts. Those who indulge in lucubrations in regard to the supposed decline of science in Britain, will find no support for their dogma in Dr Thomson's "Inorganic Chemistry."

2

4. *Elements of Practical Chemistry.* By David Boswell Reid, M.D., F.R.S.E., &c. 1 vol. 8vo. Second Edition. 1831.

The second edition of Dr Reid's work in so short a period, is a sufficient proof of its extensive circulation and general utility. Indeed it has now become the manual, not only for the students in our University engaged in practical chemistry, but also for operative chemists of every description.

Addendum to Mr Don's paper, supra p. 112.

Since the preceding sheets were sent to press, Mr Don has transmitted the following account of an additional species of Malesherbia, existing in the rich Lambertian Herbarium.

6. M. *fasciculata*, foliis lanceolatis acuminatis integerrimis, floribus fasciculatis, coronâ 10-fidâ : laciniis tridentatis.

Hab. in Chili. *D. Cuming.* ♄ (V. s. sp. in Herb. Lamb.)

Frutex erectus, ramosissimus, rigidus. *Rami* simplices, stricti, angulati, tomento brevissimo adpresso incani. *Folia* sparsa, petiolata, lanceolata, acuminata, integerrima, subtrinervia, pubescentia, suprà plana, subtùs venis paucis prominulis, semipollicaria et ultrà ; *juniora* cano-tomentosa. *Flores* in apice ramulorum fasciculati, parvi, pedunculati. *Pedunculi* uni v. triflori, tomentosi, brevissimi. *Bracteæ* lineari-lanceolatæ, acuminatæ, tomentosæ. *Perianthium* campanulatum, 15-nervium, extùs et intùs tomentosum : *coronâ* 10-fidâ, brevissimâ, membranaceâ : *laciniis* tridentatis : *dentibus* plerumque truncatis : *limbo* 10-fido ; *laciniis exterioribus* calycinis, ovatis, mucronulatis, trinerviis, purpurascentibus, brevissimis ; *interioribus* 5, petaloideis, suborbiculatis, emarginatis, venosis, persistentibus, albis, demùm scariosis. *Stamina* 5 : *filamenta* complanata, membranacea, uninervia, apice attenuata, acuminata, basi cum ovarii pedicello connata : *antheræ* ovali-oblongæ, incumbentes, biloculares : *loculis* parallelis, connatis, rimâ marginali dehiscentibus. *Ovarium* pedicellatum, uniloculare, densè tomentosum. *Styli* 3, subterminales, capillares, flexuosi, glabri. *Stigmata* parva, obtusa, pruinosa. *Ovula* numerosa erecta, funiculo umbilicali stipitata, costis 3 prominentibus parietalibus inserta. Cætera mihi ignota.

Obs. Planta habitu paululùm differt, sed characteribus omnino Malesherbiæ convenit.

List of Patents granted in Scotland, from 21*st September to* 26*th November* 1831.

1831.

Sept. 21. To James Down of Leicester, in the county of Leicester, Surgeon and Apothecary, for an invention of "certain improvements in making gas for illumination ; and in the apparatus for the same."

To Thomas Brunton of Park Square, Regent Park, in the county of Middlesex, Esq. for an invention communicated to him by a certain foreigner residing abroad, of "an improvement in certain apparatus, rendering the same applicable for distilling, brewing, making or refining sugar, and to other useful purposes."

Oct. 5. To JAMES LANG of Greenock, Scotland, North Britain, flax-dresser, for an invention of "certain improvements in machinery, for spreading, drawing, roving, or spinning flax-hemp, or other fibrous substances, dressed or undressed."

5. To JEAN JAQUES JEQUIER of Castle Street, Leicester Square, in the county of Middlesex, merchant, for an invention, in consequence of a communication made to him by a certain foreigner residing abroad, of "certain improvements in the machinery for, or method of, making paper, which he denominates the Xeranothlipte."

12. To GEORGE FORRESTER of Vauxhall Foundry, Liverpool, in the county of Lancaster, civil engineer, for an invention of "certain improvements in wheels for carriages and machinery, which improvements are applicable to other purposes."

24. To John Milne of Shaw, in the parish of Oldham, in the county of Lancaster, cotton-spinner, for an invention of "improvements in certain instruments or machines commonly called roving frames and slubbing frames, used for preparing cotton wool for spinning.

31. To GEORGE LOWE, of Brick Lane, in the parish of Saint Luke, Old Street, in the county of Middlesex, civil engineer, for an invention of "an improvement or improvements in, and connected with, the manufacture of gas for illumination."

Nov. 14. To DANIEL DUNSCOMB, Bradford, a citizen of the United States of North America, but now residing in Dorset Place, in the parish of St Marylebone, in the county of Middlesex, for an invention, in consequence of a communication made to him by Solomon Andrews, residing at Amboy, New Jersey, in the said United States of North America, of "certain improvements in lamps."

22. To SAMUEL BROWN, of Billeter Square, in the city of London, commander in the Royal Navy, for an invention of "certain improvements in the means of drawing up ships and other vessels from the water, on land, and for transporting or moving ships or vessels and other bodies, from one place to another."

26. To WILLIAM ALLTOST SUMMERS, of St George's Place, St George's, in the east, in the county of Middlesex, engineer, and NATHANIEL OGLE, of Milbrook, in the county of Hants, Esq. for an invention of "certain improvements in the construction of steam-engine and other boilers or generators, applicable to propelling vessels, locomotive carriages, and other purposes."

To WILLIAM FURNIVAL, of Wharton, in the county of Chester, Esq. for an invention of "certain improvements in evaporating brine."

To JACOB PERKINS, of Fleet Street, in the city of London, engineer, for an invention of "certain improvements in generating steam, and evaporating and boiling fluids for certain purposes."

To THOMAS SANDS, of Liverpool, merchant, for an invention, in consequence of a communication made to him by a certain foreigner residing abroad, of "certain improvements in machinery for spinning, twisting, and roving."

ADVERTISEMENTS.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On Mineralogy considered as a Branch of Natural History, and Outlines of an Arrangement of Minerals founded on the principles of the Natural Method of Classification. By L. A. Necker, Honorary Professor of Mineralogy and Geology in the Academy of Geneva, &c. Communicated by the Author.

The present short and very incomplete communication, is intended merely as a cursory sketch of the chief leading principles of a plan for the classification of minerals, differing entirely from any systematic arrangement hitherto proposed, inasmuch as, in the view we intend taking of the subject, Mineralogy is considered as a branch of natural history, and made to submit, not to the arbitrary and unphilosophical arrangements of an artificial system, but to the laws of the natural method of classification, as exemplified and illustrated in the other two branches of natural history, Zoology and Botany, in the classical works of Cuvier and De Candolle.

Having had repeated opportunities of hearing the principles of the natural method developed by the philosopher himself, who has been the first to analyze them, and to give them a philosophical form, in his admirable *Theoric élementaire de Botanique*, and, at the same time, of seeing the application of these sound principles, as given by the same author (De Candolle) in his lectures on botany and zoology, I was forcibly struck with the sad inferiority in which mineralogy stood in regard to its two sister sciences.

Being at the same time engaged in lecturing on mineralogy, I was made still more aware of the relative deficiencies of this science, and ever since, I have applied all the power of reflection I could master, to analyze the causes of such differences, and to find the means of bringing the natural history of the mineral kingdom to a level with that of organized beings. The result of many years' meditation and labour on the subject, has given rise to a work of which the first part is now nearly ready for the press. In this work I intend laying before the public, what I consider to be new and philosophical views of mineralogy as a science, and of the proper subjects of its contemplation, in which the apparently discordant characters and properties of minerals, viz. the physical, external and chemical properties, will be made to unite and control each other, in such a manner as I hope will enable me to bring together, in the same classes, families, genera, and species, minerals agreeing as much as the present state of knowledge admits of, not only in chemical composition, but also in external and physical characters.

My present purpose, in this rapid prodromus, is to present to the student of mineralogy a cursory view of the new ideas which have occurred to me in the course of this investigation. I shall give them almost in the form of aphorisms, referring to the work itself for the development of these ideas, for the demonstration of the propositions maintained, and for the discussion of, and answers to, the objections which have been, or may be supposed hereafter to be, made against any particular part of this new doctrine.

The subjoined sketch of the higher divisions of the classification, with the chief characters of the classes, orders, families, and the mention of the genera included in these various divisions, will, I trust, be of practical utility to the pupils, and will even, I hope, prove equally so to the master, till the moment when the work itself will disclose to their attention, the complete enumeration of characters, from the first subdivisions of the mineral kingdom into Classes, to the last into Species, (by which is meant what has been hitherto named Varieties or secondary forms of crystals), and into varieties either constant or accidental, of the different species.

I. GENERAL CONSIDERATIONS.

§ 1. The two prominent points in which the superiority in the methods of the natural history of organized beings over those of the inorganic kingdom shows itself most conspicuously, independent of the greater interest which is naturally attached to living beings provided with numerous and infinitely varied organs, each of which is admirably adapted to the conservation or reproduction of the species, are the following.

§ 2. 1*st*, It enables the student, in all cases, even in the natural method, which disclaims every attempt to facilitate the discovery of the name of a being, to find out, after having acquired the knowledge of the organs, the name and place in the method of any animal or vegetable individual, and that without any other auxiliary but a treatise on zoology or botany; that such a thing cannot be accomplished with any work on mineralogy, that of Mohs excepted, is well known to all who have attempted to study that science by the aid of books alone. The very entrance into a system of mineralogy is impracticable, because the first divisions are generally founded upon characters which by their very nature are never enumerated among the mineralogical characters, and in many cases cannot be ascertained. Not to speak of the divisions in Werner's and in Haüy's first system, which presupposed a knowledge not only of the component parts of a mineral, but of the mode of combination of these elements, while chemical analysis was not even mentioned as a mineralogical character; we ask, how is a student to proceed, when, with a mineralogical specimen in his hand, and after having carefully studied the mineralogical characters in his book, he comes as a zoologist or a botanist would do, with an animal or a plant, to ask the author to lead him by gradual definition to the name of the mineral; and when he finds that he has to determine, in the first place, whether his mineral belongs to the class of *autopside* or of *heteropside* metals, to those of *electro-positive*, or *electro-negative* metals, or to *leucolytes*, *gazolites*, or *chroïcolites*, for which determination the most profound chemical researches, the use of the voltaïc pile, after the complete decomposition of the mineral, are indispensable, and even in many cases would be unavailing, the constituent parts having never been entirely decomposed, and being supposed to be compound bodies merely by analogy?

§ 3. *2d*, The number of the characters enumerated in the classes which are the first or higher divisions of each of the two organic kingdoms, are to be considered as belonging in common to all the animals and vegetables, forming by their assemblage these great classes or divisions. Their number is considerable, and their importance great. In lower divisions, as in orders, or families, or genera, the characters become gradually less numerous and important; till at length some few almost unimportant characters, prefixed to each species, complete the description of each animal or vegetable, and thus terminate by real definition the enumeration of all the similitudes and differences by which this animal or vegetable is connected to, or separated from, all the other beings of the same department of nature. Hence arises, in courses of lectures given according to the natural classification, that rich and highly interesting display of analogies, and of facts common to an immense number of beings, which characterize the higher divisions of the subject in zoology and in botany; while the far less important details of discrimination between the genera or the species can be left, without any inconvenience by the professor, to the private study of the pupil. This is far from being the case with the present mineralogical methods of classification. A single fact—a single abstract property—is often the only common character which binds together, in the form of a class, an order, or a family, a large multitude of minerals otherwise entirely different in the remainder of their properties. The very name of a class contains often all that is common to all the beings of which it is composed. But, by a most melancholy compensation, the lower subdivisions, the species and varieties, require to be distinguished from each other by the accumulation of so many, and often uninteresting details, that the professor who speaks, and the student who listens, become fatigued and dissatisfied with the long enumeration of almost individual beings, which composes now the greatest part of a course of lectures on mineralogy. What, for instance, could be said which would be common to all the species of which the genus *Iron* is composed, in which are seen brought together instances of properties so different from each other, that the minerals seem arranged under that head rather for the purpose of showing the great variety of forms, of physical and chemical properties, colours, &c. under which unorganized matter may be seen, than for connecting particular substances by their most numerous or most striking analogies? Except some trifling analogies in specific gravity and hardness, what are the common ties that bind together minerals so essentially different in all their constituent parts as are the members composing the orders Haloïde and Baryte of Mohs, in the first of which the sulphates and carbonates of lime are united to the fluate of alumina, and, in the second, the carbonates of iron and of manganese to the silicate of zinc, the tungstate of lime, the sulphates of strontian and of barytes, and the phosphate, chromate, and molybdate of lead.

§ 4. In instituting an analytical inquiry into the causes of so great and essential differences as are here presented between the methods actually employed in pursuing the study of organized bodies and our present systems of mineralogy, the result of such an analysis has not led us to the conclusion to which some celebrated chemists have arrived, that mineralogy is not a branch of natural history, and that the study of inorganized bodies is but a portion of chemistry, and, consequently, can be prosecuted only according to the methods and the mode of reasoning generally employed in that science. Still less do we agree in opinion with a distinguished chemist, that, in considering minerals, the purposes and functions of natural history and of chemistry come to be the very same.

§ 5. On the contrary, it has appeared to us that the reason why mineralogy has hitherto occupied so low a station when contrasted with botany and zoology, is to be found, first, In an ill-defined conception and distinction of the purposes and mode of proceeding in natural history and chemistry in the consideration of the same beings, whether organized or inorganized; secondly, In an ill-defined conception of what ought to be the real objects of inquiry and study of natural history in the inorganized, as it is in the organized world. It is to the erroneous ideas which have hitherto prevailed on this subject that may be attributed the precarious, and, as it were, spurious rank which mineralogy at present occupies among the natural sciences, and the perpetual fluctuation that has always been observed in its methods between the doctrines and the forms of natural history and those of chemistry.

§ 6. We are now to shew that, according to sound reasoning, the purposes, the doctrines, and the forms of natural history, are in fact, and ought to be, different from those of natural philosophy and chemistry.

As the beings whose union forms the universe are the common fund out of which all the sciences of observation and experience draw the objects of their investigation, it might be, and has been, said, that those sciences, having the same objects of contemplation, are not so distinct from one another as prejudice has too long made us conceive them to be. This, indeed, would be the case, if the material objects from which a science draws its objects of contemplation were alone sufficient to constitute such contemplations a science. But it is far from being so: it is not so much the objects themselves, but the way in which they are considered, and the particular purpose for which they are studied, that establishes real and very distinct differences among the different pursuits to which the human mind may be applied, and which raises these various pursuits to the rank of so many distinct sciences.

§ 7. Natural philosophy or physics, and chemistry, are, in fact, abstract sciences, inasmuch as they abstract properties and phenomena from the existing bodies in nature which are the subjects of their consideration; this abstraction is complete and permanent, as they never return to consider and study the being themselves by which the abstract properties have been furnished. Their mode of expression, also, is abstract; they employ calculation, numbers, mathematics as much as it is possible; they inquire into causes, they speculate, they analyze, and then generalize. In the exposition of their doctrines they are not restricted to any particular form or method, but each philosopher is free to introduce his speculations or discoveries in the mode which appears to him most convenient for his purpose. Finally, the ultimate end of these abstract sciences would be to find a general and universal law as a consequence of the subordinate laws by which nature is regulated.

§ 8. Such is not the case with natural history; it is not a speculative, but a positive and descriptive science: it deals not in the abstract properties of natural beings, but these beings themselves, in their individual state, are the subjects of its inquiries. Its aim is to compare those beings with one another, to point out their resemblances and their differences. If, for a more thorough comparison of these beings, and for assembling them by the properties and characters which are common to them, natural history is called upon to abstract from them the consideration of some of their properties; such an abstraction is never complete, never permanent; it is but momentary, and the consideration returns immediately to the being itself by which the property has been furnished. Its mode of expression is merely descriptive and comparative, and the method of exposing the facts belonging to the science is not left to the arbitrary will of the philosopher, its form is regulated by laws dependent on the nature itself of the science; it is that system of gradual description, comparison, and definition, founded upon the valuation of characters, which is known by the name of Natural method of classification. The grand aim of natural history should be, to assemble together, in a great table, arranged according to their most important mutual analogies, the whole of the existing individual beings in the universe.

§ 9. From these considerations, it is easy to see that chemistry and natural history are really two very distinct and separate branches of human knowledge, and that, although they may direct their attention towards the same natural beings, the way in which each of these sciences consider these beings is materially different. Chemistry considers only the abstract notion of substance in any given body, its composition, the mode of combination of the elementary or compound substances which enter into its composition. Natural history considers the individual body or being in itself, provided as it is with all its physical, external, and chemical properties, and inquires into its chemical composition, merely that every attribute belonging to such an individual may be known, and furnish means of establishing a more complete comparison between it and the other beings existing in nature.

§ 10. But although the different sciences are, when considered in a completely abstract point of view, essentially distinct from one another, it is nevertheless true, and this remark has been often alluded to in objections to the real independence of the various sciences in regard to each other, that such an independence is by no means so complete in practice as it may be thought in theory, that all sciences are connected together by common ties, and that every one of them is in need of the others for attaining its particular purpose. We are far from denying the fact here alluded to, but what we contend for is, that it does not alter in the least what we have maintained, that the purposes of the various sciences being different, the sciences must be regarded also as different.

Natural history being obliged, in the study of individual beings, to investigate the properties of these beings, must call to aid the abstract sciences which consider abstract properties; and in this case natural philosophy and chemistry will bring their abstract mode of consideration, of arrangement, &c. But here they act merely as auxiliary sciences; and if for particular and subordinate purposes, natural history must momentarily borrow their language, these abstract sciences will never be allowed to intrude with their methods in the principal purpose of natural history, the description, comparison, and classification, of real and positive beings.

It is the same with chemistry. As that science is always decomposing known substances, and bringing in that way new and unknown bodies to light, or, by new combinations of elements, forming equally new substances, it is necessary that such new bodies should be described and compared with the existing bodies. For this subordinate and particular purpose, chemistry borrows the descriptive and comparative methods of natural history; but it would never allow the natural-historical method to interfere with its proper aim, which is the abstract consideration of substances, of elementary combination. It is so true that such a description of physical bodies is quite foreign to the chief purpose of chemistry, that wherever such descriptions exist already, the chemist never thinks of troubling himself any more with them. One of the best proofs of this assertion is the celebrated Berzelius' chemical arrangement of minerals, in which not the smallest attempt to any thing like description is made, but which consists entirely of abstract formulæ of composition.

§ 11. We have insisted upon the division of sciences into separate branches, and upon the distinction which must be made between the sciences acting in their own peculiar sphere, or merely as auxiliary to another science, because we have thought it essential before we come to inquire whether mineralogy belongs to natural history or not, to establish the position that natural history was really a distinct branch of the great tree of human knowledge.

§ 12. Having now shown that natural history is the study of individuals, the question is, whether there are individuals in the mineral kingdom, for if such is the case, those individuals fall necessarily into the domain of natural history. If there are no individuals, and if there is nothing in the mineral kingdom to study but abstract properties unconnected with each other, then of course mineralogy is not a distinct science, and natural philosophy and chemistry must take upon themselves the consideration of such of the properties of inorganized bodies as fall under their relative departments. Besides, in this view of mineralogy, we would strongly urge the necessity of giving up entirely the mode of classification into species, genera, families, &c., divisions foreign to the common use and language of chemistry, while they are, when applied to individual beings, quite proper to natural history, and essential to its progress.

But such is not our opinion, for after a rather long and abstruse inquiry into what is to be understood by the term individual, an inquiry which we leave entirely to the work of which the present notice is a mere precursor, we have become convinced, with Mohs, that there exists in the mineral kingdom real and perfectly characterised individuals,—that these individuals are the crystals, not the integrant molecules, as some have affirmed, for these latter are mere conceptions of our mind, having neither tangible shape nor real existence. These mineral individuals are not the primitive forms of crystals, but all the single crystals of primitive or secondary forms, however simple or complicated they may be.

§ 13. Now that we have found individuals to exist in the inorganized world, we may be allowed to study and arrange them according to the principles of natural history. Natural history, indeed, by its very essence, is bound, not only to consider them, but also to subject them to her method of classification. Hence we are now called upon to compare all these very numerous and varied individuals, in all their different properties, and to arrange them according to their analogies, as zoologists and botanists do with individual animals or plants.

§ 14. It is now for the first time that mineralogists will be called upon to study and classify real and positive beings; for hitherto they have only considered and attempted to arrange abstract ideas. It was the substance of minerals, and not the minerals themselves, that was the object of their studies and comparisons, owing chiefly to the use which the arts derived from these substances, so that the most useful element in such minerals was therefore considered the most important in the combination. The physical and external properties of a mineral body were, in these cases, viewed in a manner quite subordinate to the substance. They were not looked upon as equally essential to the existence of the body itself, but merely as more speedy, and more ready, indicators of the nature of the substance, than the chemical analysis. This observation, which, I believe is as new as it is true, that mere abstract ideas have been arranged into families, genera, species, which, as these very names indicate, are notions derived from existing relations among positive individuals, will account for the unfitness of such classifications to the objects for which they were employed.

It is very curious to observe, that Mohs himself, although he has perfectly recognised crystals to be the individuals of the mineral kingdom, wishing as he did to introduce into the science of mineralogy the modes of proceeding of the other branches of natural history, has never thought of availing himself of his own correct ideas on this subject, to compare individuals with one another, as is always done in zoology and botany, and to give a classification of mineral individuals and not of abstract ideas, as he has done in the manner of his predecessors. The objects of his study have not been, it is true, abstract ideas of substance, for he has carefully avoided all that related to chemical composition, but abstract ideas of certain physical matters, possessing certain physical properties, but no character whatever of individuality *. Had Mohs thought of comparing together his individuals, and had he got a more thorough and extensive knowledge of the nature and purpose of natural history, he never would have entirely laid aside characters so important as those derived from chemistry, he never would have assembled together in the same orders minerals entirely different in chemical composition, and he would then have really and effectually restored to natural history the knowledge of mineral bodies.

§ 15. It is, therefore, only by the consideration of individuals that the questions, constantly discussed among mineralogists as to the superiority to be assigned to the chemical composition or to the physical properties of minerals, can be set at rest. When the nature of the body under consideration is not perfectly defined, and when the reasoning is carried on in too general a way, as has always been the case, each mineralogist is apt to overrate the value of properties which his taste or circumstances have made him most familiar with, and it is difficult to pronounce in so arbitrary a matter. But when an individual is given which is well defined in form, in properties, and in chemical composition, it becomes evident that all these attributes, the form, the properties, and the composition, are equally inherent in the nature and essential to the existence of such an individual, and so they stand on an equal footing one with the other. It is one of the great advantages of the consideration of individual bodies, that these individuals are the most real and natural syntheses of properties or characters, in regard to which every other attempt to synthesis would be arbitrary and fantastical.

§ 16. Let us now follow in regard to our mineral individuals

* As is evident, by his having admitted into his method aëriform and liquid matter, where no trace of individuality is to be found, and as may be likewise demonstrated, in examining the part which crystallization acts in his manner of considering solid minerals.

the same principles and modes of study that have been long adopted in zoology and botany for individuals belonging to these two kingdoms. As the comparison must be instituted in the distinctive characters of these individuals, and as those characters, which, in living individuals, are the organs of which they are composed, are, in the individuals belonging to inorganized nature, the various physical and chemical properties with which they are endowed *, let us first begin by a study, as close and as complete as possible, of these properties, just as the zoologist or botanist begins his labour by abstract considerations and study of the organs, of the phenomena exhibited by them in relation to the animals or plants themselves, or to the other bodies in nature, which may have some influence upon them.

Those preliminary and auxiliary studies, which, in the science of organized beings, are termed Organology, Anatomy, Physiology, or animal and vegetable chemistry and physics, and are carried on according to the mode of proceeding of the abstract sciences, will be first considered by us under the name of Mineral Chemistry and Physics, and will comprehend the abstract consideration of all the properties or phenomena belonging to, or which are manifested by, inorganic beings. On this part of the science we shall be very brief, and shall only at present introduce the mere heads of chapters or nomenclature of the subjects that come under this head, referring for more detailed accounts to any treatise on mineralogy, and especially to the first part of Beudant's *Traité Elémentaire de Mineralogie.*

§ 17. We will next consider under the title of *Taxonomy*, adopted by De Candolle, to design the theory of classification, 1st, The choice to be made among all the various properties, of such as are best suited for being employed as distinctive characters of the individuals, species, genera, families, and classes; 2d,

* I wish it to be understood clearly, that in attempting to compare mineral with organic individuals, I do not mean to assert any thing beyond the mere fact, of characters of individuals being found common to both the organic and inorganic nature. That fact alone excepted, every thing is different in those two distinct parts of natural history, divided as they are by the more distinct line of demarcation, shewing on one side all that is endowed with, and on the other all that is deprived of, this, the most distinctive of all characters, life.

The relative value to be assigned to these characters; 3d, The use which is to be made of these characters, according to their greater or lesser value in the formation of classes, families, genera, &c.

§ 18. Finally, under the title of Classification, we shall give a specimen of the first and most important divisions of the mineral kingdom, established under the guidance of the rules previously established, which are those of the natural method of classification, a method which is neither arbitrary nor exclusive, which does not confine itself to the use of certain particular sets of properties or characters, whether chemical, physical or external, but which, in each individual being as well as in the assemblage of them, considers the whole of their properties, and endeavours to arrange together these beings, according to their most numerous, and chiefly to their most important analogies.

II. MINERAL CHEMISTRY AND PHYSICS, OR ABSTRACT CONSIDERATIONS ON THE CHEMICAL AND PHYSICAL PROPERTIES OF MINERALS.

Sect. I.—Minerals considered according to their chemical composition and properties.

A. *Of the Elements and of their mode of combination; of Chemical and Mechanical Mixtures.*

§ 19. List of the elements.—Various modes of combinations. —Definite proportions.—Chemical and mechanical mixtures.

B. *Of the means of recognising the composition and the chemical properties of Minerals.*

§ 20. Qualitative analysis or essays in the dry way; theory of the blowpipe, and its application; essays in the humid way. General idea and examples of the quantitative analysis of minerals. Calculation of the analysis. Berzelius's electro-chemical theory of combination. Chemical and mineralogical formulæ. Synthesis; account of Becquerel's mode of forming crystallized substances by the action of weak electricity.

Sect. II.—Minerals considered according to their physical properties.

A. *Of the form of mineral individuals, or of crystallization.*

§ 21. Definition of a crystal; its parts; fundamental or primitive, and derived or secondary forms. Systems of fundamental forms, with the derived forms belonging to each system. Laws of derivation. Mode of determining the relative dimensions of fundamental forms. Mode of determining the position of derived planes, in regard to the planes or to the axis of the fundamental form, and the incidences of the derived planes on the fundamental planes, or on each other. Cleavage. Optical properties of the different systems of forms, and means of ascertaining these properties. Relation existing betwixt the form and the chemical composition of minerals. Theory of isomorphism. Mode of grouping of simple crystals or individuals. Compound crystals or individuals. Macles or hemitrope crystals. Regular groups of crystals. Irregular groups of crystalline particles or distinct concretions, &c.

B. *Of the optical phenomena unconnected with the form.*

§ 22. Transparency, lustre, colour, phosphorescence, &c.

C. *Of other physical properties.*

§ 23. Specific gravity. Hardness. Nature of the streak and of the dust. Electricity. Magnetism. Taste. Feel. Sound, &c.

III.—TAXONOMY, or THEORY OF CLASSIFICATION.

Sect. I.—Of the choice of proper characters among the various properties of minerals.

§ 24. We cannot employ as characters, either distinctive or descriptive, of mineral individuals, all the facts, phenomena, and properties enumerated in the preceding chapter. It is owing to the promiscuous and indiscriminate use of them that mineralogy has been considered more as an abstract science than as a descriptive one. It being our object to place it on a true basis, we must study the nature of the characters employed in zoology and botany, as far as relates to their relations to the animal or plants described, and from that study derive rules which we shall afterwards apply to mineral individuals. We have made the required study, and, by a comparison of what has been done in zoology and botany with what has been effected in mineralogy, we have been led to establish the following rules destined to guide us in the choice of proper characters on which we are to fix the divisions of the classification from the highest down to the lowest.

§ 25. In the first place, the character must belong to the individual itself, and not to one only of its constituent parts or elements. This rule, therefore, excludes entirely the use, so often made, in the highest divisions especially, of certain abstract characters belonging only to one or to another of the elements of the chemical combination. Such, for instance, as the character of being *autopside* or *heteropside*, electro-positive or electro-negative, which belongs to one of the simple or elementary metals entering into the composition of a mineral, and not to the compound substance of the mineral, nor to the mineral itself, which is neither *autopside* nor *heteropside*, neither electro-positive nor electro-negative. For the same reason we ought to avoid giving to a collection of minerals, in the composition of which a malleable metal forms a constituent part, the character of malleability as the distinctive character of the family, because most of the individuals being compounds of one of these metals with combustibles, with oxygen, with acids, &c. are not themselves malleable. But if a distinction was required only between metals in their native state, then the character of malleability would be a very proper one.

§ 26. Secondly, the characters must be immediately recognised in the individual, or at least by such means that the individual, or a physical part of it, representing exactly the whole, being always present to the eye of the observer, there should be no doubt that the property manifested does belong to the individual, and belongs to it alone. In this respect all the external characters, as well as the physical ones, and many of the chemical properties, inasmuch as they are recognised before the body is decomposed, or in the act itself of its decomposition, are proper characters. But if, after its complete decomposition, and when its component parts have formed new combinations with other substances, ulterior operations were required, these not being immediate, and the body to be characterized, having completely vanished from the inspection of the observer, the characters derived from such operations would not be proper characters in natural history. Hence the reason why characters of the solutions of mineral bodies recognised by precipitates ought not to be employed. But the direct effects of water, of the acids or alkalis, of heat in whatever way it is employed, of fluxes, and of the greatest number of contrivances described by Berzelius to be employed with the blowpipe, having the advantage of being immediately applied to the individual itself, or to a portion of, or representing, the whole, are to be considered as excellent characters. In fact, the immediate exposition of the mineral to such chemical tests is nothing else but a change in the circumstances or in the medium in which the body is naturally placed; quite analogous to the changes experimentally produced in order to ascertain the specific gravity, the hardness, and the malleability of a mineral.

On the contrary, most of the experiments required for a qualitative analysis by the humid way being complex, and not immediate, operations, are not to be admitted among the characters.

The quantitative analysis, which is the most complicated and difficult, can still less be admitted among the characters, as its results derive their chief value from the name and the fame of the chemist who has made it. Surely the mineralogist ought to be thoroughly acquainted with the results of all the analyses made of the different minerals, called upon as he is to compare them, in their chemical composition as well as in all their physical properties, for this knowledge will enable him to find proper characters to assemble minerals allied to each other by analogies of composition. But the analysis, or the formula denoting its result, will never be held as a proper distinctive character in the eye of a naturalist.

§ 27. Thirdly, in examining in succession the various mineralogical characters, it has often been objected to each of them, as being incapable to characterize or define by itself a mineral, or a mineral species. But the same objection might equally be brought to bear against all the specific characters employed in zoology and botany. No naturalist has ever thought of characterizing a species by a single character; but, according to the method of gradual description or definition used in natural history, a single character may often be employed to distinguish a given species in its genus, a genus in its order, an order in its class, and that is all that is required.

§ 28. Fourthly, it has generally been thought necessary to give to the definition of the characters a degree of mathematical precision and exactness similar to that which is required in natural philosophy, an opinion that has often prevented the use of such characters, which, when taken in their common acceptation, would have proved equally useful and convenient for the description and the distinction of minerals. For instance, the character of solubility in water, which, in the minerals commonly called *salts*, was, when taken in the proper limits of its usual acceptation, a very good distinctive character, and even an important one, by its being closely allied to a number of equally distinctive physical as well as chemical properties; this character has been given up on account of other bodies essentially different from the so called salts by their various properties, being also, in the strict sense of the word, soluble in water, such as calcareous spar, gypsum, and sulphate of barytes. This too great nicety, for so it may be called in regard to the purposes of natural history, takes its origin in a want of discrimination between the purpose and the wants of this science and those of the exact and abstract sciences, such as natural philosophy and chemistry. In these last mentioned sciences, the object is to find and ascertain positive and absolute truths, while in natural history, as far at least as relates to classification, it is to find differential or relative qualities, and in that case a minute and mathematical precision is not required for comparative characters, when the limits into which the allegation of such characters is to be understood has been clearly defined. Thus, when we say that, by solubility in water, is meant that property of a mineral by which it is sensibly dissolved by a small quantity of water, (less than twenty times the weight of the mineral), we obtain a sufficiently accurate character to distinguish the *salts* from other minerals, which require for their solution a much greater quantity of water.

For the same reason, although it is well known that metals, when divided into extremely thin laminæ, transmit light, yet, as they never occur in nature in such a state as to exhibit this property, to which they can be brought only by artificial and difficult contrivances; and, as their smaller natural fragments exhibit on the contrary complete opacity when compared with fragments of equal size of other minerals, we may term them opaque without being taxed with inaccuracy.

In like manner, when we have previously mentioned the kind of fire, blowpipe, and gas employed to effect the combustion, and when the size of the fragment of mineral tried has been approximately indicated, we may use the character of fusibility or infusibility as perfectly correct, notwithstanding that, in circumstances different from those mentioned, the case would have proved different.

SECT. II.—OF THE RELATIVE VALUE OR IMPORTANCE OF CHARACTERS.

§ 29. The subject we are about to bring under consideration presupposes in the reader an acquaintance with what is meant in natural history by the expressions *artificial methods or systems*, and by the *natural method* of classification. Should he be unacquainted with the views on this subject, we would refer him to Cuvier's *Regne Animal*, but more especially to the deep and elaborate disquisition on this subject contained in De Candolle's masterly work, the *Theorie Elementaire de la Botanique.*

It will be sufficient for our present purpose, to remind the reader that an *artificial method*, not having it in view to assemble the beings which it considers, according to their more important and more numerous analogies, does not make use of the whole of the properties or organs as characters, and does not attend to the natural subordination of those characters: that a *system* is founded on the consideration of a single set of organs or of characters, so that it is always entirely artificial, being generally constructed in order to facilitate the discovery of the name of the being. The *natural method* is founded on a thorough knowledge of the being in all its real and effective relations to the other beings. It arranges all the individuals together in such a manner, that those, according to the definition of De Candolle, which are the nearest in the order of nature should be also the nearest in books. Hence it follows, that while, in an artificial method or system, the naturalist is at liberty to use and arrange his characters, as he thinks best suited to his purpose; in the natural method, for there is in fact but one such, he is obliged to study the natural analogies, to discriminate the relative importance of the various characters, and to adapt his plan to the plan of Nature herself. He has not to invent a classification, but to find that which really exists.

§ 30. As the natural method rests upon the subordination or relative importance of characters, we must now endeavour to explain how a knowledge of this subject is to be attained. But it is necessary previously to point out, in a few words, the various mistaken opinions which have been at different times adopted in mineralogy, as to what was to be understood by the importance of a character, of a property, or of a set of properties.

§ 31. In minerals, according to all the ancient mineralogists, and also their successors, the most useful and precious of the constituent parts were considered as the most important: hence those lead and copper ores containing a minute proportion of gold or of silver, were classed in the genera Gold and Silver; hence the assigning a greater importance to the element forming the base in a chemical combination, because it is in general the most useful in the arts; hence, in fact, the greater importance given to the abstract idea of substance, than to the physical and external properties of minerals.

§ 32. At a later period, and when it was first attempted to introduce into the study of mineralogy something of that philosophical reasoning that had been found so advantageous in the other branches of natural history, the first step was to fix what was to be understood by the term *Species*, which gave rise to the everlasting controversy between the adherents of the chemical and those of the physical characters. The determination of mineral species was the field of battle of the two contending parties. And it is curious to observe, that what was meant by a classification of minerals founded on chemical composition, or on crystallography, or on external characters, was not meant of the whole of the system or method, as it would have been the case in zoology or in botany; for so predominating was the idea that abstract substances were the real subjects of the classification, that all the upper divisions were entirely chemical, but this distinction applied merely to the very subordinate notion of what was to be considered as characterizing the species in general.

Now, it is well known, that, in a classification founded upon the natural method, although it is certainly essential to have the notion of the species well defined, it is nevertheless true that the specific characters are among the less important; the most valuable being the characters by which the higher divisions are designated. How could, then, a justly celebrated French mineralogist assert, when speaking of common rock-salt, that the circumstance of its being composed of muriatic acid and soda, was a far more important character than its being soluble in water? Such a notion can be attributed only to these two circumstances,—namely, that with this mineralogist, as indeed with all mineralogists up to the present time, the abstract idea of the substance was in a manner every thing, while the other properties were considered so entirely subordinate to this idea, that the mere notion and designation of the substance seemed to him all that was required. Secondly, that he meant only to characterize rock-salt as a species; and, in fact, the notion of its being a muriate, was but a chemical character to distinguish, as a species, this substance from all the others of the chemical genus *soda;* and the character of having soda for its base, was nothing more than a specific character to distinguish the substance of rock-salt from all the other muriates.

In the eyes of a naturalist, on the contrary, solubility in water, connected as it is with many other characters, such as the action on the sense of taste, the frangibility, the low degree of hardness and of lustre, &c., is the connecting link of a whole order of beings, and hence must stand high in the scale of importance.

§ 33. We shall not stop here to prove, that the importance attached to a class of properties for its being the first to furnish the means of distinguishing minerals hitherto confounded, or of uniting others which had been erroneously separated, is too puerile to be here discussed. The fact that crystallography was the first to unite hornblende, tremolite, and actinolite, formerly separated from each other not only by the chemist, but also by their external characters, brought forward as a proof of the greater importance of crystallographical characters over the chemical and external ones, as well as the union of the telesie and the sapphire, so much boasted of by the chemist in the disputes about precedency, are matters of no consequence whatever in the opinion of the naturalist, although they may have some small degree of interest as connected with the history of the science itself.

§ 34. There still remains to be noticed another error into which mineralogists have been often inclined to fall,—it is that of giving to a character or property a degree of importance proportioned to the difficulty experienced, to the labour bestowed, and the ingenuity displayed by the observer or experimenter in discovering that property. A false analogy between circumstances apparently alike, but really quite dissimilar, seems to have given rise to such a mistaken idea. In the study of the animal kingdom, it is generally found that the most important organs are not those which appear at the surface, but those which are concealed in the deep recesses of the interior of the animal. But it is not because such organs as the heart and the brain, for instance, are more difficult to study, and require the knowledge, the labour, and the perseverance, of a skilful anatomist to be examined and described,—it is not because latent and of difficult access that they are reckoned more important than the superficial organs, which are easily perceived; but it is as being indispensably necessary to the very life of the animal, as being essential to the most important organic functions, while the external organs appear to be mere accessary dependencies, which may even be sometimes suppressed, without the life of the animal being endangered. Now, if because the constituent elements of minerals, equally latent, equally difficult of access, some of which existing only in very minute proportions, requiring to be brought to light the most persevering and laborious efforts of a skilful chemist, were supposed more important than external properties easily ascertained, it is clear that the analogy would be overstrained. It would be true if it was demonstrated that those elements are more necessary to the existence of the being itself than the more external properties.

§ 35. In what, then, does the relative value or importance of characters consist? The idea of the relative importance of characters is a complex one; it is a compound of the consideration of the dependence existing from more particular properties to more general ones, and at the same time it takes into account the relative number of less important characters subordinate, as well as the relative number of species, genera, families to which the property to be evaluated is common as a character; in such a way that a character will be reckoned the more important as it is the more general, as it has under it a greater number of subordinate characters, and also as it is the common tie of a greater number of species, genera, and families. In comparing different characters as to their relative importance, it must be understood that the characters compared must belong to the same nature of properties, so that properties relating to the crystalline form should not be compared to chemical properties, and *vice versa*.

Thus in relation to the form of crystals, the shape and size of the faces in a secondary crystal are characters of very little importance, when compared to their number, their position in regard to the axis, and their mutual incidences; even these external limitations of secondary crystals are of smaller value than the determination of the fundamental form as given by the cleavage; lastly, the consideration of the system to which the fundamental form belongs, is of a much higher degree of importance than the specification of the fundamental form itself. Under such a point of view, the arrangement of the crystallographical characters, according to their relative value, will be as follows, beginning with the most important: 1*st*, the system of the fundamental form, and accordingly the optical properties as to refracted and polarized light; 2*d*, the particular fundamental or primitive form, and with it the cleavage, and other considerations, by means of which this form is ascertained; 3*d*, the derived or secondary form; 4*th*, and lastly, the accidental variations in shape and size to which the limiting planes of secondary crystals are often liable.

It is easy to see that, by analogous means, similar distinctions may be introduced into the other sets or series of properties, either chemical or physical.

§ 36. But there is another way of judging of the importance of characters, which, although rather of an empirical nature in the present state of the science, is nevertheless very useful, as throwing a new and essential light on the subject. Though the nature and the cause of the connection existing between the chemical composition and the physical properties of minerals is quite unknown, experience has often taught us that such a connection really exists. Nothing shows more clearly this fact, than observing the same minerals assembled close to one another, in two methods so entirely dissimilar as to their principles, as that of Mohs, and the last arrangement of mineral substances according to their electro-negative elements of Berzelius. The very same minerals which in Mohs's system, founded entirely on physical characters, to the complete exclusion of chemical composition and chemical properties, are assembled in the orders *Erze* (ores), *Metalle* (metals), *Kiese* (pyrites), *Glanze* (glances or galenas); are also found joined together in the simple metals, and in the families Sulphur and Oxygen of Berzelius's arrangement, founded solely on chemical composition. Now, in such a case, the physical characters common to all the members of such chemical groups, will be more important than the more particular or individual ones; and at the same time, the chemical element common to the composition of the members of each of these groups will be considered more important, and the chemical or mineralogical character, by which the presence of this element is denoted, of greater value, than the elements which belong only to one or to a few of the members of the same groups. It is by means of such considerations that the greater importance of the electro-negative element in the combination over the electro-positive will be established; and in this way the chemical characters which indicate the presence of the electro-negative element, as well as the physical ones, such as nature and degree of lustre, of translucidity, of hardness, which appear to hold some connection with that element, will be reckoned more valuable than the specific gravity, the colour, and in some cases the variety of crystalline form, which seem rather more connected with the base or electro-positive element of the substance. These instances will be sufficient for our present purpose, which is not to dwell on details, but only to point out the more general leading principles of our inquiries.

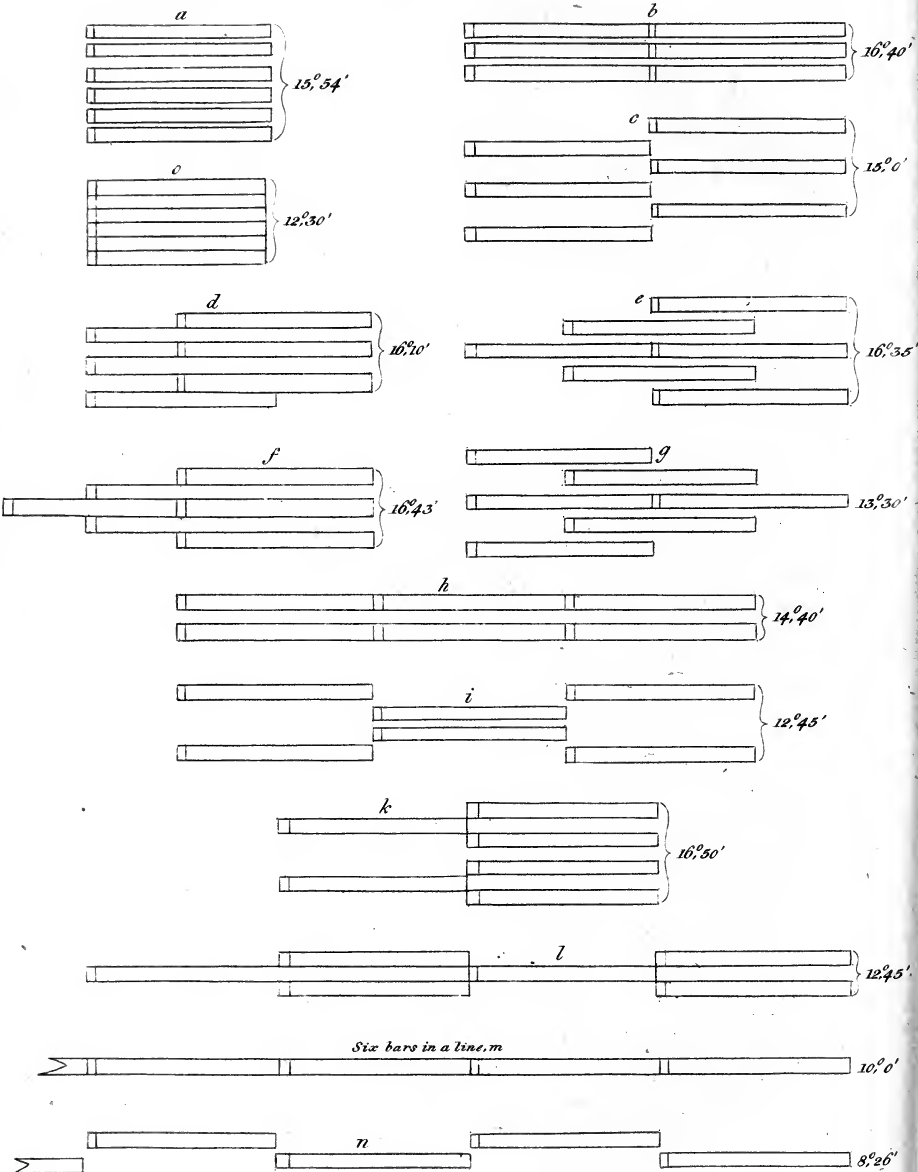
Sect. III.—Principles of classification.

§ 37. Mohs is one of the first mineralogists who has treated mineralogy as a branch of Natural History. If by setting aside some of the most important considerations and characters, the chemical ones, he has been prevented from attaining the natural method, it is to be observed, that he at least made an attempt to obtain this object; and what is worthy of remark, he proceeded in his classification according to the method of general comparison, introduced into botany by Adanson, as the first step towards a natural and philosophical arrangement of plants. He, in imitation of Adanson, first formed as many series or artificial systems as he had characters, and then disposed in the same orders those minerals which he had found to come near each other in the greater number of those series or systems.

But here the vices which have been pointed out by De Candolle, in what he has called the method of general comparison, were fully exemplified, and though Mohs has in some cases, as we have mentioned before, hinted at some very natural orders or families, the greatest part of his divisions shows his want of acquaintance with the notion of the subordination of characters; and by the omission of the chemical properties, his system has become more than any other liable to the strong objections urged by De Candolle against all the methods of general comparison, viz. that of never embracing all the characters and all the points of view under which those characters may be considered, and that of attributing to all the characters the same degree of importance, and to all the points of view the same degree of interest.

§ 38. We are now to point out in a very summary way the chief principles, which have guided us in our attempt to introduce into mineralogy a method resting on the subordination of characters. We shall not at present insist on what is but an application of the rules laid down in the preceding section, as the following sketch of the first divisions of the classification will afford practical examples of what would be here mentioned theoretically. But it is necessary to bring under the notice of

Fig. 3.



E. Mitchell Sculpt.

the mineralogist a most important consideration, which has been our chief guide in the formation of the divisions and subdivisions, from the first or more general, down to the lowest or most particular.

§ 39. There are two great and distinct points of view in which minerals may be considered, or in other words, there exist two distinct systems of mineralogical characters, the chemical and the physical, in each of which systems there are more or less important characters. Now, a certain number of mineral individuals possessing at the same time the same important physical characters and the same important chemical properties or analogies, may be said to be very closely and naturally allied together. If these important chemical and physical characters which are common to such minerals are found at the same time to be distinctive characters, and to belong only to those very same individuals, and not to others, then the groups comprising all those minerals will be found to be very natural groups; and as our purpose is to establish as many as we possibly can of these natural groups, we will in all cases make a strict rule never to assemble in the same group, whether large or small, minerals which shall not have in common the same important physical and chemical characters.

§ 40. But as it happens, though happily in a small number of cases, that minerals distinguished from all the others by their physical characters, may be found to exhibit no chemical difference from those belonging to some other group, and *vice versa*, as for instance arragonite, which differs so much in its crystalline system as well as in hardness, and in the effect of the blowpipe, from calcareous spar, though a real chemical difference has not yet been satisfactorily found between those two minerals; and as the same thing takes place in regard to a much more important group, namely, the metallic sulphurets of zinc, mercury, arsenic, and of antimony and silver (red silver ore), comprised in the order *Blende* of Mohs, so different in their translucidity and their semivitreous semimetallic appearance, from all the other opaque and true metallic sulphurets, it is necessary to point out what is to be done in such cases.

Undoubtedly, such minerals ought first to be separated from those which exhibit a difference with regard to one or other of two principal systems of characters; for as we have just seen, we are not allowed to assemble in the same division, minerals differing in their chief characters. In this way separate groups will be formed of such anomalous individuals, species, genera, orders, &c.

§ 41. But now comes the question,—When we are called upon to dispose of these anomalous groups in the classification, and to join them in superior divisions with some other groups, shall we associate them with those resembling them by their physical or by their chemical properties? Now such a question cannot be answered *a priori*, for, as we have seen before, the chemical properties and composition, as well as the physical characters, are both essential to the existence of a mineral individual, and in this respect none has a right of pre-eminence over the other.

It is then necessary to examine these two distinct systems of properties, and to see whether they possess the same degree of accuracy, of certainty, and of independence, of every consideration foreign to themselves, and to give in doubtful cases the pre-eminence to the most certain, and the most independent considerations. Now in this respect, we do not hesitate to say that the physical characters must be preferred.

In these characters there exists an evidence so simple, so immediate, so palpable, that their manifestation becomes obvious to all those who consider them in the manner pointed out by the first observers; and hence it happens, that although now an unprecedented degree of accuracy has been given to the physical and external characters, it is nevertheless to be observed that the descriptions and observations of more ancient mineralogists as Werner and Haüy, deficient as they are in that minute accuracy now required, continue still to be true as far as they go, so that Werner's descriptions, as given by his disciples, Jameson, Brochant, &c. may still be applied to the minerals for which they were intended. They have been extended, improved, and rendered more accurate, but they have never been proved to be false and consequently useless.

The case is different with the notions entertained in regard to the chemical composition of minerals, for the progress of knowledge on this subject has shown not only that the ideas of more ancient chemists but also their analyses, are so deficient in accuracy as to have rendered them now quite useless; and this observation is not limited to chemists of the last century; the analysis given of the *Wavelite*, of the *Uranite*, &c. under the sanction of very celebrated names, shows that an appeal can always be made to a more enlightened chemistry from the first decisions of a less advanced chemistry. In such a case it is quite natural that, when we see the minerals differing from each other in important physical characters, while chemistry cannot at the moment show any material difference in their composition, we should, guided by strong analogies and probabilities, still wait for the last decision of a better informed chemistry *.

§ 42. Besides their greater certainty, the physical properties or characters derive from their total independence of any anterior or auxiliary chemical notion, a great advantage over the considerations belonging to chemical composition or properties. It is known that a mineral can be perfectly characterized without any reference whatever to its composition, and Mohs's whole classification would be a proof, if wanted, of this assertion. Now, chemistry is far from being able to boast of such an independence of physical considerations. In the first place, the very idea of a chemical essay, either by the blowpipe or by any other method, or of an analysis, implies, as a matter of course, that the small portion of a physically homogeneous body, submitted as *pars pro toto* to the essay or the analysis, is a true representation of the whole; and such a notion is a strong though tacit acknowledgment of the dependence which binds the chemical researches to the consideration of physical properties, for it

* That such opinions have been maintained by some of the first rate chemists themselves, the following quotations will prove. " Il faut avouer que si la minéralogie tire de grands avantages de la docimasie, la premiere avertit à son tour le chimiste, soit par la structure du minéral, soit par quelque autre phenomène exclusif, quil y a dans ce corps quelque chose de nouveau à découvrir; et c'est ce qui est arrivé plusieurs fois entre ces deux sciences."—(*Vauquelin*, Jour. des Mines, No. li. p. 192.) " Les caractères des corps dépendent entierement de leur composition intérieure, de manière qu'une difference dans la composition en entraine toujours une dans les caractères."—(*Berzelius*, Nouveau Systeme de Minéralogie, p. 6, et *corrigenda*, p. 311. Hence, the inverse must of course be equally true, that a difference in the characters must be attended by a difference in composition.

is only by these last properties that the identity of matter between the portion of a mineral submitted to analysis, and the remaining parts of the specimen, as well as all other minerals of the same description, can be established. Were it not so, as the part analysed has been entirely dissipated and destroyed, we could know the chemical compositions only of bodies which have ceased to exist, without being able to draw from such a knowledge any inference as to the composition of still existing bodies.

Moreover, chemistry cannot proceed in its own especial purpose, without employing physical considerations, such as colour, hardness, crystalline forms, &c. to characterize the productions of its decompositions and recompositions, the precipitates, the solutions; and it is, by-the-by, a singular contrast to see chemists holding so lightly the physical properties which are distinguishing characters of natural bodies, while they give them a great weight when they are to characterize their own artificial productions.

§ 43. From the whole of the above mentioned considerations we conclude, that in those cases where the physical and chemical properties are found at variance in the same group of mineral individuals, the preference shall be given to the physical characters, until chemistry shall have clearly pointed out the cause of this difference; but, at the same time, it must be clearly understood, that such groups only in which all the members agree together, and at the same time are distinguished from all other groups by the same physical as well as chemical characters, are to be considered as strictly natural divisions.

§ 44. Let us now trace the plan of the divisions of the classification from the lowest to the highest, and, in so doing, let us not forget that we are to submit to our method only individuals in their perfect state, isolated and not aggregated one with another, that is, simple crystals supposed complete, perfect, pure, and possessing all their qualities or properties. By this mode of procedure we get rid of the greatest of the difficulties which has always beset those who, classing abstract substances, whatever external shape they might assume, were obliged to find a character common not only to all the perfect crystals composed of the same species of substance, but also to the mutilated, averted, deformed, and rolled; to those acicular, radiated, fibrous, and granular masses, which are nothing else, in fact, but groups of more or less imperfect crystals of a similar substance; or to those amorphous and compact uncrystallized masses, which, on reasonable induction from analogies, and often from observed facts, may also be considered as groups not only of microscopic, but rather, if we may say so, of molecular crystals, invisible to the eye even armed with the most powerful instruments, such amorphous masses being often formed of a pure homogenous substance, or of individuals of the same chemical nature (amorphous quartz, chalcedony, limestone, gold, platina, &c.), or being often formed of an intimate mixture of two different substances, or of two sorts of individuals, each of a different chemical nature (agates, jaspers, coloured marbles, &c.)

Now, in zoology or botany, no one has ever thought of admitting into the classification which comprehends only individuals in their most perfect states, all the mutilated, imperfect, and diseased animals or plants which may occur in nature, still less to give a place to herds of animals, with the animals which compose them, to forests of trees, either of one or of various species, to heaps of decayed wood, with the different species of trees which botany has to describe. Such, however, is what has always been done in mineralogy.

But here comes the objection,—if we admit in the classification nothing but single and perfect crystals, we shall leave out of the domain of mineralogy, a very great part of what has always been thought to belong to it. Were it so, we maintain that there is now a sufficient quantity of known crystals, differing from each other in shape or substance, to render their consideration and arrangement worthy of the attention of the natural historian. But it will be shewn hereafter, that by a suitable employment of appendices to the classes, families, genera, &c. for minerals differing from the other ones, but not yet found in perfect crystals, and, by mentioning historically after the description of each genus or of each species, the most ordinary modes in which individuals, small or large, microscopic or molecular, perfect or mutilated, are assembled together in groups, we shall have in fact enumerated the same bodies which all other works on mineralogy describe; but only in giving them their proper place, in distinguishing what is to be distinguished, and in preserving unsullied by heterogeneous mixture, a method which must confine itself to simple, pure, complete, and perfect individual beings.

§ 45. We now begin our account of the divisions of the classification, by ascertaining accurately the nature of the more important among the lowest of these divisions, that is the *species.* We have already noticed that this problem has been always a field of contention among mineralogists. Tacitly agreeing, as it appears upon one point, that the abstract ideas of substance or chemical composition, were to be the subjects they had to arrange on their classification, they seem also to have agreed that all bodies of the same chemical composition, or similar in their substance, should be considered as belonging to the same species, and the dispute was merely about which of the chemical, the physical, or the external characters, were the surest, the readiest, or the most convenient means of ascertaining differences or similitudes of chemical composition in minerals.

Under the idea that substance was the chief object of consideration, it is not to be wondered that the various forms and physical qualities which any substance could assume, should have been regarded as unimportant, unessential, and, as it were, merely accidental attributes, and that such accidents would have been looked upon as mere varieties of definite species; though it appears to us rather difficult to understand how form could ever be considered as a variety of substance.

§ 46. Very different will be our point of view when we are to class, not abstract ideas, but real and positive individuals, in which form as well as other physical properties are as essential attributes as chemical composition. Here we will find ourselves on the same ground with the zoologists and botanists, who compare together their various animal or vegetable individuals, and we will proceed in conformity with their principles.

§ 47. Their object in collecting all the individuals in a certain number of groups, of which the lowest are comprised in the highest, is to assemble together those beings which resemble each other more than they resemble those of other species, genera, order, classes. Such a definition is applied to species in regard to other species, to genera and orders in regard to other genera and orders, but it is of too general and too vague a nature not to require some more precise indications for each particular sort of division.

§ 48. Accordingly we find, that those animals or plants have been considered as belonging to the same species, which have been found on comparison to be so like each other, as, to use Haüy's expressions, to be distinguished only by separate existence, or in which each individual may be supposed to represent the whole species, provided, however, due allowance is made for the differences arising from the sex and the age of the animal, and the season of the year in which it happens to be living; so that individuals should be compared only with individuals of the same sex, of the same age, and living at the same epoch. But even such a definition, though much more accurate and precise than the preceding, would still be thought deficient in completeness and accuracy; if the expression of a general law of nature, including as a consequence all that has just been alluded to, had not been found to answer all the purposes of the most philosophical naturalist. This law is that of reproduction, by which individual beings are incessantly generated, perfectly similar to the parents from which they originate: so that the individuals belonging to the same animal or vegetable species, are supposed to be descended from parents similar to them, and differing from all others. In this case, and when a clearly and precisely expressible law is made to comprehend all the individual beings which are members of the same species, the differences existing among them, which cannot be accounted for by any expressible law, and which, by their small importance, and our ignorance of their causes, may be looked upon as accidental, will be ranked only as characterizing mere varieties, either constant or accidental.

§ 49. Now, by the very nature of the beings belonging to the mineral kingdom, no such thing as reproduction exists in minerals, so that this particular law cannot afford us any aid; but the more general fact of individuals being supposed to belong to the same species, as soon as they may be brought together under the expression of some definite law, will easily find its application as well in the unorganized as in the organized world. In this way crystals agreeing together, as well in chemical composition as in their form, not, however, primary or fundamental form, but in their actual form, be it secondary or analogous to the primitive, will be reputed to belong to the same species, because the law which indicates their composition may be clearly designed by a chemical or mineralogical formula, and their form by a more or less complicated, but always precise crystallographical symbol or definition, being itself a law, or an assemblage of crystallographical laws.

§ 50. In such a case, the greater or lesser extension assumed in different crystals of the same form, by their limiting planes and the geometrical form of these planes being determined by circumstances apparently so accidental and so particular as are not capable of being brought under the expression of any general law, will be considered by us as mere *varieties;* differences of colours in individuals of the same species, when they are produced by the presence of some ingredient in too small a proportion to be included in the chemical formula, will also rank as varieties.

§ 51. Thus, according to our views, the *primitive* or *cubic*, the *octahedral*, and the *triform*, galena or sulphuret of lead, will be three distinct species of crystals, while the three different aspects which this last species, the *triform*, may assume, viz. a cube or an octahedron with truncated edges and angles, and a rhomboidal dodecahedron with all its angles truncated, will be only varieties of the same species, being merely accidental and unimportant modifications of a general form, otherwise determined by precise laws.

Likewise the regular six-sided prisms and the six-sided pyramids of corundum will be two distinct species of crystals; but the blue or red colour which such crystals may exhibit, will only characterize a variety, for the quantity of oxide of iron, by which this colour is produced, is too small to appear in the formula $\ddot{A}l$ or *Al*, which denotes the chemical composition of the corundum.

§ 52. Some objections will assuredly be made against the new view we have offered of the mineral species, and the chief of these objections must be answered in a few words. First, the great number of crystalline forms belonging to many of the mineral substances; secondly, their very small relative interest or importance; thirdly, the difficulty and complication attending the description, and even the definition, of many of these crystalline forms, will be objected against their being made the types of our notion of mineral species. We shall only point to the organized kingdom, to show that similar objections might equally be made to the notion of animal or vegetable species. What can be more numerous than the species contained in the genera *Sylvia*, *Muscicapa*, *Psittacus*, *Fringilla*, *Anas*, &c. in the birds; *Helix*, *Conus*, *Tellina*, *Venus*, &c. in the mollusca; *Geranium*, *Erica*, &c. in the plants; and what a small degree of interest and importance is attached to the greatest part of the specific distinctions in those genera? Nevertheless, such considerations have never induced naturalists to alter the notions of the species.

As for the difficulty and length of the description of secondary forms, we would refer to the chief monographs in zoology and botany, and especially to Temminck's or Bechstein's description of European birds, and ask whether it would not be possible, even by a verbal description, to characterize in less space the most complicated crystal, than an animal or a plant, not to speak of the use of such crystallographical symbols as those of Haüy or Mohs, which would abridge and simplify con siderably such definitions.

Another much more plausible objection would be to point to the crystallographical laws themselves, or to the simple forms of which, according to Haüy, and especially to Mohs, each complicated form appears to be composed, as more proper to be assumed as the mineral species. In this objection we can but see a confusion of abstract ideas, with positive beings, and a wrong application of a method valuable surely in abstract sciences, but quite opposite to the spirit of natural history. The method of analytical abstraction followed by mathematical combination, is entirely foreign to natural history, and is perhaps too simple a contrivance for the manifold purposes and points of views which this science entertains. However, it may be well for us always to remember, that positive and really existing beings are the only objects of the contemplation of natural history; and surely nobody will pretend to say that, in the *triform sulphuret of lead*, the three simple forms, the cube, the octahedron, and the dodecahedron, which are supposed to be combined in this compound form, have, or ever had, any existence independent of the triform individual crystal.

§ 53. Having thus limited our notions of mineral species to crystals of the same actual form and composition, and that of varieties to modifications purely accidental, and not referable to any law, we proceed to the notion of genera. The genus will be a collection of species, having the same fundamental or primitive form, and the same chemical composition. Such a definition, which holds good for the greater number of genera, must be modified in those cases in which, by the substitution of isomorphous bases for one another, the general formula remaining the same (Vide Wachmeister's Analyses and Formulæ of Garnets), the particular formulæ are different, and at the same time the fundamental form remaining the same in kind experiences some variations in the angles. For such cases the particular formulæ, when the isomorphous bases manifest their presence by some mineralogical character (colour, specific gravity, effect of blowpipe, &c.), or only by a difference in the angles of the primitive form, will give rise to as many *sub-genera*, included in a great genus characterized by the general formula or the corresponding mineralogical characters, and by the general nature of the primary form. Thus the *tremolite*, *actinolite*, and *hornblende* will be subgenera of the great genus *Amphibole*; and all the rhomboidal, simple and compound, carbonates of lime, of magnesia, of iron, of zinc, and of manganese, will be subgenera of the great genus *Spar*. As for *Arragonite*, in compliance with the general rules before proposed, it will constitute a genus independent of the calcareous spar, as the individuals of that genus are very different in secondary and primitive forms, as well as in other physical characters.

§ 54. The families will be collections of genera, having, beside a common electro-negative element, some remarkable common physical or chemical characters, varying according to the classes and the orders to which they belong, but which give to the members of each family striking features of likeness. The subdivision of orders into families does not take place in such orders as are composed of genera in so small a number, and so like each other that the characters of the family would be the same as those of the order; but this subdivision may, at future times, by the increase of the genera of these orders, be made convenient and even necessary.

§ 55. The orders will be formed in some classes of genera having the same electro-negative element, whether its presence and particular nature be indicated by a chemical character, and especially by the blowpipe, the most ready and simple test for such elements, or when such mineralogical character may not be found, by an assemblage of characteristic, physical, or external properties. In other classes, where a greater resemblance prevails among the genera, a common important chemical property and mineralogical character, will be the tie which will bind together in an order many families, having each a different electro-negative element.

The existence of isomorphism, though much less frequent between acids or electro-negative, than between bases or electro-positive, elements, will sometimes require the establishment of suborders, as well as the absence or presence of water of composition in the chemical combination. The blowpipe affords an excellent character to ascertain this last fact, and the hydrated substances offer generally very essential distinctive characters in their inferior hardness, and specific gravity, and in their easier frangibility, as well as in their form, from substances composed of the same elements, but anhydrous.

§ 56. It remains for us to find for the highest divisions or classes, some great and general characters, comprehending whole groups of orders, which agree at the same time in their general composition, and in some common and distinctive physical properties. We must remember that here, as well as in the other lower divisions, it ought to be positive characters immediately belonging to the individuals themselves, and not properties of one or other of their constituent parts or elements, or abstract notions of the nature of their chemical composition, as has been hitherto done.

Now, we find that a great part of the orders are composed of individuals chemically formed of combustible or inflammable substances, either alone or combined with each other, and containing none of those substances by which combustion is supported, such as oxygen, fluorine, and chlorine, and that by far the greater number of genera of this description (69 out of 77, or nearly $\frac{9}{10}$ths) agree together in possessing a complete metallic appearance and lustre, as well internally as externally, and at the same time perfect opacity and some characteristic electrical properties. On the other hand, we find that a still greater number of orders are composed of individuals containing either oxygen, or fluorine, or chlorine combined with combustible substances, and that out of 207 genera of this description, 189 or $\frac{9}{10}$ths are deprived of any true metallic appearance or lustre, and possess transparency, or at least more or less translucidity and electrical characters quite opposite to the other series of genera.

In following this indication, we ought first to divide the mineral kingdom into two great classes; the one class composed of individuals which, with a true metallic appearance and complete opacity, contain no substance supporting combustion, as oxygen, fluorine, or chlorine; the other class of individuals, destitute of any metallic appearance, possessing more or less translucidity, a lithoid aspect, and containing oxygen, or fluorine, or chlorine. These two very natural classes will comprehend 258 out of 284, which is the total number of known genera, or the $\frac{10}{11}$th part of the existing genera.

Of the remaining 26 anomalous genera, 24 possess at the same time something of the metallic and something of the lithoid appearance, combining metallic lustre and transparency, or an earthy streak and powder. Some are metal-like oxides, the others are transparent bodies with some remaining metallic lustre, that do not contain any elemental supporter of combustion, being considered pure metallic sulphurets. Such a group, comprising only the $\frac{1}{11}$th part of the existing genera, will, as an artificial class, be placed between the two preceding natural ones, and remain there until chemistry, by further investigation, shall point out the cause of these anomalies. The same thing will be said of the two remaining anomalous genera, which, although containing no oxygen, yet being completely transparent and having a true lithoid appearance, ought to be artificially, it is true, but provisionally, brought near to the class of which such physical properties are the distinctive characters. They will be separated from this class and formed into a distinct class, of which their common property of being inflammable will be the distinctive character. This small artificial class will form a connecting link between the artificial class, already mentioned, and the class of the lithoid-like minerals containing oxygen, &c.

A division which will also be thought rather artificial, because we have yet no true chemical reason to account for the distinction between the bodies which are possessed and those which are deprived of the property of solubility in water, must be introduced in the class containing the lithoid oxides, fluorides, and chlorides, on account of the great influence which such property appears to have on many of the physical characters. Such divisions or subclasses, as well as the introduction of the two intermediary artificial classes, are quite necessary in the present state of the science, but may be expected to experience great modifications by its future progress.

§ 51. We can now see, according to the view we have taken of the distinctive characters appropriated to the different divisions of the mineral kingdom, how minerals, which are not found in perfect crystals, may nevertheless be made to appear at their proper place as appendices to the classification. For, although such minerals may be deprived of their specific characters, if they are cleavable and have a crystalline structure, their genus may be characterised. Were they even deprived of crystalline structure, and appear in the shape of compact masses or groups of molecular individuals, the manifestation of their electro-negative element by some chemical or physical character, and their other characteristic properties, would afford the means of assigning to these otherwise unknown individuals the family, the order, or at least the class, to which they appear to belong. In like manner, when the characters of such imperfect minerals do not agree completely with any of the genera, families, or orders already established, they may be made the types of new genera, families, or orders, in the same way as in zoology or botany, a single insulated organ, or part of an animal or plant, may be often sufficient to establish a new genus, order, or family.

The new species and genera of fossil animals or plants have had their place assigned in the method, although not a single complete and perfect individual of them has ever been found.

SECTION IV.—NOMENCLATURE.

We shall be very brief on this subject; and, as our present purpose is merely to establish the higher divisions of the classification, we shall say nothing of the nomenclature to be adopted for varieties, species, and genera. As to these last, which agree with what are at present called the mineral species, we will not change the names, observing, however, that it would be highly desirable that each genus should be designed by a single word; and, when such is the case, we shall willingly avail ourselves of it, in adding to it, however, the most usual synonym.

As for the names of families, we have followed the method used in Zoology and Botany,—that of giving them the name of the genus which may be considered as the best type of the whole group.

For the orders and sub-orders, founded as they are, in general, upon the electro-negative element of the combination, or on an important chemical property, the name ought to recal to the mind the nature of this element or this property; but its termination must be different from that of its chemical name, to prevent our purely natural-historical nomenclature being confounded with the chemical one. For instance, instead of naming those minerals of which sulphur is the electro-negative element manifested by the blowpipe *Sulphurets*, we will call them *Sulphurideous Crystals*; the *sulphates*, *Sulphatideous Crystals*; the *silicates*, *Silicideous Crystals*, &c.

In the classes or subdivisions of them, the name will indicate the nature of the most characteristic chemical or physical property, as *hydro-lysimous*, soluble in water; *alysimous*, insoluble; *inflammable*, burning with flame; *metallophanous*, having the metallic appearance; *lithophanous*, with the lithoid, or stony appearance; and the name of *amphiphanous*, possessing at the same time the two sorts of appearances, will be given to the crystals composing the intermediate artificial class.

CLASSIFICATION.

CLASS I.—*METALLOPHANOUS CRYSTALS.*

(*Chemical Nature.*—Substances containing neither oxygen, nor fluorine, nor chlorine.)

Metallic appearance and lustre; streak always metallic. Opake even in the purest state. Conductors of electricity or anelectrics.

Order I.—NATIVE METALS.

(*Chem. Nat.*—Simple metals, sometimes mechanically mixed one with the other.)

Possessing the characters of the simple metals employed in the arts; when pure, not susceptible of decomposition, and indicating the presence of but a single element. With the blowpipe infusible, or fusing without alteration, or volatile without any residue.

Family 1.—Malleable Metals.

Capable of being flattened with the hammer, or cut by the knife into flexible laminæ.

Genera.—Platina (with ferriferous platina); gold (with argentiferous gold*); silver (with auriferous silver); copper; iron.

(*Appendix.*—Palladium; lead ?).

Family 2.—Brittle Metals.

Falling into fragments when struck by the hammer, and torn into hard grains by the knife.

Gen.—Bismuth; antimony (with arseniferous antimony).

(*Appendix.*—Tellurium; arsenic).

Appendix to the Order.—Metal liquid at the ordinary temperature. Quicksilver.

Order II.—ALLOYS.

(*Chem. Nat.*—Combinations of simple metals with one another).

Capable of being decomposed either by fire or by acids into two metallic elements, and in both cases leaving as residue a simple metal: with the blowpipe in the open tube affording no smell of sulphurous acid, and not turning Brazil wood paper placed in the tube white.

Family 1.—Argyrideous.

Ductile; not affording with the blowpipe either smoke, smell, or sublimate.

Gen.—Electrum (Klaproth).

Family 2.—Hydrargyrideous.

Brittle; with the blowpipe in the open tube and in the matras affording a

* Except *Electrum*, which has characters indicating a true chemical combination; while the common native gold, holding variable quantity of silver (Boussingault and Michellotti), appears a mere mechanical mixture.

sublimate of quicksilver, in small globules, without smoke or smell.

Gen.—Amalgam (dodecaedral mercury, or native amalgam).

Family 3.—Arsenideous.

Brittle; with the blowpipe in the open tube, and sometimes even in the flame of a candle, or only by percussion, affording smoke, having the smell of garlic.

Gen.—Arsenic cobalt (*Weisser speiss kobalt*, Werner).

(*Appendix.*—Arsenical nickel (copper-nickel); arseniuret of iron).

Family 4.—Stibideous.

Brittle; with the blowpipe in the open tube giving out white smoke, with a pungent smell. This smoke, which covers the sides of the tube, may be driven from one part of it to another, by the application of heat, and does not leave any traces.

Gen.—Antimonial silver (with arsenical silver).

(*Appendix.*—Antimonial nickel).

Family 5.—Osmideous.

Brittle; with the blowpipe in the open tube affording neither sublimate nor smoke, but only a pungent smell like chlorine.

Gen.—Iridosmine (alloy of iridium and osmium).

Family 6.—Tellurideous.

Brittle; with the blowpipe in the open tube affording much smoke, which adheres to the sides of the tube in the shape of a white dust, capable of being fused and transformed, when heated, into transparent colourless drops. These drops are sometimes microscopic.

Gen.—Graphic tellurium (*Schrifterz*, W.); yellow tellurium (*Weiss sylvanerz*, W.)

(*Appendix.*—Molybdan silver of Klaproth (*Tellur wismuth*, Leonhard); Tellur silver of Rose (*Tellurium silver*); telluret of lead, G. Rose. Native bismuth of Esmarck, or *tellure selenié bismuthiferè* of Haüy.

Appendix to the Order Alloys.

Family Selenideous.

With the blowpipe in the open tube affording a red sublimate, accompanied by a strong smell of rotten radishes.

Seleniuret of copper; eukairit or seleniuret of copper and silver; seleniuret of lead; seleniuret of lead and cobalt; seleniuret of lead and copper; seleniuret of lead and mercury; seleniuret of silver Ag Se^2; other seleniuret of silver Ag Se^2. Other seleniuret of silver Ag Se, Pb. Se. *Silber phyllin glanz* of Breithaupt. Seleniuret of mercury (*Selen quesksilber* of Karsten ?).

Order III.—PYRITES.

Chem. Nat.—Metallic sulphurets.

With the blowpipe in the open tube giving out the smell of sulphurous acid, or turning moistened Brazil wood paper, white, introduced in the superior part of the tube. Many give out a sulphurous smell by mere friction. Lustre generally strong and specular, either externally or internally.

Family I.—Pyrites.

Fracture seldom lamellar, generally uneven, granular, or small conchoidal. For the most part hard, scratching felspar, or at least calcareous spar. Specific gravity from 6.5 to 4.1. External lustre generally more splendent than the internal.

† *Hard (not scratched by steel) and compact.*

Gen.—Iron pyrites; white iron pyrites; arsenical pyrites (with *Weissenerz*, W., or argentiferous arsenical iron).

† † *Hard, with foliated structure.*

Gen.—Cobalt glance (with sulphuret of cobalt (*Wernekink*), and bright or silvery white cobalt); magnetic iron pyrites; tin pyrites.

† † † *Soft (scratched by steel) and compact.*

Gen.—Copper pyrites; grey copper ore (with arseniferous grey copper, antimoniferous grey copper, and arseniferous and antimoniferous grey copper).

Family 2.—Galenas or Glances.

Structure more or less foliated; fracture even, or large and flat conchoidal; generally soft, scratching at most calcareous spar or talc. Specific gravity 7.5 to 4.5. Internal lustre very strong; external generally weak.

† *Malleable.*

Gen.—Silver glance.

† † *Brittle.*

Gen.—Brittle silver glance; lead glance (with argentiferous, seleniferous, bismuthiferous lead glance, and *Weissgultigerz* or white silver); Bournonite; black tellurium ore (*Nagyager-erz*, W., or *Blättertellur*, Leonhard); copper glance, or vitreous copper ore; Tennantit; bismuth glance (with bismuthiferous bismuth glance, or *Bismuth sulfureux*, Haüy; cupriferous bismuth glance, and *Nadelerz*); sulphuret of nickel, or capillary pyrites; grey antimony; sulphuret of molybdena.

Appendix to the Family Glances.—Cupriferous grey antimony, with endellione or Bournonite of St Harey; nickeliferous grey antimony; Jamesonite; Zinkenite; Haïdingerite (Berthier); Polybasite; flexible sulphuret of silver (Bournon); prismatoid copper glance (Mohs); Sternbergite.

Appendix to the Order Pyrites.

Nickel glanz (Berzelius); arsenic glanz (Breithaupt); alloy of nickel and antimony (Brard), or sulpho-antimoniuret of nickel (Beudant); *Axotomer arsenic kies*, or axifrangible arsenical pyrites (Mohs)?

Order IV.—GRAPHITES.

Chem. Nat.—Carburets or carbon mixed with iron or earthy substances.

Detonating with saltpetre; burning without flame or smoke. Specific gravity not exceeding 2.2. Very soft, scratching only talc, or at most gypsum.

Gen.—Graphite; glance coal (anthracite).

CLASS II—*AMPHIPHANOUS CRYSTALS.*

Artificial division, comprehending some metallic oxides and some metallic sulphurets; both agreeing in important physical characters, and distinct from the other oxides and sulphurets.

Metallic or adamantine metal-like lustre; streak and dust earthy; many are translucid, and even diaphanous.

ORDER I.—HEMATITES.

Chem. Nat.—Metallic oxides, generally the minimum of oxidation in metals, having many degrees of combination with oxygen.

With the blowpipe in the open tube affording neither vapour, nor smell, nor sublimate, and not turning Brazil wood paper white. Except only one (the red copper ore) none can be melted or reduced, without addition, with the blowpipe.

SUB. ORD. I.—EARTHY METAL-LIKE HEMATITES.

Opake in whatever state they may be. Dark coloured dust.

Family I.—ANHYDROUS EARTHY METAL-LIKE HEMATITES.

Not giving out water either by calcination or with the blowpipe in the matrass.

Gen.—Oxidulated iron, (with titaniferous, chromiferous, and zinciferous (Franklinite), oxidulated iron); axifrangible iron-ore, Mohs, (*Ilmenite*, Kupfer); Chrichtonite; Wolfram; Tantalite; black oxides of manganese (Braunite of Haussman, and Pyrolurite of Haïdinger?)

Appendix.—Protoxide of uranium, or pitch-ore; black cobalt ochre; Mohsite (Levy)?

Family 2.—HYDRATED EARTHY METAL-LIKE HEMATITES.

With the blowpipe in the matrass giving out water, and experiencing a change in their appearance or colour. Possessing in very small degree the metallic lustre, but capable of acquiring it when polished.

Gen.—Hydrate of iron, or brown iron-ore; hydrate of manganese, or manganite of Haïdinger.

Appendix.—Yttrotantalite?

SUB. ORD. 2.—VITREOUS METAL-LIKE HEMATITES.

Translucent either entirely or only on the edges, or in extremely thin laminæ. Dust-reddish, or reddish-brown, or light coloured.

Family 1.—INFUSIBLE VITREOUS METAL-LIKE HEMATITES.

With the blowpipe, without addition, not capable of being reduced or altered. Scratching apatite or glass. Not soluble in acids.

Gen.—Specular iron-ore; rutile, (with chromiferous and ferriferous rutile); anatase (octahedrite, Jameson); red oxide of zinc.

Appendix.—Brookite.

Family 2.—Fusible vitreous metal-like Hematites.

Capable of being immediately fused and reduced with the blowpipe. Soluble in acids. Scratching only calcareous spar.

Gen.—Red copper-ore, or ruby copper.

Appendix to the Order Hematites.

Polymignit (Berzelius).

Order II.—SULFURIDEOUS or BLENDE. (Mohs.)

Chem. Nat.—Metallic sulphurets, formerly supposed, for the most part, to contain metallic oxides, but now looked upon as entirely free from oxygen.

With the blowpipe in the open tube emitting the smell of sulphurous acid, and changing the Brazil wood paper introduced into the tube white. Scratching at most the sulphate of barytes, or only talc or gypsum. Capable of being acted upon by acids.

Gen.—Red silver; cinnabar; zinc-blende; red orpiment; yellow orpiment.

Appendix.—Red antimony; manganese blende.

CLASS III.—*INFLAMMABLE CRYSTALS.*

Chem. Nat.—Inflammable, not metallic elementary bodies.

Lithoid appearance, with a strong lustre; still retaining something slightly metallic. Burning at a greater or lesser degree of heat. Capable of acquiring electricity by friction, or idio-electric.

Order I.—SULPHUR.

Burning at the flame of a candle, with a blue flame, with a smell of sulphurous acid. Very soft. Scratched by calcareous spar. Dust-yellow; colour bright yellow. Acquiring negative electricity.

Gen.—Sulphur (with seleniferous sulphur of Vulcano).

Order II.—DIAMOND. (Carbon).

Requiring for combustion a very high degree of heat; at the 14th degree of Wedgewood's pyrometer dissipates in carbonic acid gas. The hardest of minerals, scratching all the others. Dust white; colour various, but generally light. Acquiring positive electricity.

Gen.—Diamond.

CLASS IV.—*LITHOPHANOUS CRYSTALS.*

Chem. Nat.—Metals or metalloids, combined with some substance which supports combustion, as oxygen, fluorine or chlorine.

More or less transparent or translucid, at least on the edges, or in very thin plates * No metallic lustre. Capable of acquiring electricity by friction, or idio-electric. The greatest part acquire the positive electricity.

* Even in the most opake-looking, the dust is white or light coloured, shewing that translucidity is their natural state.

DIVISION I.—ALYSIMOUS CRYSTALS.

Not sensibly soluble in water; harder and less brittle than rock-salt and alum; tasteless.

Order I.—ALUMINIDEOUS.

Chem. Nat.—Alumina and aluminates.

Insoluble in acids, and infusible before the blowpipe without addition. Completely soluble in the salt of phosphorus (double phosphate of soda and ammonia) into a transparent glass, which does not become opalescent, and without any transparent skeleton.

Sub. Ord. I.—ANHYDRO-ALUMINIDEOUS.

With the blowpipe in the matrass not giving out any water.

Family Gems.

Scratch quartz.

Gen.—Corundum; chrysoberyll ($A^4 S + 2 G A^4$ Seybert); spinelle (with pleonaste and gahnite, or zinciferous spinelle).

Sub. Ord. 2.—HYDRO-ALUMINIDEOUS.

With the blowpipe in the matrass giving out water, and becoming opake.

Family Diasporides.

Scratch only glass, some even with difficulty. Decrepitating with the blowpipe.

Gen.—Diaspore; hydro-aluminate of lead (plombgomme).

Appendix.—Gibsite.

Order II.—STANNIDEOUS.

Chem. Nat.—Oxides of tin.

Insoluble in acids; infusible by themselves before the blowpipe, but reducible with a strong reductive flame into white and malleable tin.

Family Stannolites.

Scratch glass. Specific gravity 6. Not giving water with the blowpipe in the matrass.

Gen.—Oxide of tin, or tinstone.

Order III.—SILICIDEOUS.

Chem. Nat.—Silica and silicates.

Not completely soluble with the salt of phosphorus before the blowpipe, but forming a glass, which becomes opalescent by cooling, and in almost all cases leaving a transparent skeleton of silica. Or neither soluble nor reducible.

Sub. Ord. I.—ANHYDRO-SILICIDEOUS.

Affording no water before the blowpipe in the matrass, or merely hygrometric water, which, in escaping, produces no change in the transparency of the mineral.

Family 1.—Gemmoids.

Insoluble and unalterable in acids; fracture (cleavages excepted) conchoidal, passing to uneven, and scaly. The hardest scratch quartz, the softer only felspar. Specific gravity 2.5 to 4.2

Gen.—Quartz (with calcedony, amethyst, and ferrugineous quartz); zircon; garnet (with almandine, grossular, cinnamonstone, aplome, melanite, common and mixed garnets); staurotide or grenatite; idocrase or vesuvian (with egeran, loboite, and cyprine); Andalusite; topaz; tourmaline (with rubellite, indicollite, and schorl); iolite or cordierite; emerald (with beryl); euclase; peridot or chrysolite; condrodite; axinite.

Appendix.—Saphirin; fibrolite; Sommervillite; Humite; Forsterite; hyalosiderite; Sillimanite.

Family 2.—Gadolinites.

Soluble into a gelatinous mass in acids; scratching quartz; texture compact or imperfectly foliated; conchoidal fracture. Specific gravity 3.2 to 4.2.

Gen.—Gadolinite; orthite.

Family 3.—Hauynes.

Soluble in a gelatinous mass in acids; scratching apatite; scratched by quartz; texture compact; lustre between vitreous and greasy. Specific gravity 2.2 to 3.6.

Gen.—Leucite or amphigene; haüyne; lazulite; sodalite; eudialite; helvine; nepheline (with elaolite or *Fettstein*); mellilite; gehlenite; sphene; anorthite.

Appendix.—Ittnerite; Indianite; Berzeline? (new mineral from La Riccia, near Rome.—*Bibl. Univ. Jan.* 1831.)

Family 4.—Labradorites.

Soluble in a gelatinous mass in concentrated muriatic acid; scratching apatite; texture foliated.

Gen.—Labrador felspar.

Family 5.—Felspars.

Insoluble in acids. Specific gravity 2.3 to 2.5. Scratching apatite; texture foliated; primitive forms oblique prisms.

Gen.—Albite or cleavelandite; felspar; periklin? petalite.

Appendix.—Oligoklas (Breithaupt)?

Family 6.—Wernerites.

Unalterable in acids. Specific gravity 2.5 to 2.8. Scratching apatite; scratched by felspar; compact or very imperfectly foliated texture. With the blowpipe easily fusible, with intumescence. Primitive forms pyramidal.

Gen.—Wernerite or scapolite; meionite.

Appendix.—Dipyre; nutallite.

Family 7.—Allanites.

Soluble in heated muriatic acid, with a silicious or gelatinous residue.

Scratching apatite; generally foliated texture. Specific gravity 3.5 to 4. With the blowpipe fusible, with or without intumescence, into glass or enamel.

Gen.—Allanite; Lievrite or Ilvaite.

Family 8.—Amphiboles.

Unalterable in acids; texture distinctly foliated, or fibro-laminary *; neat and rhomboidal prismatic cleavages; scratching apatite or fluorspar. Lustre vitreous, passing to the pearly and to the pseudo-metalloid lustre. For the most part fusible alone on the charcoal with the blowpipe. One only is unalterable viz. anthophyllite. Specific gravity 2.8 to 3.6.

Gen.—Epidote (with Zoizite, Withamite, manganesian epidote); amphibole (with tremolite, actinolite, and hornblende); couzeranite; achmite; pyroxene (with sahlite or malacolite, diopside, and augite); manganese-spar or rubin-spar; diallage (schiller-spar, Jameson); hyperstene; anthophyllite.

Appendix.—Schiller-spar of Leonhard; Babingtonite; pyrallolite; triklasite. pykrosmine; asbest; Breislakite.

Family 9.—Wollastonites.

Soluble in a gelatinous mass in muriatic acid; distinctly foliated texture; scratching fluor-spar; fusible with difficulty on the edges before the blowpipe. Specific gravity 2.8.

Gen.—Wollastonite or tablespar.

Family 10.—Disthenes.

Unalterable in acids; texture foliated; scratching at most fluor-spar. Before the blowpipe infusible; becomes white with a fire superior to red heat. Specific gravity 3.5 to 3.6.

Gen.—Disthene or kyanite.

Family 11.—Pinites.

Unalterable in acids; texture compact or earthy; scratching only gypsum. Specific gravity 2.7. With the blowpipe more or less easily fused.

Gen.—Pinite (with Gieseckite).

Appendix.—Crystallized serpentine.

Family 12.—Anhydrous Phyllidians.

More or less unalterable in acids; texture eminently foliated, with easily separable and very thin laminæ. Hardness difficult to ascertain, on account of the easy cleavage; some rubbed against glass destroy its polish; apparently scratch only gypsum. Specific gravity 2.7 to 3.

Gen.—All the micas and talcs which do not give out water, nor experience any change in their transparency with the blowpipe. Different genera will be found in this family in separating the individuals having a single axis of double refraction, or belonging to the pyramidal or to the rhomboidal system, or those having two axes, or belonging to the prismatic system. Besides these observations, the micas will be distinguished from the talcs by their being flexible and elastic, while the last are flexible without elasticity.

Appendix.—Rubellan; perlglimmer; and pyrodmalite?

* The fibro-laminary structure so evident and common in all the crystals of this family, shews that all the regular crystals are not simple, but compound individuals, or groups formed of elongated simple crystals.

Sub. Ord. II.—HYDRO-SILICIDEOUS.

With the blowpipe in the matrass, giving water, and losing their transparency.

Family 1.—Hydro-Phyllidians.

Same characters, as those of the anhydro-phyllidians, except those which indicate the water of composition.

Gen.—All the hydrated micas and talcs; Cronstedtite.

Family 2.—Triphanes.

But feebly attacked by acids; texture foliated; lustre between vitreous, greasy, and pearly. Spec. grav. 3, 6. Before the blowpipe fusible, with intumescence into a colourless and transparent glass.

Gen.—Triphane or spodumen.

Appendix.—Killenite.

Family 3.—Zeolitines.

Do not form a gelatinous mass with acids; scratch fluor-spar; vitreous or pearly lustre. Spec. grav. 2.0 to 2.9. Fusible before the blowpipe.

Gen.—Chabasite; carpholite; harmotome, or cross-stone.

Family 4.—Zeolites.

Soluble in acids, for the most part in a gelatinous mass; texture compact or thick foliated; the harder scratch apatite, the greatest part only fluor spar, some merely calcareous spar. Spec. grav. 2.0 to 3.3. Vitreous or pearly lustre. With the blowpipe easily fusible with or without intumescence.

Gen.—Gismondine; prehnite; dioptase; silicate of zinc; datholite; analcime, or cubicite (Gmelenite?) mesotype; Thomsonite; stilbite; Heulandite; Brewsterite; epistilbite; apophyllite; Laumonite.

Appendix.—Phillipsite; Comptonite; Edingtonite; Allophane?

Appendix to the Order Silicideous.

Chiastolite, or macle; octohedral silicate of manganese from Piedmont (Berzelius); Sapparite; sidero-schistolite; Bucklandite; glaucolite; thullite; Turnerite; zurlite; ostranite? ligurite; pyrorthite.

Order IV.—BORIDEOUS.

Chem. Nat.—Borates.

Scratch feldspar; easily soluble with the three fluxes * employed with the blowpipe, into a diaphanous glass; with a certain proportion of soda the glass crystallizes; with Turner's re-agent (a mixture of 4½ parts of bisulphate of potassa with 1 part of fluate of lime), gives a pure green colour to the flame of the blowpipe. Insoluble in acids.

Gen.—Boracite, or borate of magnesia.

* Viz.—Borate of soda or borax; double phosphate of soda and ammonia, or salt of phosphorus; and carbonate of soda, or soda.

Order V.—MOLYBDENEOUS.

Chem. Nat.—Molybdates.

With the blowpipe easily soluble in the three fluxes; with borax into an almost colourless glass in the outer flame; in the inner flame, into a transparent glass when warm, and becoming dark, opake and brownish by cooling; with the salt of phosphorus a small quantity of the mineral gives a green glass, a greater proportion a black and opake glass. Insoluble in acids when cold, difficultly soluble in warm muriatic acid. Scratch gypsum.

Gen. Molybdate of lead, or yellow lead spar.

Order VI.—SCHEELIDEOUS.

Chem. Nat.—Tungstates.

With the blowpipe easily soluble in the three fluxes; with the salt of phosphorus (when the particle of mineral is very small relatively to the flux) into a colourless glass at the outer flame, and into a fine blue glass at the inner flame. Completely soluble without effervescing, or leaving a yellow powder in warm muriatic acid. Scratch fluor spar.

Gen.—Tungstate of lime or scheelite; tungstate of lead.

Order VII.—CHROMIDEOUS.

Chem. Nat.—Chromates.

With the blowpipe soluble in borax and the salt of phosphorus, into a glass which is green at the outer flame; with soda on the charcoal the mass is absorbed, on the platina leaf melts either entirely or partially, into a glass which is green at the reductive, and yellow after cooling at the oxidating flame. Entirely or partly soluble, without effervescence, in muriatic acid. Scratch gypsum.

Gen.—Chromate of lead, or red lead spar; Vauquelinite.

Order VIII.—FLUORIDEOUS.

Chem. Nat.—Fluates.

With the blowpipe melt with borax and salt of phosphorus; these minerals, mixed with melted salt of phosphorus, and the mixture warmed at the extremity of an open tube, in which is introduced the flame; a liquid is disengaged, which corrodes the tube, and turns Brazil wood paper yellow; the harder scratch fluor spar, the softer only gypsum.

Gen.—Fluor spar; cryolite; fluate of yttria; fluate of cerium.

Order IX.—PHOSPHATIDEOUS.

Chem. Nat.—Phosphates.

With the blowpipe fusible either alone or with borax and salt of phosphorus; melted with boric acid, a fragment of iron wire introduced in the globule, and heated at a strong fire, is melted in vitreous globules of phosphuret of iron. Soluble in acids. Scratching fluor spar, or gypsum.

Sub. Ord. or Fam. I.—ANHYDRO-PHOSPHATIDEOUS.

With the blowpipe in the matrass not giving out any water nor smell of garlic.

Gen.—Apatite; Wagnerite; Klaprothite, or blue feldspar of Krieglach; phosphate of lead; amblygonite.

Sub. Ord. or Fam. II.—HYDRO-PHOSPHATIDEOUS.

With the blowpipe in the matrass giving water and losing their transparency, but not emitting any smell of garlic.

Gen.—Wavelite; kakoxen; uranite; Vivianite, or phosphate of iron; hydrophosphate of copper; Libethenite (Breithaupt).

Sub. Ord. III.—ARSENI-PHOSPHATIDEOUS.

In the matrass, or in the open tube, or on charcoal, with the blowpipe giving out arsenical fumes, with the smell of garlic.

Gen.—Arseniferous phosphate of lead; arseniferous Libethenite, or phosphate of copper.

Order X.—ARSENIDEOUS.

Chem. Nat.—Arseniates.

With the blowpipe, melting with borax and salt of phosphorus, and disengaging a smell of garlic. Melted with boric acid, the fragment of iron-wire introduced in the globule remain unchanged and unmelted. Soluble without effervescing in acids. Soft, scratching at most calcareous spar.

Gen.—Arseniate of lime (pharmacolite); arseniate of lead; olivenite (prismatic arseniate of copper); copper mica (rhomboidal arseniate of copper); liriconite or linzenerz (octohedral arseniate of copper); euchroite; arseniate of iron; skorodite; arseniate of cobalt; arseniate of nickel.

Order XI.—SULPHATIDEOUS.

Gen. Nat.—Sulphates.

Fusible with the blowpipe in borax and in salt of phosphorus, giving a brown colour to a glass of silica and soda, with which they are fused.

Sub. Ord. I.—ANHYDRO-SULPHATIDEOUS.

Not giving out water in the matrass with the blowpipe; insoluble in cold acids, or but very imperfectly soluble in heated acids. Scratch calcareous spar, or gypsum.

Gen.—Baritine, or heavy spar; celestine, or sulphate of strontites; karstenite, or anhydro-sulphate of lime; sulphate of lead; glauberite, or Brongniartine?

Appendix.—Polyhalite.

Sub. Ord. II.—HYDRO-SULPHATIDEOUS.

Giving out water in the matrass with the blowpipe, and losing their transparency. Soluble in acids. Scratched by calcareous spar.

Gen. Gypsum.

Appendix.—Alunite, or alumstone?

Order XII.—CARBONIDEOUS.

Chem. Nat.—Carbonates.

Soluble, with effervescence, in acids, cold or warm; (sometimes the mineral must be reduced to powder, and sometimes the acid must be diluted with water, in order that the characteristic property may manifest itself). Scratching at most calcareous spar, generally gypsum.

Sub. Ord. I.—SULPHO-CARBONIDEOUS.

With the blowpipe colouring brown a glass of silica and soda.

Gen.—Sulphato-carbonate of lead; cupreous sulphato-carbonate of lead; sulphato-tricarbonate of lead.

Sub. Ord. II.—PURE CARBONIDEOUS.

With the blowpipe not giving out any colour to a glass of silica and soda, not colouring the flame when melted with salt of phosphorus and deutoxide of copper.

Gen.—Carbonate of lead; Witherite; Strontianite; baryto-calcite; Arragonite; Great Genus Spar, (comprising, *a*, calcareous spar; *b*, Gioberite, or carbonate of magnesia; *c*, carbonate of iron; *d*, carbonate of manganese; *e*, carbonate of zinc; and the compound carbonates, such as dolomite; brown or pearl spar; ferriferous carbonate of lime; manganesiferous carbonate of lime; sparry and earthy calamine, composed of carbonates of zinc and of lime;) malachite; azurite.

Sub. Ord. III.—MURIO-CARBONIDEOUS.

With the blowpipe melted in the salt of phosphorus, mixed with deutoxide of copper, giving a green colour to the flame.

Gen.—Murio-carbonate of lead; lead spar from Mendip? or peritome bley baryt?

Order XIII.—CHLORIDEOUS.

Chem. Nat.—Muriates, or chlorides.

Not effervescing with acids; with the blowpipe, in the salt of phosphorus mixed with deutoxide of copper, giving to the flame a bright green colour; soft; scratching only talc or gypsum.

Gen.—Muriate of silver, muriate of copper; muriate of mercury.

Order XIV.—MELLATIDEOUS.

Chem. Nat.—Mellates.

With the blowpipe on charcoal becomes black, burns, then becomes white, and diminishes in size; in the matrass gives out water and becomes opake. Soluble in nitric acid. Scratch gypsum.

Gen. Mellite, or honey-stone.

Order XV.—OXALIDEOUS.

Chem. Nat.—Oxalates.

Burns before the blowpipe, leaving for residue a dark porous mass, which is attracted by the magnet. Soluble in acids without effervescence Scratch talc.

Gen. Humboldtite, or oxalate of iron.

Order XVI.—HYDRATEOUS.

Chem. Nat.—Hydrates.

With the blowpipe in the matrass giving out water and becoming opake; soluble in borax and salt of phosphorus into a transparent glass; not soluble in soda; entirely soluble, without effervescence, in acids. Scratched by calcareous spar; slightly flexible with elasticity.

Gen.—Hydrate of magnesia.

DIVISION II.—HYDROLYSIMOUS CRYSTALS.

Sensibly soluble in water, sapid, harder and not less brittle than rock-salt and alum; generally light.

Order I.—CARBONAQUEOUS.

Chem. Nat.—Carbonates.

Effervescing with acids.

Gen.—Natron, or carbonate of soda.

Order II.—NITRAQUEOUS.

Chem. Nat.—Nitrates.

Detonating on live charcoal.

Gen.—Nitrate of lime; nitrate of soda; nitrate of potassa, or nitre.

Order III.—BORAQUEOUS.

Chem. Nat.—Borates.

With the blowpipe fused on charcoal, in a mixture of 4½ parts of bisulphate of potassa, and 1 part of fluate of lime, giving a bright green colour to the flame.

Gen.—Borate of soda, or borax.

Order IV.—MURIAQUEOUS.

Chem. Nat.—Chlorides, or muriates.

With the blowpipe, fused in a mixture of salt of phosphorus and deutoxide of copper, giving a green colour to the flame.

Gen.—Salmiac, or muriate of ammonia; rock-salt or muriate of soda, or chloride of sodium.

Appendix.—Cotunnia? or muriate of lead? Monticelli and Covelli.

Order V.—VITRIOLS.

Chem. Nat.—Sulphates.

With the blowpipe giving a brown colour to a glass of silica and soda.

Gen.—Sulphate of soda; Mascagnine, or sulphate of ammonia; alum; sulphate of potassa; Reussine; Epsomite, or sulphate of magnesia; sulphate of iron; sulphate of copper; Gallizinite, or sulphate of zinc; sulphate of cobalt; sulphate of uranium; sulphate of manganese; sulphate of nickel.

Order VI.—ACIDACEOUS.

Chem. Nat.—Free acids.

Difficultly soluble in water, giving a red colour, when moist, to test paper tinged with blue vegetable colours.

Gen.—Arsenious acid; boracic acid.

Appendix Division.—Crystals soluble in alcohol.

Inflammable, soft and light.

Gen. Schererite (with Hatchetine? and mountain tallow?)

To these will follow in our book two appendixes, one of crystalline minerals, not enough known in all their characters, to be yet included in the classification; the other of minerals not likely ever to be found in a crystalline state, and being probably groups of molecular individuals, either of only one genus, and thus homogeneous in substance, or of more than one genus, and therefore being heterogeneous or mixed minerals.

If, instead, as we have done above, giving the pre-eminence in doubtful cases to the physical characters over the consideration of the chemical composition, we should have given the preference to this last consideration, the methodical arrangement would have assumed in its highest divisions the form which we are now to point out; but then it would not have been a classification of natural history, as the heads of classification would not have been positive characters belonging to individuals, but mere abstract notions of a chemical nature.

Division I. Substances containing no element supporting combustion.

Corresponding to the *Metallophanous*, to some of the *Amphiphanous*, and to the *Inflammable* crystals.

Sect. I. *Inflammable metallic substances.*

A. Simple metals (*Metallophanous Simple Metals*), 12 genera normal.

B. Compound combinations of simple metals (*Metallophanous Alloys*), 24 genera normal. Total, 36 normal genera.

Sect. II. *Inflammable metallic substances combined with not metallic inflammable elements.*

A. Sulphurets (a *Metallophanous Pyrites*), 31 genera normal.
(b *Amphiphanous Sulfurideous*), 6 genera anomalous.

B. Carburets (*Metallophanous Graphites*), 2 genera normal. Total, 33 normal genera, 6 anomalous.

SECT. III. *Simple inflammable, not Metallic Substances.*

(Inflammable crystals), 2 anomalous genera.

DIVISION II. SUBSTANCES CONTAINING ONE OR MORE ELEMENTS SUPPORTING COMBUSTION.

Corresponding to the *Lithophanous*, and to some of the *Amphiphanous* crystals.

SECT. I. *Substances containing Oxygen, as a predominating electro-negative element.*

A. Oxides (in general of the lowest degree of substances capable of many degrees of oxidation) of iron, tungsten, manganese, zinc, titanium, uranium, either free or combined with one another *(Amphiphanous Hematites)*, 18 genera anomalous.

B. Oxides of tin, of silicium, of aluminium, either free or combined with oxides of metals, or of metalloids *(Lithophanous crystals)*, 113 normal genera.

C. Acids: boric, tungstic, molybdic, phosphoric, arsenic, sulphuric, carbonic, nitric, either free or combined with oxides of metals and of metalloids *(Lithophanous alysimous* and *hydrolysimous)*, 65 normal genera.

SECT. II. *Substances containing fluorine as predominating electro-negative element.*

Order of the *Fluorideous* in the *Lithophanous alysimous*, 4 normal genera.

SECT. III. *Substances containing Chlorine, as predominating electro-negative element.*

Lithophanous, alysimous chlorideous, and *hydrolysimous muriaqueous,* } normal genera.

N. B. These last 12 genera normal as what relates to the class, are place differently in the Natural History classification, in regard to the other genera of the class.

ILLUSTRATION OF THE METHOD.

To complete the general idea which we have been endeavouring to give of our views on the subject of the classification of minerals, it may be proper to extract from the work already alluded to, the entire description of a genus or two, in order to show the way in which we consider this part of the subject ought to be treated.

First instance taken from the Metallophanous Malleable Simple Metals.

Genus. COPPER.

Synonimes.—Native copper, Cuivre natif (Haüy), Gediegen Kupfer (Werner), octædrisher kupfer (Mohs), octahedral copper (Jameson).

Chemical Nature.—Pure copper.

Colour * reddish yellow. Primitive form the cube; scratch calcareous spar, scratched by fluor spar. Spec. grav. 7.8 to 8.58. When insulated and rubbed acquiring positive electricity. Fusible at the 27th degree of Wedgewood's pyrometer. Soluble, with a green colour in nitric acid, and with a blue colour in ammonia.

First Species.—*Primitive Copper.* A cube. Sign of the planes P all square; inclined to one another at 90°.—*Cornwall.*

2. *Octahedral Copper.*—Regular octahedron. Sign of the planes *r* all equilateral triangles inclined to one another at 109° 28′ 16″, produced by a complete † modification by one plane on each solid angle of the primitive form, *from Cornwall.*

Var. *a*, *Transposed.*—Solid, with three re-entering angles. The half of the octohedron appear as if it had turned on the other half of the crystal a sixth part of the circumference. Its surface consists of eight triangles and six trapeziums.

N. B. This may be also considered as twin crystals, or a regular mode of assemblage of two individuals of this species mutually penetrating one another.

3. *Cubo-octahedral Copper.*—A cube, or an octahedron, with truncated angles. Sign of the planes P *r*. Incomplete modification by one plane on each solid angle of the primitive form. Incidence of *r* on P 125° 15′ 52″.

Var. *a*, Cube being the predominating form. Incidence of P on P 90°.

Var. *b*, Octahedron being the predominating form. Incidence of *r* on *r* 109° 28′ 16″.

4. *Cubo-dodecahedral Copper.*—A cube with all its edges truncated, or replaced by one plane, or a rhomboidal dodecahedron having its six quadruple angles truncated or replaced by one plane. Sign of the planes P *s*. Incomplete modification by one plane on all the edges of the primitive form. Incidence of *s* on P 153° 26′ 5″.

Var. *a*, Cube predominating.

Var. *b*, Rhomboidal dodecahedron predominating. Incidence of *s* on *s* 120′.

5. *Triform Copper.*—A cube truncated on all the edges and solid angles. Sign of the planes P *s r*. In complete modification by one plane on all the edges and angles of the primitive form. Incidence of P on *s* 153° 26′ 3″, of *s* on *r* 144° 44′ 8″, of P on *r* 125° 15′ 52″.

MODE OF AGGREGATION OR GROUPS OF INDIVIDUALS OF THIS GENUS.

These occur, as those of the preceding genera, in reticulated or diverging branches, in delicate threads (Temerwar), in laminæ, and grains; also in

* The metallic lustre and streak, the property of not being decomposed, and the malleability being characteristic of the class, the order and the family are not repeated here.

† In alluding to the existing relation between the planes of the secondary and those of the primary form, we call *complete*, such modifications by which the primitive planes are entirely intercepted, and *incomplete*, those which still leave remaining a part of the primitive form.

mamillary and botryoidal groups, and in cleavable masses. More rarely, molecular individuals are assembled in compact masses.

Second example taken from the family Pyrites, of the order Pyrites, in the class Metallophanous Crystals.

Genus. SULPHURET OF COBALT, OR GREY COBALT-ORE.

Comprising the *Glanz kobalt* and *Weisser speiss kobalt* of Werner; the *Cobalt gris* and *Cobalt arsenical blanc argentin* of Haüy; the *Octahedral cobalt-pyrites*, and the *Hexahedral cobalt-pyrites* or *Silver-white cobalt* of Mohs and Jameson; the *Schwefel kobalt* or sulphuret of cobalt of Berzelius, and the *Kobalt kies* of Hausmann.

N. B. The *Grauer speiss kobalt* of Werner, and the *Cobalt arsenical foncé* of Haüy, belong to the family Arsenideous, of the order Alloys.

Chemical Nature.—Sulphuret of cobalt combined with sulphurets of iron and copper, and with arseniurets of cobalt and iron. These various combinations which change neither the colour nor the primitive form of the sulphuret of cobalt, but are distinguished by some peculiar characters, occasion a division of this genus into three subgenera, for each of which will be given the analyses and the mineralogical signs belonging to it.

CHARACTERS COMMON TO THE THREE SUBGENERA.*

Primitive form, the cube; colour, tin or silver-white; lustre, splendent and specular. Spec. grav. 6 to 6.6. Scratch apatite, scratched by feldspar. Give often sparks when struck by steel. With the blowpipe, give a blue colour to borax.

I. *Subgenus.* COBALT-PYRITES.

Kobalt kies, Hausmann. *Schwefel kobalt*, or sulphuret of cobalt, Berzelius.

Giving no fumes nor smell of garlic with the blowpipe.

Sulphuret of cobalt predominating, and combined with a small proportion of sulphurets of copper and of iron.

Berzelius's formula of the sulphuret of cobalt of Bastnæs, $Fe\,S^4 + 4\,Cu\,S + 12\,Co\,S^3$.

Analyses of the sulphuret of cobalt

	of Ryddarhyttan, near Bastnæs (Sweden), by Hisinger.†	of Mussen, near Arnberg, by Vernekinck.‡
Cobalt,	43,20	0,4386
Iron,	3,53	0,0534
Copper,	14,40	0,0410
Sulphur,	38,60	0,4100
Vein stone,	0,33	0,0067
Arsenic,	none	none
Loss,	0,04	0,0000
	100,00	0,9497

* The characters of the family, the order, and the class, already given above, are not repeated here.

† Afh. y Tyr. iii. 316, and Ann. de Chim. t. 83, p. 329.

‡ Ann. des Mines, x. pp. 3, 4.

With the blowpipe in the matrass does not decrepitate, nor disengage any volatile substance. In the open tube, gives sulphurous acid without any trace of arsenic, and a white sublimate in microscopic globules, which is sulphuric acid. Alone on charcoal, after roasting, melts into a grey metallic globule. (Berzelius.) Soluble in nitric acid, and at the same time emitting nitrous gas, and leaving a whitish residuum in the liquid, which is first pink-coloured and after brown.

First Species.—*Octohedral Cobalt-pyrites.* Sign of the planes *r*. A regular octohedron, produced by a complete modification by one plane on each of the solid angles of the primitive form. Incidence of *r* on *r* 109° 28′ 16″, from *Mussen* (Prussia), Vernekinck.

Var. *a*, *Cuneiform.*—The terminal angle prolongated in an edge. From *Mussen*, idem.

2. *Cubo-octohedral Cobalt-pyrites.*—A regular octohedron with all its solid angles truncated by a plane. Sign of the planes P *r*. Same modification as that of the preceding species, but incomplete. Incidence of P on *r* 125° 15′ 52″. From *Mussen*, Vernekinck.

MODE OF AGGREGATION OF THE INDIVIDUALS OF THIS SUBGENUS.

In bunches with shining crystalline surface. From *Bastnæs.*

II. *Subgenus.* GLANCE-COBALT.

Cobalt-gris, Haüy; part of the *hexahedral cobalt-pyrites*, or *silver-white cobalt* of Mohs and Jameson.

Combination of almost equal volumes of sulphuret and arseniuret of cobalt. Berzelius's formula, $Co\,S^4 + Co\,As^2$.

Analyses of the glance-cobalt

	of Skutterud (Norway), by Stromeyer.	of Tunaberg (Sweden), by Tessaert.
Arsenic,	43,47	49,00
Cobalt,	33,10	36,66
Sulphur,	20,08	6,50
Iron,	3,23	5,66
	99,88	97,82

Very lamellar texture, cleavages easy and very shining, parallel to the planes of the cube.

With the blowpipe in the matrass experiences no alteration; in the open tube is with difficulty roasted; gives out arsenious acid merely with a strong heat, and at the same time the smell of sulphurous acid. On charcoal, give out abundant fumes, and fuse after having been some time roasted. Leave at last a brittle white metallic globule (Berz.)

First Species.—*Primitive Glance-cobalt.* Sign of the planes P, a cube. Incidence of P on P 90° *from Tunaberg.*

Var. *a*, *Triglyphe.*—The planes marked with striæ in three directions, perpendicular to one another, *from Tunaberg.*

2. *Octahedral Glance-cobalt.*—(See the first species of the first subgenus). *From Tunaberg.*

3. *Dodecahedral Glance-cobalt.*—Sign of the planes *e*. A pentagonal dodecahedron, twelve pentagonal planes produced by a complete and unsymmetric modification * of one plane (instead of two) on all the edges of the primary form. Incidence of *e* on *e* and *e′* 126½°, and 113½° *from Tunaberg.*

4. *Icosahedral Glance-cobalt.*—Sign of the planes *e d*, a solid with twenty triangular planes, of which, in the normal state, eight (*d*) are equilateral triangles, and twelve (*e*) are isosceles triangles. Combination of two incomplete modifications, one of one plane on all the solid angles, and the other an unsymmetric one of one plane (instead of two) on all the edges of the primary form, which is totally intercepted by such a combination of modifications. Incidence of *e* on *d* 140° 46′ 7″.

5. *Cubo-icosahedral Glance-cobalt.*—Sign of the planes M P *e d*. The same combination of modification as the preceding species, but not intercepting entirely the primitive form, and leaving the common base of each two adjacent isosceles triangles replaced by a plane.

Incidence of *e* on P 153° 26′ 5″.
... *d* on *e* 140° 46′ 7″.
... *d* on M 125° 15′ 52″.
... *d* on P 152° 15′ 52″, *from Tunaberg.*

III. *Subgenus.* SILVER-WHITE COBALT.

Weisser speiss kobalt of Werner; *Cobalt arsenical blanc argentin* (Haüy). A part of the *hexaedral cobalt-pyrites* and of the *silver-white cobalt* of Mohs and Jameson.

Mixture of glanz-cobalt with arsenical pyrites, or of sulphuret and arseniuret of cobalt with sulphuret and arseniuret of iron. Berzelius's formula. $Co\,S^4 + Co\,AS^2, Fe\,S^4 + Fe\,AS^2$.

Colour, silver-white; texture more compact than lamellar; external lustre less vivid than that of the glance-cobalt. Before the blowpipe disengages much arsenical fumes with a strong smell of garlic, and leaves as a residue a brittle, white metallic globule.

First Species.—*Primitive silver-white Cobalts.* A cube. Sign of the planes P. Their mutual incidence 90°.

MODE OF AGGREGATION OF THE MOLECULAR INDIVIDUALS OF THE WHOLE GENUS.

In compact masses.

* We call *unsymmetric* modification what Mohs calls in this case *semi-tessular*, when the half of the planes which ought to exist according to the law of symmetry are suppressed.

Some account of the Famine in Guzerat, in the years 1812 *and* 1813. By Captain JAMES RIVETT CARNAC, Political Resident at the Court of Guicawar. In a Letter to WILLIAM ERSKINE, Esquire.

To meet your wishes, by a description of the calamities which visited this province, I send you the few following observations. At the same time, I am conscious of my own inability to perform this task with the interest and accuracy which it deserves, and indeed am firmly persuaded that no adequate representation can be made of the manifold miseries I have had the mortification to witness. When we attempt to give an idea of the effects of a famine, it must immediately occur, that such visitations of Providence do not vary materially in their progress and consequences, and that the statements which in all ages have been produced by similar calamities, leave little of novelty in a general point of view: I shall therefore confide more in the relation of positive facts for the gratification of your curiosity, than of any observations which my own feelings may occasionally prompt, in the course of this letter, on the horrid scenes created by the misfortunes of our fellow creatures.

It is interesting to mark the harbinger of those calamities which fell upon Guzerat:—the superstitions of the natives attributed them to the sins of this quarter of India; while we cannot but lament that the danger, which, in its origin was at the remotest extremity, should at last have fixed its influence in the western division of the peninsula. It has often been remarked, that the appearance of locusts is a prognostic of other evils. Flights of these destructive insects first appeared from the eastward, in the Bengal provinces, about the beginning of the year 1810, and taking their course in a northerly direction, passed through parts of the country designated by the southern people Hindostan; and, in the revolution of fifteen months, arrived at the province of Marwar, skirting the large western desert of India. In the year 1811, the annual fall of rain failed in Marwar; and when every vestige of vegetation had disappeared, the locusts made way into the north-west district of

Guzerat, named Puttun, and from thence scoured Kattiwar; on one occasion only, appearing as far south as the city of Baroach on the Nerbudda. Beyond this point the locusts were not known to extend; and by the commencement of the monsoon of 1812, this plague vanished from the face of the country.

The destruction committed by these insects in the western parts of Guzerat was deplorable. During the circuit of the subsidiary force at the latter end of 1811, extensive tracts were covered with cultivation; and, until examined, the spectator would have considered the harvest as being in a most flourishing condition. The locusts, however, had devoured the grain, and the stalks were left as unworthy of being cleared from the ground. The failure of grain in Marwar, and the ruin by the locusts of the products of the land during the preceding year, drove the inhabitants of that unfortunate country into the bosom of Guzerat, where their condition was comparatively improved, though one of the causes which compelled them to seek refuge at a distance from home, had begun to operate also in that province. Miseries seemed to follow the footsteps of the Marwarees, and to mingle their neighbours in their untoward destiny; for it was in the year 1812 that Guzerat also experienced a failure of rain, when the demands on its resources had augmented in a twofold degree. The enhanced price of grain, added to the apprehensions of the inhabitants, which impelled them to store their individual resources in times of such danger, and the villanies practised by the higher classes to derive pecuniary advantage from the pressing wants of the people, soon reduced the half-famished emigrants to the greatest privations: the endurance of hunger was supported, however, by the Marwaree people with unaccountable pertinacity, which in some degree blunted the natural feelings of sympathy in their lot. Whether the ready assistance rendered to these people on their first entrance into Guzerat, had induced them to imagine, that under no circumstances the hand of charity would be withdrawn; or whether it was from the innate indolence of their character, or the infatuation which often accompanies the extremes of misfortune,—that they rejected the certain means of subsistence by labour,—it is notorious, that in all cases when the benevolent tendered employment to these people, it was uniformly declined, even with the certainty of death being the consequence of refusal. The diversity between the laudable energies of the Mahratta, when under the influence of similar misfortunes, and the apathy of the Marwaree, was strikingly evinced.

The mortality which ensued among the emigrants, who had sought refuge after the sufferings of a famine in their own country, covered with disease, regardless of every consideration but that promoted by the calls of hunger, almost surpasses my own belief, though an unhappy witness of such horrid events.

In the vicinity of every large town, you perceived suburbs surrounded by these creatures. Their residence was usually taken up on the main roads under the cover of trees; men, women, and children promiscuously scattered, some furnished with a scanty covering, others almost reduced to a state of nudity, while, at the same moment, the spectator witnessed, within the range of his own observation, the famished looks of a fellow creature, aggravated by the pain of sickness; the desponding cries of the multitude, mingled with the thoughtless playfulness of children, and the unavailing struggles of the infant to draw sustenance from the exhausted breasts of its parent. To consummate this scene of human misery, a lifeless corpse was at intervals brought to notice by the bewailings of a near relative; its immediate neighbourhood displaying the impatience and wildness excited in the fortunate few who had obtained a pittance of grain, and were devouring it with desperate satisfaction. The hourly recurrence of miseries had familiarized the minds of these poor people, as well as of people in general, to every extremity which nature could inflict,—in a short time, these emanations of individual feeling among themselves, which distinguished the first commencement of their sufferings, gradually abated, and the utmost indifference universally predominated. I shall venture to give you a few examples, which came under my own eyes, and which, in spite of the painful sensation which they excite, I bring myself to describe, from the desire of elucidating the depression to which a rational being can be reduced.

During the progress of these miseries, I have seen a few Marwarees sitting in a cluster, denying a little water to sustain her drooping spirits, to a woman stretched beside them, with a dead infant reposing on her breast. In a few hours this woman had also expired, and her dead body as well as that of the child, remained close by them, situated as before described, without a single attempt to remove them, until the government-peons had performed that office. I have seen a child, not quite dead, torn away by a pack of dogs from its mother, who was unable to speak or move, but lay with anxious eyes directed to the object of its fond affection. It was pursued by its former little playmates, which had shared in its extreme adversity; but the ravenous animals (who had acquired an extraordinary degree of ferocity from before having fed on human bodies) turned upon the innocents, and displayed their mouths and teeth discoloured with the remains of the child; a rescue was attempted by ourselves, but the remains of life had been destroyed, and in struggling for its limbs, the dogs had actually carried off one of its arms. I have witnessed those animals watching the famished creatures, who were verging on the point of dissolution, to feast on their bodies; and this spectacle was repeated every successive day in the environs of this town. Lastly, To my knowledge, those feelings and prejudices "concentrating all their precious beams of sacred influence," those which life in ease and affluence would only have resigned with itself, in the extremes of distress, seemed to have lost their power. Distinctions of cast were preserved until the moment when the hand of adversity bore heavy, then the Brahmin sold his wife, his child, sister, and connexions, for the trifle of two or three rupees, to such as would receive them. With these individual cases I will leave you to estimate the extent of mortality; but it is in my power to state as a fact, that the number of the Marwarees who died in a single day at Baroda, could scarcely be counted, and the return of burials in twenty-four hours often exceeded 500 bodies. What reflections are not excited by the enumeration of such dreadful evils, and what gratitude has each of the living to cherish for the mercy shewn to him! It would be doing an act of injustice, however, to the natives of opulence in Guzerat to pass over their exertions to alleviate the surrounding distress. The charity of the Hindoos is proverbial; it constitutes one of the primary tenets of their morality, and is generally unaffectedly dispensed. On the occurrence of the distress and famine, large subscriptions were made, aided by a liberal sum from the native government, and the objects of the institution were obtained by proper regulations, devised for that purpose. I cannot say what numbers were relieved, but the monthly expense of feeding the poor in this town amounted to some thousands of rupees. It was a cruel sight to those possessed of sensibility, to witness the struggles when the doors were opened to apportion the victuals. Every sentiment of humanity appeared to have been absorbed by the crowds collected around; and it was no unusual thing to be informed, that such and such a number had fallen a sacrifice to their precipitate voracity. Many also whose wants had been supplied, continued to devour until the means intended for their relief proved in the end their destruction in a few hours. Children were often crushed to death, when attending for their pittance of food, under the feet of their own parents. The establishment of which I have been speaking was imitated in most of the principal towns in Guzerat, and added a few months of life to a class of beings reserved for greater miseries; indeed, subsequent events would seem to show that these people were marked for total annihilation, and that in their destruction the inhabitants of this country were to be deeply involved.

I have observed, in a former part of this letter, that the Marwarees had resorted to Guzerat covered by disease, the consequence of limited and unwholesome food. I shall not dwell on the spectacles which were furnished in this particular respect; but the object of adverting to it is to mention, that this misery was heightened by the confluent small-pox, which committed incalculable ravages; add to this, that the women, to obtain food on their entry into the country, had prostituted themselves, and contracted diseases only inferior in malignancy to the one above stated.

The carelessness of the Indian in all matters which do not affect his immediate interests or his religion is well known to us; his conduct would hardly be supposed to be governed by rational principles. Of his indifference to the dying we have had abundance of evidence; but he is yet more callous to the dead. It was this kind of apathy which appeared to me to have chiefly occasioned the contagion experienced in 1812, and the consequent mortality. The bodies of the Marwarees during the famine were left unheeded on the spot where life expired, and their putridity must doubtless have affected the atmosphere. As demonstrative that some influence was created by these circumstances, I beg your attention to the number of deaths, which will presently be specified, at Ahmedabad, where the sickness raged with the greatest violence, observing at the same time, that at Baroda the government had the precaution to bury the dead; while this act, so necessary for self-preservation and common decency, was not performed elsewhere in the Guicawar districts with uniform attention. The mortality at Ahmedabad is computed at a hundred thousand persons, a number nearly equal to one half of its population. The demand for wood to burn the Hindoos, called for the destruction of the houses; even this was barely sufficient for the performance of the rites required by the Hindoo faith, and the half-consumed bodies on the banks of the Pabeirmuttee evince, at this hour, to what straits the Hindoos were reduced in fulfilling the last duties to their kindred. A description of the fury with which the contagion raged in that unhappy city would scarcely be credible. The disease pervaded every habitation, entire families fell victims to its unsparing hand; and, in many instances, the dead body of one person had no sooner been disposed of, than the party returned to repeat the same office to another. It is worthy of remark, that latterly the females were engaged in removing the dead and committing them to the pile; the urgency must have been extreme, to have induced this departure from usages in rites held in sacred estimation. It can be no question, that a part of the mortality is attributable to the peculiar insalubrity of the climate in this province after the rainy season; but as the mortality commonly exceeded the proportions of deaths in former years in the rate of ten to one,—to what can such excess be ascribed, but the cause I have ventured to assign? It is a curious fact, however, that, with the exception of Ahmedabad, the Mahomedan population did not suffer so severely as the Hindoos. The cause assigned among themselves I have heard to be the nature of their diet, and the support which animal food gave to the body. I am not qualified to form a judgment on such a subject, but the reason is certainly not unworthy of attention. At the same time, I am aware that the parallel case of mortality among the Europeans at Kaira can be adduced against the solidity of the reason assigned, though it is but fair to observe, that the Mahomedans suffered in a greater proportion than in former years, and that the regiment at Kaira were new-comers, and, of course, exposed to increased dangers, from the influence of climate and the prevailing causes of sickness.

The influx of a large proportion of the population of a country yielding an annual revenue of L. 500,000, cannot be accurately ascertained: the emigrants arrived in Guzerat in detached bodies, and, for the purpose of convenience, spread themselves over the face of Guzerat, from the borders of the Gulf of Kutch to Surat, in many instances, even flocking from ports on the coast to Bombay, which they were enabled to do, in consequence of native chiefs and opulent merchants granting them passage free of charge. It should, however, be observed, that the larger proportion of the people who resorted to the presidency were from the Kitiwar, which suffered, from the want of rain and ravages of locusts, in a much greater degree than the province of Guzerat. It is also out of my power to give any certain account of the number of Marwarees who perished in the famine. I have seen, in an evening ride in the suburbs of this town, in which every practical means for saving them were benevolently exercised, not less than fifty bodies scattered around, which the servants of Government had not had time to inter. I would, therefore, from a review of all the circumstances related, be inclined to estimate, that not more than one in a hundred of these poor creatures ever returned to their native country.—*Memoirs of the Lit. Society of Bombay, vol. i.*

On Physical Geography.

The following remarks of the celebrated Professor Schouw, of Copenhagen, are illustrative of our opinion, formerly stated, in regard to the present imperfect and erroneous systems of geography taught ln our schools, and embodied in printed works.

"I do not fear to affirm," he remarks, "that, paradoxical as the assertion may appear, our abridgments of geography do by no means describe the globe, or fulfil what ought to be expected from them, in relation to the science of which they treat. The blending of geography and statistics is injurious, as it attempts to unite things which are necessarily distinct, and separates things which have a necessary connection. Thus, the alpine region, which certainly forms one whole, is found in the books of geography in various places, under the heads of Switzerland, Italy, France, Germany, Hungary, &c.; so that that which forms a great unit cannot be seized at one view, and therefore the recollection of it cannot fail to be confused and imperfect. Spain and Portugal, so closely united by nature, are also separated; in treating of Russia, Nova Zembla and the Crimea are taken into the account; in describing Denmark, they speak of Iceland, Greenland, and the Danish colonies in Asia, Africa, and America; and thus is produced a most singular confusion of countries and climates, the most diverse and opposite. These defects, in addition to that of introducing so much statistical matter that has little or no relation to geography, are such as to prevent the scholar's acquiring from them any just and faithful image of our globe. There are, indeed, treatises expressly on physical geography; but they contain only the most general notions of this science,—of seas, mountains, rivers, climates, &c.; but we do not find in them the globe divided into its natural parts, nor the examination and comparison of these different parts.

"A second defect of our treatises of geography, whether political or physical, is, that the countries are not compared with each other. The comparative method has produced the most happy fruits in zoology, geognosy, and other sciences;—physical geography may, in like manner, be developed by a comparison of all countries, considered under all their physical relations."

The author thinks as we do, that, in order that geography may deserve the name of a science, the pupil should understand the relations which exist between the exterior form of the globe, the properties of the atmosphere, of vegetables and animals, and in what manner the climate is connected with the soil, how it influences the animal and vegetable kingdoms, and how all these physical causes modify the character of the human race. He has often been surprised that teachers should so fatigue their pupils with a fastidious enumeration of the political divisions of foreign countries, and with a crowd of minute details relative to statistics, while they furnish them only with a superficial notion of the orographic structure of Europe, of climates, and of the distribution of the principal vegetables and animals.

Professor Schouw then proceeds to the comparison of the three great chains of mountains before mentioned, first pointing out their natural limits, in the following manner: "That vast chain," says he, "which rises in the Scandinavian peninsula (Sweden and Norway), does not occupy the whole of it. In truth, an almost continuous series of large lakes, viz. Wenner, Wetter, Malar, &c., but little elevated above the sea, and a plain interspersed with low hills, separates the southern part of Sweden from the great chain. The isthmus also, situated between the Gulf of Bothnia, the Icy Sea and the White Sea, and uniting the peninsula to the continent, is so little elevated above the sea, according to De Buch and Wahlenberg, and the mass of Scandinavian mountains disappears so completely at its surface, that there is really no connection between these mountains and those of Finland. This isthmus is therefore the natural limit of the Scandinavian chain; on all the other sides, this chain is surrounded by the North Sea, the Icy Sea, and the Gulf of Bothnia.

"The natural limits of the Alps it is rather more difficult to establish. The Apennines are so closely connected with the (so called) Maritime Alps, that they are justly considered as an arm of that chain. In like manner, towards the east, the Alps extend to the mountains of Croatia and Dalmatia, and even to those of Bosnia, the eastern portion of which formerly bore the name of Hemus. But as in physical geography we are allowed to consider, when we form subdivisions, not one alone, but a great number of different relations, each of those spurs ought to be separated from the principal branch, on account of the difference of climate and vegetation which characterizes them; and, even independently of these, the change of direction which is evident at the points of junction of these branches with the Alps, the lowering of the ridges, and their geognostic character, would be sufficient to require or to admit of their separation. The Alps and the Pyrenees can be considered as a single chain of mountains, only by those who embrace the hypothesis of the connexion of all possible chains. The Rhone is a natural limit of the Alps toward the west. With respect to the Jura the question is more doubtful; nevertheless, as it is separated from the Alps, and united to other mountains, by geognostic as well as by other relations, and as the region between the Alps and the Jura is low, I am inclined to consider it as not belonging to the Alps. Still less can we admit as appertaining to them the inferior mountains of the interior of Germany and France. Thus, the natural limits of the Alps are,—on the east, the plains of Hungary; on the south, the Adriatic Sea, the Lombardo-Venetian plains (the valley of the Po), and the Mediterranean Sea; on the west, the Rhone; and, on the north, Lake of Geneva, the Lake of Neuchatel, the Aar, the Rhine, from its junction with the Aar to the Lake of Constance, and the Danube.

" The Pyrenees are terminated on the east by the Mediterranean; on the west, by the Atlantic; on the north, by the low region (a great portion of which is almost a perfect plain), watered by the Adour, the Garonne, the Aude, and Jeta; on the south by the district of the Ebro. They have some connexions, towards the south-west, with the chain which extends into the Spanish peninsula along the southern coast, and with some other mountains of that peninsula. But the reasons which induce us to separate the Apennines from the Alps, are equally in favour of a separation of these chains from that of the Pyrenees."

The three chains being thus defined, the author examines and compares them under all imaginable points of view, namely, their geographical situation, their extent, their direction their elevation, their acclivities, their summits, the valleys which they form, the rivers which flow from them, the lakes which they embosom, their geognostic formation, their climate and temperature, the height and limit of perpetual snow, the plants and animals which they nourish, and the tribes of men which inhabit them. Each of these points constitutes the subject of an article replete with interesting facts; and it will be easily perceived that such a sketch is not susceptible of being extracted. We shall confine ourselves to the summary with which the author concludes this comparison.

"1. The Scandinavian mountains occupy 13° of Latitude; the Alps 4½°, the Pyrenees 1°.

"2. The Scandinavian mountains belong to a region altogether maritime; those of the Pyrenees less so, and those of the Alps not at all.

"3. The Scandinavian mountains are of greater extent than the Alps, and the latter have a more extensive range than the Pyrenees.

"4. The Alps and the Pyrenees pursue a direction approaching that of the equator; the direction of the Scandinavian chain is rather that of the meridian.

"5. The Alps are the loftiest; next the Pyrenees; and, lastly, the Scandinavian mountains. The most elevated summits are, in the Alps, from 14,000 to 15,000 feet (French); in the Pyrenees from 10,000 to 11,000; and, in the Scandinavian chain, from 7000 to 8000. The mean height of the most elevated part is, in the Alps, from 10,000 to 12,000; in the Pyrenees, from 7000 to 8000; and in the Scandinavian chain, from 4000 to 5000.

"6. The passes in the Pyrenees are as high as in the Alps; in the Scandinavian mountains we often cross a kind of tableland in travelling across the chain.

"7. The inclination of the acclivities is very various in Scandinavia; it is much less so in the Alps and Pyrenees. In these latter chains, the southern declivity is the most rapid; in the first it is the western.

"8. In Scandinavia the central high mountain chain is almost flat; in the Alps, the ridges are not acute; those of the Pyrenees approach more nearly to that form.

"9. Longitudinal valleys are large and numerous in the Alps; they are inconsiderable in the Pyrenean and Scandinavian mountains. Transverse valleys exist on both sides of the Alps and Pyrenees; they occur chiefly on the western slope of the Scandinavian chain.

"10. The largest rivers flow down the eastern side of the Scandinavian mountains, and the smaller down the western side. Three large rivers descend from the north side of the Alps; in the Pyrenees, one only flows down the southern slope, and many of less importance take their rise from the northern side. In Scandinavia the water-shed is sometimes interrupted.

" 11. Lakes of considerable extent, and in great numbers, are found near the southern, northern and eastern bases of the Alps, and near the eastern bases of the Scandinavian mountains; there are none at the feet of the Pyrenees. High or elevated lakes are numerous in Scandinavia; they are small and rare on the Alps and Pyrenees.

" 12. In Scandinavia there are but few secondary mountains, the range being almost entirely composed of primitive rocks. No thermal springs are found among them.

" 13. The east side of the Scandinavian chain enjoys a continental climate, and the west side a maritime climate. On the south-western foot of the Alps the mean annual temperature is high and the winter very mild; on the southern and still more on the western foot the climate is continental; to the north of the Alps the difference between the temperatures of winter and summer goes on increasing as we advance towards the east. The difference diminishes as we ascend.

" 14. If we do not take the heights into consideration, the difference of the mean temperature is considerable in Scandinavia; it is less in the Alps, and still less in the Pyrenees. But if the height be taken into account, we find that it is highest in the Alps, and lowest in Scandinavia.

" 15. In approaching the Alps, the quantity of rain increases; it is very great on the southern side, and very small at the eastern extremity. The western side of the Scandinavian chain is under a pluvial sky, the eastern side enjoys a dry climate.

" 16. The limit of snow in Scandinavia descends from 5200 feet to 2200, in advancing from north to south. In the northern Alps it is at the height of 8200 feet, in the eastern Alps at 8000, and in the southern Alps 8600. In the northern Pyrenees it is at 7800, in those of the south 8600 feet. The Alps present the greatest quantity of snow, as well as the greatest and most numerous glaciers.

" 17. The upper regions of the three chains much resemble each other. The limit of trees in Scandinavia is formed by the birch, and descends in advancing from south to north, from

3300 feet to 1500; in the Alps it is formed by the fir, and is found at 5600 feet in the northern Alps, and at 6200 in the southern. In the Pyrenees it is also formed by the fir, and exists between 6500 and 6900 feet. In Scandinavia, the region of birch is distinguished from that of fir; in the Alps and Pyrenees that of fir is distinguished from that of beech and chestnut.

" 18. The limit of the Cerealia, in Scandinavia (60° to 61° North Latitude) is found at 2000; under the latitude of 70° it descends to the sea. In the northern Alps it is found at 3400, in the southern at 4500; in the northern Pyrenees at 5900, and in the southern at 5200. The limit of the region of the vine is at 2500 feet in the southern Alps.

" 19. The varieties presented by the animal kingdom are of less importance.

" 20. It is not possible to explain by physical causes the differences which characterize the races of men who inhabit the three mountainous regions thus brought into comparison."

Account of a Hurricane in North America. By J. J. Audubon, Esq. F. R. S. L. & Ed.

Various portions of our country have, at different periods, suffered severely from the influence of violent storms of wind, some of which have been known to traverse nearly the whole extent of the United States, and to leave such deep impressions in their wake as will not easily be forgotten. Having witnessed one of these awful phenomena in all its grandeur, I shall attempt to describe it for your sake, kind reader, and for your sake only, the recollection of that astonishing revolution of the etherial element.

I had left the village of Shawaney, situated on the banks of the Ohio, on my return from Henderson, which is also situated on the banks of the same beautiful stream. The weather was pleasant, and I thought not warmer than usual at that season. My horse was jogging quietly along, and my thoughts were, for once at least in the course of my life, entirely engaged in commercial speculations. I had forded Highland Creek, and was on the eve of entering a tract of bottom-land or valley that lay between it and Canoe Creek, when, on a sudden, I remarked a great difference in the aspect of the heavens. A hazy thickness had overspread the country, and I for some time expected an earthquake, but my horse exhibited no propensity to stop, and prepare for such an occurrence. I had nearly arrived at the verge of the valley when I thought fit to stop near a brook, and dismounted to quench the thirst which had come upon me.

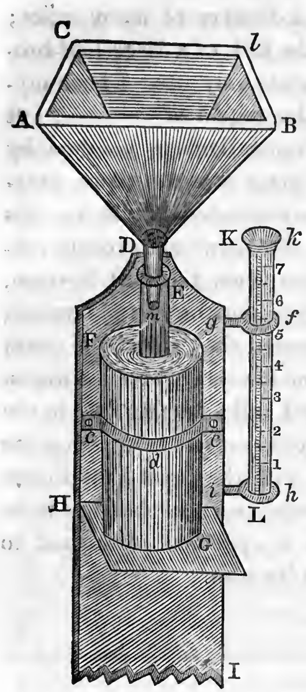
I was leaning on my knees with my lips about to touch the water, when, from my proximity to the earth, I heard a distant murmuring sound of an extraordinary nature. I drank, however, and as I rose on my feet, looked towards the south-west, where I observed a yellowish oval spot, the appearance of which was quite new to me. Little time was left me for consideration, as the next moment a smart breeze began to agitate the taller trees. It increased to an unexpected height, and already the smaller branches and twigs were seen falling in a slanting direction towards the ground. Two minutes had scarcely elapsed, when the whole forest before me was in fearful motion. Here and there were one tree pressed against another, a creaking noise was produced similar to that occasioned by the violent gusts which sometimes sweep over the country. Turning instinctively toward the direction from which the wind blew, I saw, to my great astonishment, that the noblest trees of the forest bent their lofty heads for a while, and, unable to stand against the blast, were falling into pieces. First the branches were broken off with a crackling noise, then went the upper parts of the massy trunks, and, in many places, whole trees of gigantic size were falling entire to the ground. So rapid was the progress of the storm, that, before I could think of taking measures to insure my safety, the hurricane was passing opposite the place where I stood. Never can I forget the scene which at that moment presented itself. The tops of the trees were seen moving in the strangest manner, in the central current of the tempest, which carried along with it a mingled mass of twigs and foliage that completely obscured the view. Some of the largest trees were seen bending and writhing under the gale; others suddenly snapped across; and many, after a momentary resistance, fell uprooted to the earth. The mass of branches, twigs, foliage, and dust that moved through the air, was whirled onward like a cloud of feathers, and on passing disclosed a wide space filled with fallen trees, naked stumps, and heaps of shapeless ruins, which marked the path of the tempest. This space was about a fourth of a mile in breadth, and to my imagination resembled the dried up bed of the Mississippi, with its thousands of planters and sawyers, strewed in the sand, and inclined in various degrees. The horrible noise resembled that of the great cataracts of Niagara, and as it howled along in the track of the desolating tempest, produced a feeling in my mind which it were impossible to describe.

The principal force of the hurricane was now over, although millions of twigs and small branches that had been brought from a great distance were seen following the blast, as if drawn onwards by some mysterious power. They even floated in the air for some hours after, as if supported by the thick mass of dust that rose high above the ground. The sky had now a greenish lurid hue, and an extremely disagreeable sulphureous odour was diffused in the atmosphere. I waited in amazement, having sustained no material injury, until nature at length resumed her wonted aspect. For some moments I felt undetermined whether I should return to Morgantown, or attempt to force my way through the wrecks of the tempest. My business, however, being of an urgent nature, I ventured into the path of the storm, and, after encountering innumerable difficulties, succeeded in crossing it. I was obliged to lead my horse by the bridle, to enable him to leap over the fallen trees, whilst I scrambled over or under them in the best way I could, at times so hemmed in by the broken tops and tangled branches as almost to become desperate. On arriving at my house I gave an account of what I had seen, when, to my surprise, I was told that there had been very little wind in the neighbourhood; although in the streets and gardens many branches and twigs had fallen in a manner which excited great surprise.

Many wondrous accounts of the devastating effects of this hurricane were circulated in the country after its occurrence. Some log-houses, we were told, had been overturned, and their inmates destroyed. One person informed me that a wire sifter had been conveyed by the gust to a distance of many miles; another had found a cow lodged in the fork of a large half-broken tree. But as I am disposed to relate only what I have myself seen, I shall not lead you into the region of romance, but shall content myself with saying that much damage was done by this awful visitation. The valley is yet a desolate place, overgrown with briars and bushes thickly entangled amidst the tops and trunks of the fallen trees, and is the resort of ravenous animals, to which they betake themselves when pursued by man, or after they have committed their depredations on the farms of the surrounding districts. I have crossed the path of the storm at a distance of a hundred miles from the spot where I witnessed its fury, and, again, four hundred miles farther off, in the State of Ohio. Lastly, I observed traces of its ravages on the summits of the mountains connected with the Great Pine Forest of Pennsylvania, three hundred miles beyond the place last mentioned. In all these different parts it appeared to me not to have exceeded a quarter of a mile in breadth.

Description and Explanation of a simple Rain-Gage, calculated to show the depth of Rain fallen around it to the ten-thousandth part of an Inch. By Matthew Adam, A. M., Rector of the Royal Academy of Inverness, and Associate of the Society of Arts for Scotland. Communicated by the Author.

The parts composing this Rain-Gage, are represented in the annexed diagram, on a scale of $\frac{1}{8}$th of an inch to an inch; viz. 1st, A square-mouthed filler, A B *l c* D *m*, to collect the rain water, having the length of each side A B, A C, &c., of its mouth equal to 10 inches, or its superficial area equal to 100 square inches, and about half an inch of its mouth bent up, so as to prevent any part of the rain entering it from being afterwards blown out by wind. Its throat D is closed, with exception of 10 or 12 small holes, each about $\frac{1}{8}$th of an inch in diameter, to permit the descent of the rain water, and to retard its escape by evaporation. 2d, A large bottle E F G, which admits in-

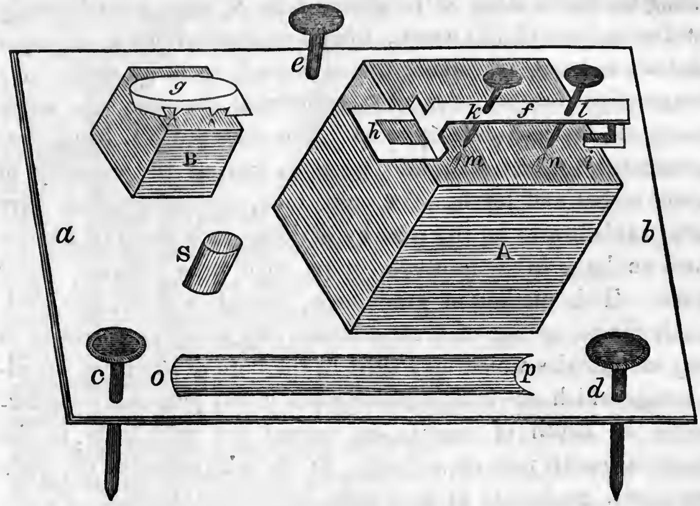


to its mouth a part of the tube D *m* of the filler, and is large enough to contain all the rain water which may thus enter it in the course of twelve hours. 3d, A cylindrical glass tube K L, having its inside diameter about ½ or ⅔ds of an inch, its lower extremity, L, hermetically closed, its upper extremity, K *k*, funnel-shaped, so that the rain water to be measured may be easily poured into it from the bottle; and one of its sides accurately graduated, from L to K, into portions having the capacity of cubic inches, and tenths, &c., of a cubic inch. 4th, A post D I, fixed vertically in a sheltered situation, and having, 1*st*, a horizontal shelf H G perpendicular to it, about 2 or 3 feet above ground, to support the bottle; 2*d*, A bent iron hoop *c d e*, fixed to post at *c* and *e*, so as to hold the bottle firmly in its place when exposed to storm; and, 3*d*, Two strong wire hold fasts, *f g*, *h i*, screwed into the post at *g*, and *i*, and formed so as conveniently to hold the graduated glass measure K L, that it may be always ready to ascertain the number of cubic inches, and tenths, and hundredths of a cubic inch, of the rain water which has entered the bottle, and consequently also the depth of rain which has fallen in the adjacent country in hundredth, thousandth, and ten thousandth parts of an inch.

Explanation.—The superficial area of the mouth of the filler being 100 square inches, it is obvious that 100 cubic inches of rain water must pass through it into the bottle, when 1 inch deep of rain falls in the adjacent country; that every cubic inch of this water, being the hundredth part of the whole, must indicate the hundredth part of an inch deep of rain; and that every tenth and hundredth part of a cubic inch of such water, measured in the graduated glass tube K L, must likewise indicate the thousandth and ten-thousandth parts of an inch deep of rain. If the inside diameter of the cylindrical glass measure K L be only half an inch, the circular area of a section of it, viz. $(\frac{1}{2})^2 \times .7854 = .19635$, or nearly $\frac{1}{5}$th of a square inch, will be contained 509 times in 100 square inches, the area of the square mouth of the filler. And as the depths of square and cylindrical measures of equal capacity are inversely as the areas of their bases, it is clear, that to measure 100 cubic inches of rain water, which may be contained in one inch deep of a square mouthed measure, whose side is 10 inches, there will be required a depth or length of 509 inches of the cylindrical glass measure, whose diameter is only half an inch. Consequently the hundredth part of this length, or 5 inches and nearly $\frac{1}{11}$th of an inch of it, will be required to contain 1 cubic inch, or to measure the hundredth part of an inch deep of rain. Half an inch of it will be required to contain $\frac{1}{10}$th of a cubic inch, or to measure the thousandth part of an inch deep of rain; and consequently the $\frac{1}{10}$th part of $\frac{1}{2}$ inch, or $\frac{1}{20}$th of an inch of this measure, will be required to contain the hundredth part of a cubic inch, or to measure the ten-thousandth part of 1 inch deep of rain. If a similar measure, $\frac{2}{3}$ds or $\frac{3}{4}$ths of an inch in diameter, be graduated in the same manner, the divisions, even when carried only to tenths or to twentieths of a cubic inch, are sufficient to enable a careful observer to determine the depth of rain fallen around the gage to the ten-thousandth part of an inch. Because by inspection, he can easily judge of the tenth or the fifth part of the smallest division on the scale; which tenth or fifth, being about $\frac{1}{40}$th of an inch in length, indicates the $\frac{1}{100}$dth part of a cubic inch, or the ten-thousandth part of a depth of 1 inch of rain. Here it is obvious that the metallic filler, and the graduated cylindrical glass measure, are the principal parts of this rain gage; that its value depends on the accuracy with which these parts are constructed; and that it may be very accurately made at half the expense of the common and patent rain gages, which show the depth of rain falling around them only to the hundredth part of an inch.

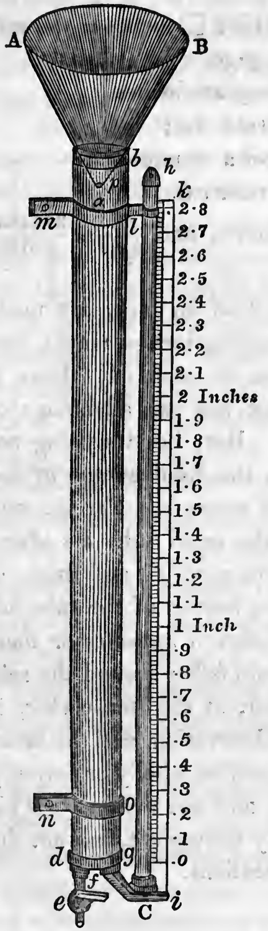
The rain gage above described, has been in use since the 18th of September 1829, and appears to Mr Adam to answer its purpose well. For, though the inside diameter of the largest graduated measure used is nearly $\frac{3}{4}$ths of an inch, the distance between the divisions marking $\frac{1}{20}$th of a cubic inch is equal to about $\frac{1}{8}$th of an inch, and by inspection he can easily observe to $\frac{1}{5}$th of this distance, or the depth of rain falling around the rain gage to the ten-thousandth part of an inch. But a smaller measure, with larger divisions, is occasionally used for minute quantities of rain. The depth of rain is therefore entered in the register in inches, and four decimals of an inch. The first two decimals being obtained from the cubic inches, and the last two from the tenths and decimals of the tenth of a cubic inch, on the graduated measure. Thus a quantity of rain measuring 17 cubic inches $\frac{7}{10}$ths and $\frac{9}{100}$dths of a cubic inch in the graduated measure, is marked .1779 of an inch deep in the register: and a quantity of rain measuring only $\frac{2}{100}$dths of a cubic inch in the graduated measure, is marked .0002, or 2 ten-thousandth parts of an inch in the register. This latter portion is an extremely minute quantity of rain. But there are many such minute entries in the register, varying from 1 to 12 ten-thousandth parts of an inch. And it is remarkable, that many of them are noted as miniature showers, or depositions of dew, from the air enclosed in the bottle; these depositions having been observed to vary in quantity with the variations of sky and temperature, and to take place frequently at periods when the sky was clear, and always, when thus entered, at times when no rain fell from the external air. These entries may therefore, it is thought, be considered as measurements of miniature showers, or dew, deposited by the air contained in the bottle, under the varying temperatures and states of weather noted in the Register.

In order to graduate the cylindrical glass measure K L with the utmost accuracy, Mr Adam constructed two cubic tin-plate measures A and B, the one upon a cubic inch of hard wood, and the other upon a similar cube made exactly equal to the $\frac{1}{10}$th part of a cubic inch, each of its sides being $= \sqrt[3]{\frac{1000}{10}} = \sqrt[3]{100}$ $= 4{\cdot}6415$ tenths of an inch, so that, when both measures were carefully levelled upon a plane table *a b*, supported by three screws *c*, *d*, *e*, ten fills of the latter filled the former so exactly, that a single drop added to, or subtracted from, the amount, caused the surface of the water in the cubic inch measure A to be either slightly convex or concave, that is, to be either heaped or not completely full. But, as the eye cannot decide when a cubic measure is completely filled with water, and not heaped, Mr Adam constructed two level triers, *f*, *g*, one for each of the measures, A, and B, capable of detecting a deviation from an



exact fill of either measure by a single drop from a fine tube, or by less than the thousandth part of an inch. This was effected by bringing the flat and sharp supports, *h*, *i*, and the fine points of the screws, *k*, *l*, of the level trier *f*, for example, exactly into the same plane, upon a piece of plate glass, before it was placed on the mouth of the cubic measure A. That measure being placed on the table *a b*, and nearly filled with water, was then accurately levelled by turning one or more of the screws *c*, *d*, *e*, of the table, until the distances between the fine points of the screws *k*, *l*, of the level-trier *f*, and their reflected images, *m*, *n*, seen in the water, appeared to be perfectly equal when the level-trier was placed successively in different directions upon the mouth of the measure. The measure was then filled up by means of a small glass dropping tube, until the fine points of the screws *k*, *l*, and their reflected images *m*, *n*, came exactly into contact. This was done with such precision, that less than a single drop too much, or too little, was easily detected in either of the measures, especially in the smaller measure B. When the measures A and B were thus adjusted, and a tin-plate tube *S*, made exactly to fit, and slide upon the cylindrical measure KL of the rain gage, its graduation from L to K was commenced by pouring into it successive fills of the measure B, and graduating it, at each fill, by means of a fine diamond pencil drawn across the tube KL, along the upper edge of the sliding tube *S*, when placed exactly at the surface of the water; three longitudinal lines, at proper distances, being previously drawn from L to K by means of a longitudinal section, *o p*, of a cylindrical tin-plate tube made closely to fit, and slide upon it. The measure KL being thus graduated, or divided, into portions having the capacity of cubic inches and tenths of a cubic inch, the subdivisions were afterwards drawn on the tube by dividing each tenth of a cubic inch on large tubes into two, or on small ones into ten, equal parts. This method of graduation, though tedious, has obviously the advantage of great accuracy, by being independent of any inequalities which may exist in the bore of the tube, an advantage which was indispensable when it was proposed to determine the depth of rain fallen around the rain gage to the ten-thousandth part of an inch. If the graduation of the glass measures, professing to shew cubic inches and decimals of a cubic inch, sold in the chemical apparatus shops in London at four or five shillings each, could be depended on, the rain gage above described might be procured at the expense of a few shillings. But, as this is not the case, where much accuracy is wanted, it is necessary to incur the higher expense, or the trouble, of a careful graduation.

The common rain gage, represented in the annexed diagram A B *c h*, on a scale of $\frac{1}{8}$th of an inch to 1 inch, as made and sold in Edinburgh at L. 4, 4s., has a funnel-mouthed brass cap A B *a* about 7 inches in depth, of which the lower part *a b* slides about 2 inches tightly over the upper extremity of a cylindrical brass tube *b d*, 2·07 inches in inside diameter, and 30·5 inches in length. The lower extremity *d g* of this tube is furnished on one side with a stop-cock *d e*, and on the other with a strong brass canal appendage *f c i*, through which the rain water descends and rises in the glass tube *c h* until its surface be at the same level in both tubes. To one side of the glass tube *c h*, which is ·564 of an inch in inside diameter, and 30·5 inches in length, is closely applied a graduated brass scale *i k*, rivetted to a strip of mahogany, and, with the glass tube, supported by the appendages *f c i* and *l k*. The appendages *m l*, and *n o*, have countersinked holes drilled in them at *m*, and *n*, by which the rain gage may be screwed to a post in the place selected for its use. The funnel mouth of the brass cap AB *a* terminates on the inside at the depth of 6¼th inches by an aperture *p*, about ⅓th of an inch in diameter, through which the rain entering at AB descends into the tube *b d*, and rises in the glass tube *c h*; at *h* the glass tube is covered with a brass cap about 1 inch in length, through the top of which is drilled a hole about $\frac{1}{20}$th of an inch in diameter, to permit the escape of the inclosed air when the water ascends in it, and, like the small aperture at *p*, to retard by its smallness the escape of the water by evaporation, until it has been observed and noted in the register; after which it is permitted to escape by turning the stop-cock at *e*.



Now, the lengths of cylinders of unequal diameters, which contain equal quantities of rain, being inversely as the areas of their bases, or of sections parallel to them, in order to find the length of a division on the scale *i k*, which shall indicate a depth of 1 inch of rain fallen around the rain gage, it is necessary to calculate the area of the circular mouth AB, and also those of parallel sections of the tubes *b d*, *c h*; then, dividing the former by the sum of the latter, the quotient will indicate the length of the required division for 1 inch, by the repetition and subdivision of which the requisite divisions or graduation of the scale will be completed, on the supposition that the tube to which it is applied is truly cylindrical, though such tubes are seldom, if ever, found of the required length.

Thus, let $a = (6{\cdot}8)^2 \times {\cdot}7854 = 36{\cdot}31689$ □ inches = the area of the circular mouth A B of the rain gage.

$b = (2{\cdot}07)^2 \times {\cdot}7854 = 3{\cdot}36536$ square inches

= the area of a circular section of the tube *b d*;

and $c = ({\cdot}564)^2 \times {\cdot}7854 = {\cdot}24983$ of a square inch

= the area of a circular section of the tube *c h*.

Then $b + c = 3{\cdot}61519$ square inches, and $\frac{a}{b+c} = \frac{36{\cdot}31689}{3{\cdot}61519}$ = 10 inches nearly.

Therefore 10 inches, 1 inch, and $\frac{1}{10}$th of an inch, are made the lengths of the several divisions, marking inches, tenths, and hundredths of an inch deep of rain on the scale *i k*. Here it may be remarked, that this rain gage has the advantage of giving little trouble to the observer. But, besides being not very minute in its indications, it has the disadvantage of not measuring the whole of the rain which enters it. For the rain which enters it must fill $1\frac{1}{2}$ inch of the small tube *d e* above the stop-cock *e*, and also 3 inches of the canal *f c* and tube *c h*, before any part of it can remain on the bottom of the tube *bd*, or reach .0 on the scale *i k*, that is, before it indicates or measures any portion of the depth of the rain fallen around the rain gage. Now the former source of error, at the stop-cock *e*, is evidently repeated at every successive observation, and the latter at *f c*, in consequence of evaporation, is either wholly or partially repeated at every interval between dry and wet weather. This rain gage, therefore, though sufficiently convenient, has not the advantage of much accuracy in its indications.

Inverness, 28*th January* 1832.

General View of Meteorological Observations for the Years 1830 *and* 1831, *extracted from the Register kept by Matthew Adam, A. M., Rector of the Royal Academy of Inverness, in Lat.* 57° 30′ *N. and Long.* 4° 12′ *W. from Greenwich, at an altitude of about* 30 *feet, and distance from the sea of about one mile.*

Months.	Year 1830.				Year 1831.			
At 9h. 30m. A. M. and at 8h. 30m. P. M.	Mean of the lowest temperatures at night.	Mean of the observed mean temperatures (at 9h. 30m. A. M., and at 8h. 30m. P. M.)	Mean of the altitudes of the Barometer A. M. and P. M.	Monthly depths of Rain A. M. and P. M.	Mean of the lowest temperatures at night.	Mean of the observed mean temperatures (at 9h. 30m. A. M., and at 8h. 30m. P. M.)	Mean of the altitudes of the Barometer A. M. and P. M.	Monthly depths of Rain A. M. and P. M.
	Degrees of Fahrenheit.	Degrees of Fahrenheit.	Inches.	Inches.	Degrees of Fahrenheit.	Degrees of Fahrenheit.	Inches.	Inches.
January,..	33·63	38·17	29·98	0·8140	32·183	34·96 —	29·79	0 9620
February,	32·64	36·85	29·623	1·4174	34·43	39·305	29·10 —	2·5752
March, ...	39·46	44·99	29·68	2·3266	38·61	44·39	29·587	2·3884
April,......	40·315	48·45	29·521	1·8917	40·32 —	47·42	29·637	1·4694
May,......	44·951	52·25	29·062	1·2339	41·226—	50·355	29·895	1·3365
June,......	45·75	55·08	29·535—	2·6829	52·00	60·465	29·787	1·1766
July, ...	52·50	59·363	29·683	5·2772	54·70 —	62·74	29·80	2·0712
August,...	48·76	55·403	29·686	2·3156	55·40	62·41	29·80	1·5130
Septemb.	47·583	54·16	29·459	3·3613	48·90	55·60	29·76	2·0460
October,..	44·20 —	50·455	29·937	1·0714	47·97 —	53·43 +	29·49	1·8105
Novemb. .	38·15	43·226	29·461	3·7770	36·17 —	40·40	29·59 +	3·7897
December,	32·05 —	35·807	29·513	2·4026	39·15 —	42·935	29·52	1·9927
				Ann. depth of Rain.				Ann. depth of Rain.
Annual Means,	41·666—	47·846 +	29·595	28·5716	43·422—	49·534—	29·646	23·1312

N. B. The mean temperatures, and the atmospheric densities or varying barometric pressure, whose monthly means are noted in the above table, and also the depths of rain, shown by Mr Adam's Rain Gage to four decimal places, or to the ten-thousandth part of an inch, were observed and noted each day at 9 h. 30 m. A. M., and likewise at 8 h. 30 m. P. M., as recommended by the Royal Society of Edinburgh; but the lowest temperatures at night, shewn by a Register Thermometer, were observed and noted only at 9 h. 30 m. A. M. In the year 1830 the extremes of the lowest temperatures at night, viz. 22½° and 63°, occurred on 20th February and on 28th July, while those in 1831, viz. 11° and 61°, occurred on 1st February and on the 9th of both July and August.

By inspection of the above Table for the years 1830 and 1831, it will be observed that there is a marked difference between the mean temperatures, the mean atmospheric densities or pressures, and the depths of rain, which occurred in the same months of these two successive years; that the mean temperature of 1831 commenced lower, rose to a greater elevation in June, July, and August, ended higher, and exhibits a decidedly higher annual mean than the corresponding mean temperature of 1830; that the monthly depths of rain for 1831 commenced higher, but in June, July, and August, descended much lower, ended lower, and exhibit a decidedly lower annual amount, than the corresponding monthly depths and annual amount of rain for 1830; and that the mean barometric pressure, or atmospheric density, appears in general to increase with an elevation of the mean temperature, and to diminish with an increased depth of rain, and, consequently, that the mean annual atmospheric density of 1830 was, as it should be, under the circumstances noted in the Table, considerably less than that of 1831.

The varying force and directions of the wind, the auroræ boreales, solar and lunar halos, &c., entered in the register, are necessarily omitted in this general view of the phenomena.

M. A.

On the probable Origin of Mineral Springs. By C. E. Stifft, formerly Mining Engineer to the Duke of Nassau.

When it was the fashion to refer volcanic phenomena to burning beds of coal or the decomposition of iron-pyrites, mineral waters were considered, as a matter of course, to derive their origin from the same source. Although, now-a-days, it is scarcely necessary to demonstrate the insufficiency of these hypotheses, they shew in a very striking manner that very early these two classes of phenomena were considered as deducible from one common origin, or at least stood to each other in the relation of cause and effect. Others thought, that the state of igneous liquidity, although no longer visible in the consolidated crust of our globe, might still exist in its interior, and give rise to both the appearances in question. A third class considered their origin as more explicable upon the supposition of immense strata of sulphur of bitumen, or of the metallic sulphurets existing in the earth's interior. And a fourth thought it most reasonable to suppose, that in the subterranean laboratories were carried on immense galvano-electrical processes, comprehending within their compass whole mountain chains. In support of all these hypotheses many facts have been brought forward. Every one, however, is exposed to numerous contradictions, and there are many facts which can be explained upon none of them. Whatever may be the value of these speculations, or the merit of their proposers, as men who have materially advanced the domain of science, it appears to me that none of them are founded upon any thing like certainty with respect to the *primary cause.* I lay it for the present aside altogether, although it appears to me very probable that at a great depth a focus must be supposed to exist, in which, as a primary cause, are elaborated, the natural products which appear to us in the form of volcanoes and mineral springs. I therefore do not consider volcanic rocks and mineral waters as standing to one another in the relation of cause and effect; but as the products of one and the same cause, of the great volcanic focus existing in the interior of the globe. So long as the gaseous exhalations of this focus are retained by the great mass of superincumbent rock, the intensity of their pressure must gradually increase, till at last they force themselves out by the elevation and tearing of the strata, and the eruption of gas. Hence the different lavas and volcanic rocks. But should a free exit be permitted to these gases through fissures and canals already existing, volcanic eruptions could no longer take place, while these products would find a continued and peaceful issue in the form of mineral springs; the meteoric waters which sink downwards through different fissures serving as their conductors to the surface of the earth.

What powers have operated and still maintain the activity of this focus will for ever remain beyond the bounds of our knowledge. Supposing, moreover, this focus to exist, and that volcanoes and mineral springs are its outward manifestations, men's opinions will still remain divided regarding their mode of production. Some will consider mineral springs, and also volcanic eruptions, as the direct products of this focus. Others will limit its agency to the determining of certain chemical processes, and consider mineral waters as derived from the lixiviation of the rocks which they have met in their subterranean passages.

I believe that I have been the first publicly to maintain the former of these opinions. I have been induced to adopt it on the following grounds.—

1. The very general distribution of mineral springs over the earth's surface, and their emergence from every rock formation, without regard to its relative age or composition. Mineral springs of exactly the same character are seen to issue both from the oldest granite and the newest tertiary formations, in the same way that volcanic products traverse the whole series of formation.

2. The uniformity and permanency in their constitution and temperature, and in all their leading characters; a similar uniformity is equally characteristic of the volcanic products of a district.

3. The gaseous exhalations which accompany both mineral springs and volcanoes.

4. The occurrence of most of the ingredients of mineral springs as sublimates in volcanoes.

5. The inconsiderable effects of very extensive and destructive earthquakes in those districts where mineral springs emerge from the bowels of the earth.

6. The evident influence of violent earthquakes upon mineral springs at immense distances from the seat of convulsion. This fact is in my opinion of great importance, as it seems to demonstrate that the focus of mineral waters is at a great depth, and cannot be deduced from any local cause.

7. The known fact, that very often volcanic eruptions are accompanied by the bursting out of new thermal springs, which sometimes cease when the volcanic agency becomes feeble, sometimes return periodically like the eruptions themselves.

Besides this, from all those districts which bear the traces of former volcanic activity, there also issue mineral springs which present in a greater or less degree those characters which distinguish volcanic products. Sulphureous springs, for instance, appear in those districts where sulphureous sublimations are a product of volcanic activity. Przystanowski considers beds of sulphur as the cause of volcanoes; to me they seem to be merely the sublimations consequent upon their activity. If only gas rose from the orifices of our sulphureous springs, we would see the formation of similar sulphur beds. In this way I explain the existence of native sulphur which is found at Ems between the greywacke strata from which the thermal waters issue, but in situations where no springs exist. It does not follow from these principles that we are to exclude the action of atmospheric causes. On the contrary, I am of opinion, that by far the greater quantity of the water of hot springs, and all that of cold springs, is derived from the atmosphere, which is conducted by well known modes into the interior of the earth, and unites partly with the water of the matters which go to prove the central focus, partly without reaching as far as the focus, merely takes up the exhalations and sublimations it finds in its progress, and reissues at the surface according to the known laws of hydrostatics, aided no doubt in some measure by the pressure of the ascending gases.

This explains why hot springs, with few exceptions, are generally more powerful, and more strongly impregnated with solid matters than cold, and why they are more independent than the latter on changes of the seasons, weather, &c. The opinion which considers that mineral waters derive their impregnation from a solution or lixiviation of the rocks which they traverse, assumes, in common with the preceding one, the existence of a central focus, whether it be an active or extinguished volcano, or merely the heat still remaining as a consequence of the former fluid state of the earth. The vapours ascending from this centre, according to this theory, prepare the rocks for solution in the water which penetrate from above, as well as communicate to this water a greater solvent power or capability of taking up the different mineral matters which they may meet in their course.

In my opinion, the two last theories are most in accordance with facts, but as one only can be the correct one, the many contradictions to which the theory of solution is subject, are so many negative proofs in favour of considering mineral springs as direct products of the common focus, with this similarity, that upon either view the water penetrates from above. The following are therefore a few of the considerations which appear to me to oppose the theory of lixiviation.

It is now an established fact in the history of mineral waters, that their impregnation is generally nearly the same at all times even after very long intervals. But, as the water does not percolate through the whole mass of the rocky strata, but takes its course through the different fissures and canals by which they are traversed, it is evident that its solvent power can act only on the walls of these canals, and even supposing it to extend farther, it must always find a limit at no great distance. Whenever, therefore, the solution of all the soluble matter within these limits is completed, the impregnation of the spring must gradually decline, and finally disappear altogether; which is directly the reverse of what is observed.

On the other hand, this uniformity is easily explained on the theory of sublimation. The conducting channels of any water remaining the same, as well as the focus from which it derives its foreign constituents and the capacity of the water itself, the impregnation of the spring must necessarily continue the same also.

Bichof has answered in a satisfactory manner the objection which has been made to the theory of solution, on the ground of the prodigious amount of the solid ingredients of mineral waters, by shewing that the quantity contained in the rocks is more than sufficient for their fullest supply during the longest periods. But to make use of this superfluity, it is necessary that the water do not merely traverse the conducting channels, but have free access to the interior of the rocky masses, for otherwise they would have no influence on the process of solution.

But if, in spite of this contradiction, the water should be supposed to have free access to every part of the mass, then, in consequence of this solution, these different rocks would undergo an inevitable change of composition. Where, however, I may ask the geognost, do we find these changed basalts, clinkstones, and greenstones? A clinkstone or a basalt which has been deprived of its carbonate of soda, is no longer either a clinkstone or basalt. We certainly observe that almost all mineral waters exert a sort of action on the surrounding rocks, converting them into an earthy sort of mass; but these effects are limited to the immediate vicinity of the springs, and consequently cannot be taken into account in the present instance. These changes seem, moreover, to consist rather in a diminution in the cohesion of the parts of the rock, than in their chemical decomposition. Hot springs generally burst out in the lowest situations, and are more abundant both in water and in foreign contents, but contain less gas, especially less carbonic acid, than cold springs which emerge at a greater elevation. This rule holds true both of the hot springs of Nassau and Bohemia. Now, this is directly the reverse of what we ought to expect, according to the theory of solution; for the carbonic acid ought to promote the solvent power of the water on the rock. Cold springs, which contain a larger dose of this acid, ought to attack the rock with greater force, and the more as, on account of their greater elevation, they are longer in contact with it, and contain more solid matters, which is the contrary of what actually occurs.

Recent researches have detected many ingredients in mineral waters, which were in vain sought for by the older analysts. This seems to me to be also at variance with the theory of solution, which might explain the want of an ingredient formerly known to exist; but not the occurrence of a new substance, especially when of easy solubility, as the carbonate of soda, which has been lately found in the Pyrmont water. The great quantity of carbonic acid which rises from the interior of the earth, has been explained upon the supposition of the existence of great deposits of carbonate of soda in the focus of volcanic activity. Is it not, then, much more reasonable to suppose that this alkaline salt found in mineral waters, ascends from this focus, than that it was lixiviated from the solid rock? The former is certainly the more credible, when we know that carbonate of soda is sublimed during volcanic eruptions.

Besides, it is a well known fact, that almost all the constituents of mineral springs have been also found in the form of sublimates, such as the muriate of soda, muriate and sulphate of lime, sulphur, iron, &c. Why should these, then, be supposed rather to exist in combination with the rocky masses, from which they are to be washed out by the water, than as sublimations in the different fissures and canals through which the water circulates? The latter supposition is certainly by far the simpler of the two.

An experiment performed by Breislak * goes far to support my opinion. He collected and condensed the vapours which ascended from the Solfatara, and found that they yielded him daily from six to seven vessels, each of the capacity of 480 bottles, of a mineral water containing sulphuretted hydrogen, muriate of ammonia, sulphate of alumina, and sulphate of iron. What was here artificially effected by Breislak is carried on by Nature herself, on the great scale, when she combines the products ascending from the earth's interior with the atmospheric waters descending from its surface.

As far as the present state of our knowledge admits, I hope that my view regarding the origin of mineral waters rests upon solid grounds. Future experiments are requisite either to establish it on still firmer arguments, to give it still greater extension, or to substitute in its stead another and a better theory. If, then, mineral springs and volcanoes are effects of one and the same cause, and as we know that the latter are not in a state of incessant activity, but are sooner or later extinguished; can it be established by observation that such will be likewise the lot of mineral springs?

This question can hardly be positively answered, because the period since which mineral waters have been the object of scientific research is far too limited; for it is only very recently that the sciences have reached such a pitch as to enable us to prosecute these inquiries with sufficient precision. Even the method of decomposing mineral waters renders it difficult to observe such a change, if it should occur, unless it be very considerable. Yet I fear that, as far as we can at present answer the question, it must be supposed that all of them will one day cease to flow

* Breislak, Reisen durch Campanien, ii. 56. 1802.

from the earth's interior; for the very reason that their phenomena are not periodical, like those of volcanoes, it will always be difficult to note a diminution which is incessantly going on. For this purpose, a series of continued and exact observations would be requisite, such as has never been yet instituted; but, to render them available for the solution of the problem, they would require to be prosecuted for centuries, which cannot be the work of a single observer. The proprietors of mineral waters may, therefore, console themselves with not being disturbed in the quiet possession of their monopolies, since they have less to fear from this consideration than from the changes and revolutions in the systems and fashions of medicine, which are at present so much in their favour.

It is farther probable that hot springs will last longer than cold; and those which lie low than those at considerable elevations.

M. Stifft has concentrated into the following propositions the results of his observations on the mineral waters of Nassau, in connection with the geological constitution of the country:

1. Mineral springs are generally independent of the geognostic structure of their immediate vicinities.

2. A mineral water, whatever may be its constitution, seldom appears isolated, but is in almost every case grouped along with others into linear series of greater or less regularity.

3. The strata in the vicinity of mineral springs often exhibit marked undulations, amounting, in some cases, to a total rupture of their continuity.

4. The rocky strata in the vicinity of many mineral waters are often in a state of dissolution, converted into a soft argillaceous mass, or into an accumulation of sandy particles—a state very much resembling the *faults* of miners.

5. In their natural state, mineral springs generally emerge from a marshy soil.

6. Thermal waters are generally more abundant, and are more largely impregnated with solid matters than cold springs, but contain a smaller quantity of gaseous matters in a state of combination with the water.

7. Generally mineral springs follow the course of mountains composed of igneous rocks.

Notice regarding a Specimen of Siren lacertina which was preserved alive for more than six years at Canonmills, near Edinburgh. Communicated by Mr NEILL.

IN the number of this Journal for April 1828, (vol. iv. p. 346 *et seq.*), an account was given of the habits of a specimen of Siren lacertina, which had then been kept at Canonmills for more than two years. In the course of that time it had not undergone any change, nor shewn any symptom of being a larva or imperfect animal, which some eminent naturalists had supposed the siren to be. The reptile continued alive and well till October last, when it had got over the brim of its reservoir, and perished before its escape was observed.

It may be proper briefly to recapitulate some parts of the history of this specimen. It was sent in May 1825, by Dr Henry T. Farmer, from Charleston, South Carolina, where it occurs sparingly in rice marshes, to Dr Monro, Professor of Anatomy in the University of Edinburgh. It came in a small barrel, having a perforated lid, and the lower part containing some of the native mud of the reptile, among which it nestled. Having long been in the practice of keeping alive such curious animals as occurred, Dr Monro put the siren under my care, that it might be preserved in life as long as possible. I may remark that M. Bosc, when in America, having failed to procure a live specimen for the collection at the Jardin des Plantes, we may conclude that Dr Monro's was the only living example which had ever been seen in Europe. I believe that the animal occurs also in creeks of the Mississippi and Ohio; for M. Audubon, the celebrated American ornithologist, happening to be at Edinburgh in the spring of 1830, paid me a visit at Canonmills; and recognised the siren as an old acquaintance, occasionally taken in the trawl-nets, and called by the fishermen *water-dog* and *water-puppy*.

At first I placed the animal in a water-box, containing a quantity of hypnum and sphagnum, and set on the trellis of a green-house or conservatory. One evening, in May 1826, the animal made its escape over the edge of the box, and must have fallen nearly three feet. It had on that occasion remained from ten to twelve hours out of the water; but it had burrowed in moist earth during most part of that time. In formerly mentioning this circumstance, I stated (vol. iv. p. 353.), that "the branchiæ were doubtless to a certain degree dried, and thus obstructed, and it evidently took some time before they could freely perform their accustomed office." In April 1827, I transferred the siren's reservoir to a bark-stove or hot-house. Here it became more lively, and ate earth-worms, bansticles, and small minnows more greedily.

In the summer of 1828, a drawing of the animal was made by my excellent friend Mr Patrick Syme (now of Dollar Academy), for No. VI. of the "Illustrations of Zoology" of another distinguished friend, Mr James Wilson. On that occasion, the siren was kept for several hours, on different days, in a shallow white assiette, with merely a sufficiency of water to preserve the gills in a moist state; and the animal repeatedly got upon the table, and even made its way to the floor, but did not at all suffer from this degree of exposure to the atmosphere.—I may remark, in passing, that Mr Syme's drawing is of the size of nature, and forms by far the best representation of the animal which has been published; and that the copious letter-press by Mr Wilson embraces all the correct information concerning its structure and habits, detailed in the luminous and pleasing style which characterizes all the writings of that naturalist.

During the years 1829 and 1830, and down to October 1831, the animal continued to inhabit the same reservoir in the hot-house; but we had found an inclined plane (which we at first placed in the reservoir) to be unnecessary, as the siren never shewed any inclination to avail itself of it, and we had discontinued the use of mosses, as these rendered the water turbid, particularly when the sphagnum began to decay. I may here notice, however, that the turbid state of the water had enabled us to make one slight observation. The minute particles of decayed sphagnum were so exactly of the same specific gravity as the water, that they floated about in every possible direction; and during sunshine, when the siren was lying perfectly quiescent at the bottom, gentle currents were discernible, by means of these particles, constantly flowing from the clefts in the branchial apparatus, and occasionally exciting languid motions in the delicate fimbriæ at their extremities. We thought that we observed in the animal a preference for pure water, as it regularly became more lively as often as the water was changed; and we found by experience that any floating foliage that served to hide or cover it, was highly agreeable to its dispositions. We therefore at last adopted the plan of keeping a large patch of frog-bit (Hydrocharis morsus ranæ) constantly vegetating on the surface. This tended also to keep the water from corrupting. When this floating patch was slowly moved from side to side of the reservoir, the siren kept most accurately beneath it, endeavouring to avoid observation; and in this exercise it shewed great alertness and sagacity.

On the morning of the 22d October 1831, the siren was found by the gardener lying dead on the paved footpath of the hot-house, not far from the reservoir. It did not appear to have met with any injury in its fall from the reservoir, which was placed on a trellis about three feet above the pathway. The fall indeed must have been broken by intervening flower-pots, and no external marks of lesion appeared on the body. The fine fimbriæ of the branchial apparatus, however, were completely dried and shrivelled up; and I have no doubt in my own mind that the death of the animal arose from this cause. The older naturalists supposed these fimbriæ or fringes to be opercula or gill-covers, and regarded the vertical clefts or perforations in front of the fringes as the true gills; but Mr Wilson is certainly right in considering the fringes as the true gills.

In the New York Medical and Physical Journal for June 1824, Dr Samuel L. Mitchell gives an account of the examination of several specimens, dead and alive, which had been transmitted to New York by the same Dr Farmer of Charleston who sent the living specimen to Edinburgh. Dr Mitchell seems to think it most probable that the air-sacs, called lungs, do not perform any direct respiratory function, but are mere receptacles of air, performing only an auxiliary service, in occasionally furnishing the branchiæ or gills with the atmospheric air which the animal from time to time inhales, and which is detained in these receptacles till wanted. I cannot help thinking that this view acquires additional probability from the circumstance of the Canonmills siren having died without any other apparent cause than the exsiccation of the extreme fimbriæ or fringes, that is, the true gills.

The Siren, therefore, came into my possession in June 1825, and lived till October 1831, or for the space of six years and four months. During that long period, no structural change took place, nor was the slightest tendency to any such change discernible. The animal had evidently increased in size. When it arrived it was "nearly a foot and a half long," (Edin. New Phil. Journ. vol. iv. p. 349). When it died, it was fully twenty inches in length; and it had also perceptibly increased in grossness. It may therefore, I think, be pretty confidently concluded, that it is no larva, though Pallas and De Lacepede considered it in that light; but a perfect animal, according to the view early adopted by Linnæus, and now sanctioned by Cuvier*

CANONMILLS,
14*th December* 1831.

On the Fossil Bones of Wellington Valley, New Holland, or New South Wales†. By Mr PENTLAND. Communicated by the Author.

A. GENUS DASYURUS.

A. 1. Portion of the right branch of the lower jaw, containing the three posterior molares.

A. 2. Portion of the superior maxillary bone of the right side, containing the third and fourth molares, and the alveoli of the two anterior molares.

C. 3. Portion of the superior maxillary bone of the left side, containing one molar tooth, much worn down by age.

A. 4. One of the metacarpal bones, probably the external of the left metacarpus.

* We hope to be able, in some future Number, to give an anatomical and physiological account of the examination of the internal structure of the specimen, which was restored to Dr Monro with this view.—EDIT.

† The numbers refer to the specimens which we have deposited in the Edinburgh College Museum.—EDIT.

A. 5. Fragment of one of the lower canine teeth.

C. A. 6. Fragment of the anterior part of the superior maxillary bone, containing the left canine tooth.

I agree entirely in opinion with my friend Mr Clift, that these specimens are referable to an animal of the genus Dasyurus, and to a species, if not exactly the same, at least very nearly allied to the Dasyurus Ursinus of Harris (Lin. Trans.). I have compared the fossil specimens 1. and 2. with the head of the living species, belonging to the College of Surgeons in London; and although resembling in many respects, it appeared to me that there existed a difference in the form of the teeth, to warrant my concluding that the fossil remains belong to a variety of the D. Ursinus, not identical with the living, and which, on comparing more perfect specimens, may be found to constitute a distinct, and consequently new, species of this genus.

It may not be unnecessary to observe, that the D. Ursinus is the only living species of this genus approaching in size (although inferior in stature) to the fossil, (the D. Cynocephalus of Harris, constituting the genus Thylacinus of Temminck), and is at the present day confined to Van Diemen's Land.

B. Genus HYPSIPRYMNUS.

B. 1. Portion of the head, containing the three anterior molares *in situ*, on each side, with the alveoli of the fourth.

I have carefully compared the fossil specimen with the heads of the several species, many simple varieties of Kangaroo Rat described by modern zoologists, and have found it to correspond exactly with none of them. In size and general form it resembles more the *Potoroo Leseur* of Quoy and Gaymard (a species found by these naturalists on the Island of Dirch Hartich, in Seal's Bay) than to any other. The most marked difference which the fossil offers with the living species consists in the great extension of the bony palate posteriorly, which, in all the living specimens I have examined, some of which were old individuals, never extended beyond a transverse line passing through the spaces which separates the 2d and 3d molares:

whereas, in the fossil, the bony palate will be seen to extend as far back as the posterior edge of the 4th molares. I am therefore led to consider the fossil Hypsiprymnus as different from all the known living species of this genus.

C. GENUS MACROPUS, OR KANGAROO PROPER.

C. 1. Portion of the pelvis of the left side of a very large kangaroo.
2. Inferior extremity of the femur of a very large species of kangaroo.
3. Fifth caudal vertebra of a large species of kangaroo.

These three specimens appear to me to belong to a species of kangaroo, differing from any of those known to zoologists, by its superior stature; these bones resemble in every detail of their configuration to the same in the Macropus major of Shaw, but exceed them in dimensions in the proportion nearly of 3 : 2. We may reasonably conclude, therefore, that the animal to which these fossils belonged, differed by its gigantic stature alone from all the known living species of the genus Macropus.

C. 4. Fourth lumbar vertebra of a kangaroo, scarcely equal in size to the Macropus major.
5. Fragments of the lower jaw of a kangaroo, containing the three posterior molares.

These two specimens belong to a species which does not appear to differ materially from the living varieties of the same size; in this latter respect they correspond nearly to the Macropus rufo-griseus of Peron and Lesueur.

C. 6. Fragment of the lower jaw on the right side, containing the four anterior molares, and the socket of the fifth, of a kangaroo of the size of the M. major.
7. Fragment of the right tibia of the same species.
8. Fragment of the upper maxillary bone of the left side, containing the four posterior molares.
9. Two posterior molares of the same species.

The specimens No. 8. and 9. belong to a species of kangaroo very distinct from any of the preceding, and easily distinguished by the square form of the molares; in which respect, as well as in size, the fossil more nearly resembles the Macropus ruficollis of Peron and Lesueur than any other living species, although evidently different. The M. ruficollis inhabits the neighbourhood of Port Western and Bass' Straits.

C. 10. Portion of the humerus and ulna of a kangaroo, which, from their proportions, belong probably to the same species as specimens C. 4. and 5.

From what precedes, it will appear that the fossil bones of Wellington Valley present us with at least three species of kangaroo, if not four, of which two are evidently distinct from all the known varieties. I have been enabled to compare them with the skeletons of all the species described by authors, with one single exception, which is the Macropus rufus of Desmarest, probably the M. Lanigerus of Hamilton Smith, a species inhabiting the same district in which the fossils have been discovered. To pronounce definitively, therefore, that the fossil belongs to an unknown species, or one no longer in existence, it will be necessary to examine the skeleton of the M. Lanigerus, which cannot be done at present, as no specimen exists in any European museum *.

D. Genus HALMATURUS.

D. 1. Fragment of the left superior maxillary bone, containing five molares *in situ*, of a gigantic species of this genus.

This specimen is remarkable, as shewing the absence of the bony palate, as far forward as the space which separates the first and second molares; a character which, in some measure, distinguishes this subgenus from the Kangaroos properly so called; since, in the latter, the bony palate is in general either perfect, or only pierced by a few small openings.

D. 2. Portion of the superior maxillary bone, with fragments of two molares.

D. 3. Fragment of the left Os innominatum of the pelvis of an animal which appears to be referable to the same as the two preceding specimens.

D. 4. Mutilated os calcis of the same animal.

* We trust our friends in New Holland, by transmitting a skeleton and skin of this species, which is found near Port Macquarrie, will enable us to answer the important query stated above.—Edit.

D. 5. First dorsal vertebra of the same.

D. 6. 17th caudal vertebra of the same.

D. 7. Inferior part of the left tibia of an animal allied to the genus Kangaroo, although differing in the details of its configuration. From all the living specimens I have examined, it belongs, probably, to the same animal as Nos. 1. 2. and 3.

D. 8. Fragment of the left humerus of the same species.

I have reason to believe that all the specimens from D 1 to 8 inclusive, belong to the same species of Halmaturus, very different from any animal now in existence.

The genus Halmaturus, as re-established by Frederick Cuvier, and which is well characterized by its five persisting molares,—by the tail not covered with fur, as in the ordinary kangaroos, and by other anatomical characters, consists at present of only two species, the Macropus fasciatus, or elegans, and the Halmaturus Thetis of Frederick Cuvier, the former scarcely equal in size to a rabbit, and the second of the size of the fox. The fossil remains above noticed belong to an animal exceeding in stature the largest species of kangaroo by one-third. We may reasonably, therefore, conclude, that these fossils belong to a species unknown to zoologists, and probably extinct at the present day.

D. 9. Fragment of the superior maxillary bone, containing four molares of a smaller species of Halmaturus.

D. 10. Two fragments of the superior maxillary bone, with four molares, of a still smaller species of Halmaturus, nearly allied to the Halmaturus Thetis of Frederick Cuvier.

D. 11. Left femur entire, of a small species of Halmaturus, which, from its proportions, appears to me to belong to the same species as preceding specimen—it differs in form from all the living specimens with which I have compared it.

D. 12. Id. id. id.

D. 13. Fragments of the same.

D. 14. Inferior extremity of the same.

D. 15. Fragment of the right tibia of the same species.

D. 16. Upper extremities of the right tibia and fibula.

D. 17. Fragment of the right Os innominatum, with the cotyloid cavity.

C D. 18. The same bone of a smaller individual of the same species.

D. 19. Central first phalange.

D. 20. Inferior extremity of the tibia and fibula, with the bones of the tarsus still adhering, belonging to a species of Kangaroo or Halmaturus, still more diminutive in size than that to which the specimens 10–19 belong.

D. 21. Inferior extremity of the left humerus, of a small Halmaturus: it does not belong to the Wombat as Mr Clift supposed.

It is my opinion, that all the preceding specimens from No. 10 to 21 inclusive, excepting only No. 20, may be referred to the species of Halmaturus, to which the molares No. 10 belong, and which is very distinct from either of the two living species of that genus. The fossil Halmaturus resembles, in many respects, the H. Thetis already mentioned, although it differs in others so as to render it impossible to suppose them to belong to the same, founded on the anatomical differences which the bones present on comparison, and on their comparative proportions. I doubt not, therefore, that the fossil lesser Halmaturus will be found to differ no less from the living species than most of the other remains of the New Holland cavern.

E. Genus PHASCOLOMYS, or WOMBAT.

Left branch of the lower jaw of a very large wombat.

A careful comparison of this specimen with the same bone in three skeletons of the living wombat, has not enabled me to discover any marked difference; the fossil, however, must have belonged to an animal exceeding in size the common wombat by nearly one-third. May not this arise from a specific difference between the fosil and the living? which the few fragments of the former we possess does not permit of our establishing on more certain characters,—I mean anatomical,—than those deduced from the mere difference of size.

C. E. 2. Fragment of the lower jaw of the wombat, with three mutilated molares.

F. ELEPHANT.

Middle portion of the right femur of a small elephant, probably a young individual.

There does not exist a doubt, that this bone, which Mr Clift supposed to resemble the radius of the hippopotamus, belongs to a small variety, or to a young individual of the genus Elephant; and what is still more remarkable, that it bears a nearer resemblance to certain fossil varieties of that genus, *e. g.* the fossil elephant so common in the valley of the Arno, than to either of the living species. The New Holland fossil, if the bone of a full grown individual, which is doubtful, would have belonged to an animal one-third smaller than the ordinary Asiatic elephant; but, as the epiphyses are broken off, it is difficult to pronounce with certainty as to the age or size of the elephant to which the fossil belonged,—suffice it to repeat, that it is the bone of an elephant, a fact of considerable interest as connected with the recent geological revolutions of the great Australasian Continent.

I presume it was this specimen that gave rise to the supposition which I have seen mentioned in some of the periodicals of 1831, that bones of the dugong had been discovered in the caverns of Wellington Valley, with remains of land animals, arising from the circumstances that the fossil in question bears a slight resemblance to the upper part of the radius of the dugong; but, in addition to the difference of size,—the fossil possessing three times the dimensions of the radius of the dugong,—it offers all the characters of the bone in the elephant to which I have referred it, without one of the characters of the radius of the dugong, if we except perhaps the flattened form observable in the latter towards its upper extremity.

Conclusion.

From the foregoing comparison of the fossil bones of the caverns of Wellington Valley, results, 1*st*, that they belong to at least nine different animals, viz.

Dasyurus, or Devil of the Colonists, one species.
Hypsiprymnus, or Kangaroo Rat, one species.
Macropus, of Kangaroo Proper, three or four species.
Halmaturus, two species*.

* The elegant or banded Kangaroo of authors belongs to the genus Halmaturus.

Phascolomys, or Wombat, one species.
Elephant, one species.

2d, That of these nine animals only two species of kangaroo do not differ in their anatomical characters from species inhabiting the same continent; whereas there is reason to suppose that the seven remaining species differ from all those hitherto known to zoologists, and that some of them belong to extinct species.

3d, That with a single exception, all the genera to which these fossils are referable, are now found inhabiting the Australasian Continent, a remarkable coincidence with the fossil animals of the same geological epoch in Europe, where, with few exceptions, the animals which have been found in what have been called Diluvial Deposits, belong to genera still inhabiting our countries.

4th, That the elephant was an inhabitant of New Holland at no very remote period, as it appears to have been not only of every part of the Old World, but of the American continent.

In addition to the bones contained in Professor Jameson's collection, I have since examined those sent to the Geological Society of London, which belong to the same animals, with the exception of a cervical vertebra of a large animal, little inferior in size to a large deer, the extraordinary form of which has not enabled me to refer it any known genus.

Although I have attentively examined these several fossils, I have not been able to discover any trace of gnawing of carnivorous animals, or of erosion produced by the motion of water in conjunction with pebbles and rolled stones, as are frequent in the fossil bones of our European caverns.

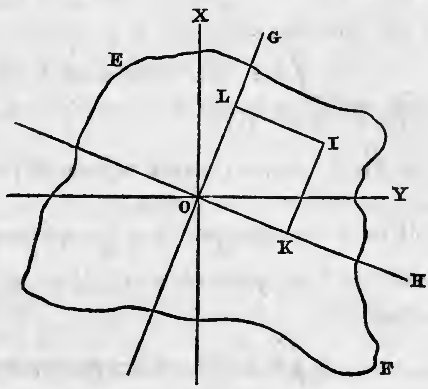
PARIS, *January* 1832.

Analysis of the Vibration of Wires. By EDWARD SANG, Esq. Teacher of Mathematics. Communicated by the Author.

DURING the past summer, Mr Addams exhibited, in this city, a variety of interesting phenomena connected with vibration. Not the least remarkable of these was one, first pointed out, I believe, by Dr Wollaston, that of the formation of elegant trajectories by the lateral vibrations of a wire. Unaware of the existence of any regular investigation of their nature, I submitted them to a strict analysis, in the course of which I was led to a variety of interesting conclusions. Induced by the results of this investigation to reject the round wire and to substitute rectangular prisms of various degrees of flatness, I was delighted at obtaining, both theoretically and experimentally, many algebraic curves remarkable alike for their beauty and for their curious properties.

If a slender steel bar, fixed at one end, and having a small polished ball attached to the other, be thrown into a state of vibration, the image of a luminous object, seen by reflection from the surface of the ball, is observed to describe certain beautiful curves, which either lie nearly in one plane, or are curves of double curvature, according as the wire is straight or bent. I shall proceed first to consider the motions of the straight wire.

Let the origin of co-ordinates be placed at the fixed extremity of the wire, the axis z coinciding with the position of rest; and suppose that the free extremity is drawn aside from z by a distance e, measured in a direction making with X the angle φ. If EF represent a transverse section of the wire, O being its centre of position OX and OY parallels to the axes X and Y, and OG the direction of deflection: OH will be the axis of torsion of that section of the wire.



I being any element of the section, the compression upon it will, clearly, be proportional to $e \cdot \theta z \cdot \mathrm{IK}$; θz being some function of z depending on the nature of the curve of flexure, and constant throughout the section EF. The force evolved by this compression will thus be proportional to $e \cdot \theta z \cdot \mathrm{IK} \cdot ds$, ds being the element of the section. Now this force, acting at the extremity of the lever KI, tends to rectify the position of the wire by turning it round the axis OH; and again conceived as acting at the extremity of the lever IL, it tends to turn the wire round OG as an axis of torsion. These two forces, estimated as acting on the extremity of the wire, may thus be represented by $e\Theta z \,.\, dz \,.\, \text{IK}^2 ds$ and $e\Theta z \,.\, dz \,.\, \text{IK} \,.\, \text{IL} \,.\, ds$. Hence the aggregates of all such forces occasioned by elements of the section EF, are

Force parallel to GO, $e \,.\, \Theta z \,.\, dz \,.\, \Sigma \,.\, \text{IK}^2 \,.\, ds$,

. . . . . to HO, $e \quad \Theta z \,.\, dz \,.\, \Sigma \,.\, \text{IK} \;\,.\, \text{IL} \,.\, ds$;

and thus the whole force urging the extremity of the wire to return in the direction GO is $e \,.\int.\, \Theta z \,.\, dz \,.\, \Sigma \,.\, \text{IK}^2 \,.\, ds$; while the entire disturbing force acting in the direction HO is $e\int \Theta z \,.\, dz \,.\, \Sigma \,.\, \text{IK} \,.\, \text{IL} \,.\, ds$.

Or, since $\text{IK} = x \cos\varphi + y \sin\varphi$; $\text{IL} = -x \sin\varphi + y \cos\varphi$, these forces are,

In the direction GO,

$$e\int \Theta z \,.\, dz \,.\, \Sigma\, (x \cos\varphi + y \sin\varphi)^2\, ds.$$

In the direction HO,

$$e\int \Theta z \,.\, dz \,.\, \Sigma\, (x \cos\varphi + y \sin\varphi)\, (-x \sin\varphi + y \cos\varphi)\, ds.$$

If for φ we substitute $\varphi + \frac{\varpi}{2}$, we obtain for the value of the rectifying force pertaining to a direction at right angles to the former,

$$e\int \Theta z \,.\, dz \,.\, \Sigma\, (-x \sin\varphi + y \cos\varphi)^2\, ds,$$

which, added to the former, gives the constant amount

$$e\int \Theta z\, dz \,.\, \Sigma\, (x^2 + y^2)\, ds;$$

and thus we arrive at this very remarkable conclusion, that the sum of the rectifying forces pertaining to two directions at right angles to each other is constant for the same wire. Whenever, then, the stiffness in one direction is a minimum, that in the perpendicular direction is a maximum.

Let us inquire, indeed, for the directions of greatest and least rigidity. Differentiating the expression for the redressing force, φ being regarded as the primary variable; supposing that Φ is its peculiar value in the case of minimum or maximum rigidity; and equating the differential to zero, we obtain

$$\int \Theta z \, . \, dz \, . \, \Sigma \, (x \cos \Phi + y \sin \Phi) \, (- x \sin \Phi + y \cos \Phi) = 0;$$

but this is just the value of the disturbing force belonging to the direction Φ, so that, when the wire is deflected either in the direction of least, or in that of greatest, rigidity, it returns directly to the position of rest, and its extremity oscillates in a straight line. This property aids us in detecting the directions of greatest and least flexibility.

Extracting, from the above equation, the value of Φ, we obtain

$$\Phi = \tfrac{1}{2} \tan^{-1} \frac{2 \int . \, \Theta z \, dz \, \Sigma \, . \, xy \, ds}{\int . \, \Theta z \, dz \, \Sigma \, (x^2 - y^2) \, ds}.$$

Now this expression never can become imaginary; every elastic wire, therefore, has one direction of greatest, and another of least flexibility, these two being at right angles with each other, since Φ, $\Phi + \frac{\varpi}{2}$, $\Phi + \varpi$, $\Phi + \frac{3\varpi}{2}$, &c., all the roots of the above equation pertain only to two such lines. In that case, indeed, when both $\int . \, \Theta z \, . \, dz \, . \, \Sigma \, . \, xy \, ds$ and $\int \Theta z \, dz \, \Sigma \, (x^2 - y^2) \, ds$ are zero, the value of Φ would become indeterminate, and the wire would become equally flexible in all directions.

In order that X and Y may be the directions of greatest and least flexibility, $\tan 2\varphi$ must be zero, whence $\int \Theta z dz \, . \, \Sigma xy \, ds = 0$. Let us then suppose this to be the case, and, for abbreviation's sake, put $\int \Theta z \, . \, dz \, \Sigma \, x^2 \, ds = A$; $\int \Theta z \, . \, dz \, \Sigma \, y^2 \, ds = B$; A being supposed less than B; the redressing force pertaining to the direction φ will then be $e(A \cos \varphi^2 + B \sin \varphi^2)$, and the disturbing force pertaining to the same direction $e(B - A) \sin \varphi \cos \varphi$.

These forces decomposed into others parallel to the axes X and Y, and collected, become

Force in the direction X, $- A \, . \, e \cos \varphi$;
Force in the direction Y, $- B \, . \, e \sin \varphi$.

But $e \cos \varphi$ is the distance of the extremity of the wire from the plane YZ; $e \sin \varphi$ its distance from the plane XZ; wherefore the tendency of the ball to return to either of these planes is just proportional to its distance from it. The vibrations, therefore, parallel to the directions of greatest and least flexibility are, each of them separately, isochronous, and go on without any mutual disturbance.

Were the elasticity of the wire perfect, the ball would reach, at each vibration in the direction X, to a constant distance from the plane YZ; and at each vibration in the direction Y, to another distance, also constant from the plane XZ. The whole trajectory would thus be included in a rectangle, with its sides parallel to the directions of greatest and least flexibility. From the imperfection, however, in the elasticity of all wires, the dimensions of that rectangle gradually contract. Its shape even is subjected to a variation, depending on the means which have been employed to flatten it: if the wire has been filed, the rectangle rapidly becomes elongated in the direction of greatest flexibility; but if it has first been drawn nearly to the required shape, and then adjusted by hammering, this elongation becomes almost imperceptible.

If T and U represent the times of vibration, a and b the extreme distances of evagation in the directions X and Y, the position of the ball at any instant will be given by the equations

$$x = a \cos \frac{\varpi t}{\mathrm{T}}\,; \quad y = b \cos \frac{\varpi\ (t - v)}{\mathrm{U}},$$

the time t commencing when the ball is at its greatest distance from the plane YZ, and v being the interval between that epoch and the instant when the ball has reached its greatest distance from XZ.

The velocity of the trajectile at any instant in the direction X is $-a \frac{\varpi}{\mathrm{T}} \sin \frac{\varpi t}{\mathrm{T}}$; and its velocity in the direction Y, $-b \frac{\varpi}{\mathrm{U}} \sin \frac{\varpi (t - v)}{\mathrm{U}}$, so that its absolute velocity is

$$\varpi \sqrt{\left\{ \frac{a^2 - x^2}{\mathrm{T}^2} + \frac{b^2 - y^2}{\mathrm{U}^2} \right\}}.$$

If v be made zero, the beginning of the time t will correspond to the instant when the ball is at the corner of the rectangle, at which epoch, since x and y are equal respectively to a and b, the velocity of the trajectile is zero. Thus the equations

$$x = a \cos \frac{\varpi t}{\mathrm{T}},\ y = b \cos \frac{\varpi t}{\mathrm{U}},$$

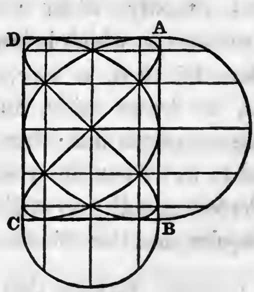
represent a motion caused by drawing the wire aside, and then abandoning it to the effects of its own elasticity, in which case comparative and absolute magnitudes of a and b are determined by the direction and extent of the primitive deflection; of these the essential characters of the trajectory are entirely independent. But if an impulse be given to the wire at the instant of its discharge, the time v has some finite magnitude upon which the shape of the curve essentially depends. On account, however, of the imperfections to which all adjustments are liable, it will be seen that v passes gradually through every assignable value; and thus all the varieties of the trajectory described by a given wire can be exhibited by drawing it aside and abandoning it.

For the delineation of the curve we have the following simple geometric construction.

Round the point of rest let two straight lines, whose lengths are a and b, turn uniformly in the times 2 T and 2 U: let one line constantly parallel to Y pass through the extremity of a, and another parallel to X through the extremity of b; the intersection of these two lines will trace out the curve.

Perhaps a more convenient construction may be as follows.

Having formed a rectangle, whose sides AB and BC are $2a$ and $2b$; on these two sides as diameters describe two semicircles, and divide each of the semicircumferences into equal parts, their numbers being as T : U; from the points of section draw lines parallel to the sides of the rectangle, thus dividing it into a multitude of minute spaces. Then, beginning at the corner of any one of these, trace a line to its opposite corner, thence to the opposite corner of the next, and so on, until, having reached the ex-



treme boundary, the line must be reflected from some one side of the rectangle ABCD; the curve line thus indicated is the trajectory.

Did we attempt to find the algebraic equation of the curve by eliminating t from its phoronomic equations, we would be arrested at once by transcendental expressions; yet on the assumption of particular values for T and U, these disappear, and the equations become finite. I shall examine only the two most remarkable cases.

First, let us suppose that the wire is equally flexible in all directions, in which case $A = B$, and since $A T^2 = B U^2$, $T = U$. The equations of the curve then become

$$x = a \cos \frac{\varpi t}{U}; \; y = b \cos \frac{\varpi (t - v)}{U}.$$

If from these we eliminate t, we obtain, after all the reductions,

$$b^2 x^2 - 2 a b x y \cos \frac{\varpi v}{U} + a^2 y^2 = a^2 b^2 \left(\sin \frac{\varpi v}{U} \right)^2$$

an equation at once recognised as belonging to the ellipse. The form of this curve depends mainly on the value of $\frac{v}{U}$; we may therefore examine its most important varieties by attributing to v successive values from O to U.

When v is made zero, the equation takes the form $b x = a y$, which belongs to one diagonal of the containing rectangle. When $v = \frac{1}{2} U$, the equation becomes $b^2 x^2 + a^2 y^2 = a^2 b^2$, which is that of an ellipse whose axes are $2a$ and $2b$, and which touches the four sides of the rectangle at their middle points. Lastly, when $v = U$, the equation is converted into $b x = -a y$, which belongs to the other diagonal of the rectangle. If, then, a wire, which is equally flexible in all directions, be drawn aside, and then let go, its extremity will describe a straight line; but, if any lateral impulse be communicated to it, its extremity will describe an ellipse.

Perfect equality in stiffness being unattainable, we have next to inquire into the effects of a minute deviation from it. For this purpose, suppose that $T = U + \frac{U}{n}$, n being a very large number. The trajectile setting out from the corner A, crosses the rectangle towards C, but reaches the side CD previous to its reaching BC, by the time $\frac{U}{n}$. The curve must therefore touch BC at a distance from C, denoted by b ver $\frac{\varpi}{n}$. Leaving this point of contact, the trajectile will reach the side AD at a distance from A, denoted by b ver $\frac{2\varpi}{n}$. In this way the straight line is slowly converted into an ellipse, which goes on dilating itself until, when the number of vibrations has amounted to $\frac{1}{2} n$, the points of contact have reached the middles of the sides of the rectangle. After this, the ellipse slowly collapses, and at last merges into the straight line DB; thus exhibiting all the phases that were obtained, by supposing v to pass through all values from O to U. From this position the ellipse again gradually expands, the points of contact returning along the sides of the rectangle; but there is this remarkable distinction between the motions, that the movement, which was at first sinistral, has now become dextral.

When there is any considerable disparity between the stiffness of the wire in the two principal directions, there is no difficulty in recognising them. A careful attention to the phenomena above described, enables us to detect them, however small the difference may be. The directions of greatest and least flexibility evidently bisect the angles made by the crossing of the two diagonals: these, then, are at once found; but we have yet to determine which is the direction of greatest, which that of least, flexibility; and for this we have only to notice, that the contacts of the trajectory, with the two sides parallel to the direction of least flexibility, always move along those sides in the same direction with the motion of the trajectile.

Since the impression which light makes upon the retina of the eye endures for about the fifth part of a second, the impressions of several complete circuits must be co-existent. Did the trajectile retrace accurately the same path, that would appear an immoveable ellipse of light; but since at each new revolution it departs a little from its former course, the aggregate line must receive continual accessions on the one side, while the traces on the other are gradually dying away; and thus the line appears to move gradually onwards.

Although, in ordinary cases of vision, the light which continually enters the eye cause no increase of brilliancy, the impression of the final brightness is not instantaneous. If an object be viewed for a time less than sufficient for the attainment of this final brightness, the intensity of the impression must depend on the duration of the glance, as well as on the natural brilliancy of the object. Wherever, then, the trajectile moves more slowly, the impression of its path must be more vivid; since, from a given length of the curve, a greater quantity of light is sent into the eye. The aggregate brightness of the whole line making up, as it were, that of the ball when viewed at rest, the optical illusion is irresistible—that the matter of the line, unchanged in quantity, is merely subjected to a variation in its arrangement.

The five varieties of Fig. 1. show the successive appearances of this curve at four equal intervals of time; the variation in the thickness of the lines is intended as a faint indication of the varying brilliancy of the actual appearance.

When the direction in which the ball is drawn aside makes equal angles with X and Y, the whole curve is included in a square; and the ellipse, at its greatest width, becomes a perfect circle. In this case, the axes of the ellipse do not vary in direction, but, as is shown in Fig. 2, lie always along the two diagonals.

The beauty of the trajectory described by the extremity of the round wire, arises chiefly from this circumstance, that its successive traces lie very close together, and that the eye has thus sufficient time for studying and comprehending its form. Were the distance between these traces perceptible, the eye would be perplexed by the rapidly changing and intricate form of the curve; and, instead of pleasure, we would have the fatigue of an unavailing attempt to follow out its mazes. Random compressions of the wire can hardly produce any fine effect; but, when the times of vibration have been carefully adjusted to some simple ratio, other curves, more surprising certainly, and perhaps more beautiful than the ellipse, are exhibited. I shall examine minutely only one of these.

When the times of vibration of the wire are adjusted in the ratio of 2 to 1, the general equations of the curve become

$$x = a \cos \frac{\varpi t}{2\,\mathrm{U}}, \qquad y = b \cos \frac{\varpi (t - v)}{\mathrm{U}};$$

when t is eliminated from these, we obtain for the algebraic equation of the curve

$$a^4\left(y + b \cos \frac{\varpi v}{\mathrm{U}}\right)^2 + b^2 (a^2 - 2x^2)^2 = a^2\left(a^2 b^2 + 4 b x^2 y \cos \frac{\varpi v}{\mathrm{U}}\right)$$

which belongs to a continuous curve of the fourth order.

If the adjustment of the wire be perfect, the form of the curve will continue unaltered until the vibrations die away; but if the adjustment be slightly defective, the line will gradually exhibit every form obtained, by supposing v to vary from zero to U.

On assuming $v = 0$, the equation becomes

$$a^2 (b + y) = 2 b x^2,$$

which is that of a common parabola passing through A and B, and touching CD at its middle. If we suppose $v = \frac{1}{2}\mathrm{U}$, the equation becomes

$$a^4 y^2 = 4 b^2 x^2 (a^2 - x^2),$$

which is that of a knot of the fourth order, touching AD and BC at their middles, and passing twice through the origin. Lastly, if we suppose $v = \mathrm{U}$, the equation is converted into

$$a^2 (b - y) = 2 b x^2,$$

which belongs to a parabola passing through C and D, and touching AB at its middle.

The five varieties of Fig. 3. represent the appearance of this curve, when $v = 0, \frac{1}{4}\mathrm{U}, \frac{1}{2}\mathrm{U}, \frac{3}{4}\mathrm{U}$, and U.

No circumstance connected with this subject was so unexpected as the formation of the common parabola. The object which I first proposed for my amusement was the explanation of the change from the sinistral to the dextral movement, as exhibited by the round wire. Having, for this purpose, investigated the general equations of the motion, I was naturally led to inquire what would be the effects of supposing T and U to bear other ratios to each other than that of equality. The simplest of all these, that of 2 : 1, gave, for the form of the trajectory, the common parabola. The hope of seeing this exhibited by the wire itself, led me to employ flat bars. Highly gratified by the exact resemblance between the curves which I had traced on paper, and those exhibited by the motion of the ball, I observed other varieties of the general curve, and found, in the exact agreement of all the phenomena, another confirmation of the generally received law of the elasticity of springs. It is needless to give the analysis of any other varieties; suffice it that I have delineated a few of the more beautiful, and indicated the proportions from which they spring.

Hitherto I have only spoken of vibrations performed by the whole length of the wire, but it is well known that these are frequently accompanied by vibrations of its aliquot parts. The centre of a smaller trajectory, described in less time, is then carried along the principal curve. The complex curve thence resulting, bears the same relation to these trajectories that the epicycloid bears to the circle; its general phoronomic equations are,

$$x = a \cos\left(\pi \frac{t - u}{T}\right) + a' \cos\left(\varpi \frac{n t - u'}{T}\right)$$

$$y = b \cos\left(\varpi \frac{t - v}{U}\right) + b' \cos\left(\varpi \frac{n t - v'}{U}\right);$$

It is not merely possible that the fundamental vibrations may be accompanied by a set of secondary ones; these also may have their secondaries, and so on; the equations of the complex curves being obtained by annexing new terms of the forms,

$$a'' \cos\left(\varpi \frac{n n' t - u''}{T}\right) \text{ and } b'' \cos\left(\varpi \frac{n n' t - v''}{U}\right)$$

to the above expressions.

On account of the great number of arbitraries which enter into such equations, the variety of the curves produced by the same wire is endless. In order to their perfect exhibition, the wires must be much elongated. Those produced by the round wire are by far the most beautiful; the complexity of the others prevents the eye from catching their entire shape. Were the subject of sufficient importance, it would be easy to examine the nature of these epicycloidal curves. It may already have appeared, indeed, sufficiently trivial for the calculus that has been applied to it; yet, when it is considered that it is almost the first case of complex vibration which has yielded to a strict analysis, and that it may ultimately lead to a knowledge of the more intricate acoustic phenomena, I may be pardoned the having pushed to such an extent a mere exercise for amusement.

The whole of these curves can be delineated on paper by means of a very simple apparatus; of this I intend to give a description at an after time; and, at least, this benefit has arisen from the investigation, that it has led to the invention of an effective parabola and ellipto-graph, suited to the description of minute curves.

To those who are conversant with such investigations, it will at once appear that a similar analysis would apply to the motion of the mast-head of a ship, and that that point describes, when the vessel both pitches and rolls, some one of these trajectories.

I have next to proceed to the investigation of the nature of curves described by the extremities of bent wires; but this I shall defer till another opportunity.

32, St Andrew's Square,
October 15. 1831.

On the Uniform Permeability of all known Substances to the Magnetic Influence, and the Application of the fact in Engineering and Mining, for the Determination of the Thickness of Solid Substances not otherwise Measurable. By the Rev. William Scoresby, F. R. S. Lond. & Edin., Correspondent of the Institute of France, &c. &c. Communicated by the Author.

The *general* permeability of solid substances by the magnetic influence, is a fact so extensively accredited, as to be acted upon by all practical men who make use of the compass; but I am not aware of any series of experiments having been professedly undertaken, to ascertain whether this permeability be at once universal, and uninterrupted or unlimited. The results of experiments undertaken with the view of determining these particulars, will, I apprehend, go far to shew, that, of a vast number and variety of bodies in which experiments have yet been made, not even excepting iron in all its states, conditions, and combinations, *all* are perfectly permeable, and, as it were, *quite transparent* to the magnetic influence. And if so, we have a strong probability, by simple inference, that every substance in nature is equally permeable.

In regard to substances *not ferruginous*, a great variety has been subjected to trial, and these of various solidity, condition, and thickness; but in no case has any perceptible hinderance been offered, either by one substance, or by a variety of different substances in combination, to the transmission of the magnetic influence. The principal substances to which my experiments have extended, are stone, wood, and metals of various species; brick, earth, water, paper, leather, hair, feathers, wool, plastering, glass, rosin, and also the skins and bodies of different animals. The thickness of the different substances has of course been very various, from a few inches to many feet, or indeed to several yards. The magnetic influence employed in these experiments was chiefly that of three pairs of bar-magnets constructed under my own direction, a pair of one foot (C), a pair of two feet (B), and a pair of three feet in length (A); and the instruments for determining the degree of influence consisted of a pocket compass by Dolland, and one of Captain Kater's azimuth or surveying compasses.

The nature of the experiments simply consisted in the observation of the angle of deviation in the needle of the compass, under the action of one or two magnets, with different solid substances successively interposed between the magnets and the compass; and then comparing the deviation so obtained with the deviation produced at an equal distance, and in the same direction, when nothing solid was in the line of the attraction. And in all cases the corresponding deviations at equal distances, were precisely the same, whether there was a mass of stone, wood, earth, or other substance, though of several feet in thickness interposed, or whether there was nothing. Thus the smaller magnet being placed at $13\frac{3}{4}$ inches from the compass, in the line of the *west* point (that is, at right angles to the magnetic meridian) produced a deviation on the needle of 35°; but when a large mass of ivory, a lot of books, a thick block of fossil wood, an electrophorus contained in a tinned iron case, first in its neutral condition, and then excited, with a variety of other solid substances, were successively interposed, the deviation was precisely the same. In like manner when the interposed substances consisted of walls composed of various materials, or large blocks of stone of many tons in weight, the results were equally conclusive that the solid substances, though placed in the most likely mode to interrupt the attraction, if that were possible, had no influence whatever.

This fact being verified in a great variety of bodies not ferruginous, it next became an object to ascertain the effect of interposed iron. As iron in its metallic state, however, does not occur under circumstances at all likely to interfere with the application of the magnetic influence, designed to be made by this paper, my observations, in the present instance, will be chiefly confined to the influence of such ferruginous substances, on transmitted magnetism, as may possibly be encountered in tunnelling or mining operations. It is only, indeed, on a very small scale that I have had opportunity of making experiments on iron ores—the specimens of these ores to which I could have access in this place, being chiefly merely cabinet specimens. They may serve to shew, however, that no difficulty whatever is to be apprehended in practical operations from the occurrence of iron ores; but that the magnetic influence is as freely transmitted through such substances as through those not capable of a magnetic condition. For in a series of experiments with iron ores in considerable variety, successively interposed between a small magnet of 4¼ inches in length, and a pocket compass, the north pole of the magnet, and the centre of the compass being 8 inches apart, the deviation of the needle, which was 20° when nothing was interposed, remained uniformly, and, as far as the eye could discern, precisely the same. The ores made use of were from 1 to 7 inches in thickness, and consisted of the following varieties:—Hæmatites, iron-pyrites, sulphuret of iron, Teitenisen, arseniate of iron, argillaceous clay-ironstone, spathose-iron, compact red iron-ore, micaceous specular-iron, kidney iron-ore, and iron-sand. Besides these, three magnetic specimens were subjected to trial, one of which, a piece of Franklinite, being interposed, produced an *increase* of deviation of one degree; another, a piece of magnetic iron-ore, three inches in thickness, being placed in its most neutral position, increased the deviation also one degree, whilst another specimen of the same mineral, highly magnetic, diminished the deviation exactly the same quantity. These differences, therefore, do not affect the general conclusion, but merely indicate either an error of observation occasioned by the magnetic condition of the substances themselves, or a modified influence on the needle, through a change in the magnetic condition of the minerals induced by the proximity of the magnet.

The facts now briefly stated—indicating the uniform and universal permeability of solid substances by the magnetic influence, suggested the idea that the measure of the magnetic influence, as transmitted through solid substances, would afford a mean of ascertaining the thickness of substances not otherwise determinable. For as the deviation of the compass needle under the action of a straight bar-magnet, at a given distance, and in a given direction, affords a satisfactory indication of the intensity of the action of the magnet, of course the same deviation produced by the same magnet, under similar circumstances as to direction, &c. will give a satisfactory indication of equality of distance.

This, indeed, is a corollary necessarily resulting from the experiments already described, for determining the uniform permeability of solid substances to the magnetic influence, and therefore needs no proof. But still verification experiments were necessary, in order to determine, for practical purposes, these two points; 1*st*, The degree of accuracy with which the thickness of solid substances may be measured by the observation of deviations; and, 2*dly*, The distance to which the magnetic influence may be so employed.

I. As to the degree of accuracy with which the thickness of solid substances may be determined by the method of magnetic deviations.

It may be necessary in the outset briefly to state, the different processes employed for ascertaining and comparing the magnetic influence.

Fig. 1.

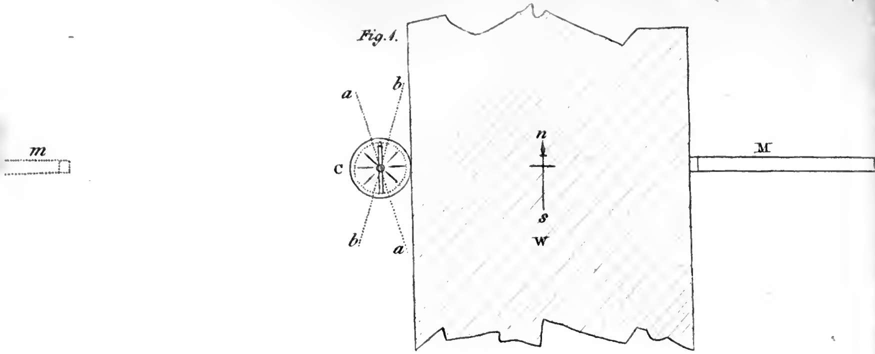
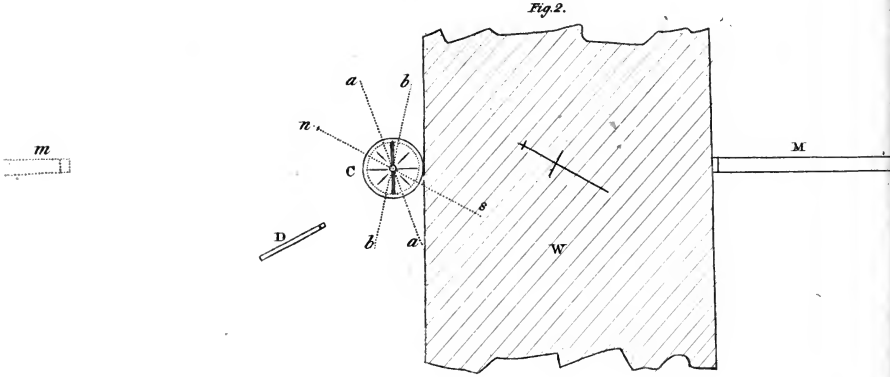
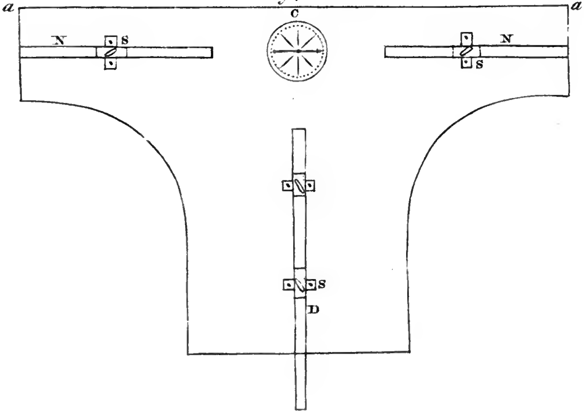


Fig. 2.



The Compass Apparatus.

Fig. 7.



F. Mitchell sculp.t

Case I.—*When the Distance to be Measured is in an east and west direction.*

Let W, Fig. 1. Plate V. represent the wall or septum of a building or a mine, lying nearly in the direction of the magnetic meridian, the thickness of which is to be determined. The compass is placed at C, and, previous to the application of the magnet, is so adjusted in position, that the needle is made exactly to coincide with the north and south line of the instrument. The north pole of the magnet M, being then presented to the compass, on the opposite side of the wall, will repel into the direction *a a* the north pole of the needle, the deviation of which is to be carefully noticed. Then bringing the same magnet round, and presenting the north pole in the opposite position, as at *m*, it is moved backward or forward (in an east and west direction from the compass) till the deviation produced in the direction *b b*, is the same as before. Then the distance from the pole of the magnet to the centre of the compass, in the latter position, ought to correspond with the distance through the wall to the centre of the compass; for where the deviations under similar actions are equal the distances will be equal.

Case II.—*When the Distance to be Measured lies in an oblique or parallel direction, as to the Magnetic Meridian.*

Fig. 2. Plate V. represents a wall or septum of a mine lying obliquely to the magnetic meridian. The compass is placed at C, with the north and south line parallel to the wall, the needle assuming the direction of *n*, *s*. A small *directing magnet* is placed at D, and so adjusted as to deflect the needle from its meridional position into a state of parallelism with the wall. The needle is now made to coincide exactly with the meridional line of the compass, by an adjustment in the position of the compass, when, the magnet being placed beyond the wall, as at M, the deviation, in the direction *a a*, is observed as before. Then, whilst every thing remains the same, the magnet is brought round to *m*, into the straight line drawn from the magnet, and prolonged through the centre of the compass, and adjusted in distance, so as to produce the same deviation, in the direction *b b*, which, of course, gives the interval as in the former experiment.

When the action of the magnet on the compass is found to be very small, or when particular accuracy is required, the *sum of the deviations*, produced by the two poles of the magnet M in succession, is taken, instead of the single deviation, by which not only is the angle doubled, but the error of observation reduced to one-half.

The first verification experiments, for ascertaining the degree of accuracy with which distances might thus be determined, using only ordinary instruments, namely, a pocket-compass and a twelve-inch bar magnet, were made through the walls and furniture, &c. of my own house. This magnet, acting on the compass through a partition wall of brick and plastering, produced a deviation in the compass of 45°. The comparative experiment, when the magnet was brought round into the room, and placed in the opposite position as to the compass, gave a similar deviation at the distance of $19\frac{1}{4}$ inches: the distance through the wall was then ascertained to be $18\frac{3}{8}$ inches, making an error of $\frac{7}{8}$th of an inch, or $\frac{1}{20}$th of the whole distance. A similar experiment was then made through a brick wall and book-case, filled with books, when the comparative experiment gave the thickness $21\frac{5}{8}$ inches, whilst the real thickness was found to be $21\frac{6}{8}$; errors $\frac{1}{8}$th of an inch, being only $\frac{1}{174}$th part of the whole distance. These results encouraging me to proceed, I subsequently made the experiments contained in the following table, using only the pocket-compass for the deviations, and two pairs of bar magnets, one pair (B), of two feet in length, and the other (C), of 12 inches, for giving the magnetic influence.

No. of Experiments.	Magnets employed.	Interposing Substance. Nature of it.	Interposing Substance. Thickness.	Interposing Substance. Direction.	Distance of Compass from interposing substance.	Distance of Magnet from interposing substance.	Total Distance of Magnet and Compass.	Deviation.	Comparative Experiments. Deviation.	Comparative Experiments. Distance.	Comparative Experiments. Error.	Comparative Experiments. Propor. of Error.
			F. I.		I.	I.	F. I.	°	°	F. I.		
1	1 C	Brick wall with plastering..................	0 6	E. & W.	1	11 3/8	1 6 3/8	45	45	1 7 1/4	0 7/8	1/21
2	1 C	Brick wall and bookcase with books......	1 8 3/4	E. & W.	1	0	1 9 6/8	30 1/2	30 1/2	1 9 5/8	0 1/8	1/174
3	2 B	Two brick walls, bolster and pillows......	4 6	E. & W.	1	...	8 6	10	10	8 9	3	1/35
4	2 B	Do. [Experiment repeated with the other poles of the magnets }				...	8 6	6	6	8 9	3	1/35
5	1 C	Electrophorus in tinned iron-case	0 0 3/4	N. & S.	6	7	1 1 3/4	35	35	1 1 3/4	0	Exact
6	1 C	Do. *excited*...........	0 0 3/4	N. & S.	6	7	1 1 3/4	35	35	1 1 3/4	0	Exact
7	1 C	Coal-box of copper filled with coals......	0 10	N. & S.	1	2 3/4	1 1 3/4	35	35	1 1 3/4	0	Exact
8	1 C	Mass of ivory	0 6	N. & S.		...	1 1 3/4	35	35	1 1 3/4	0	Exact
9	1 B	A solid block of freestone	2 11	N. & S.	1	0	3 0	13	13	2 11 3/4	0 1/4	1/144
										[Mean of 3 Expts.]		
10	2 B	Large solid block of limestone............	5 10	N. & S.	1	0	5 11	5	5	5 9 5/8	1 3/8	1/52
11	1 B	Solid block of granite......................	2 9 1/2	N. & S.	1	0	2 10 1/2	15	15	2 10 3/4	0 1/4	1/138
12	2 B	A large block of freestone.................	7 6	N. & S.	1	0	7 7	2 1/2	2 1/2	7 6 1/4	0 3/4	1/121

Notes.—In Experiments 5 to 8, the Comparative experiment was not made in the usual manner, the substance mentioned in column 3 being only placed betwixt the Magnet and Compass, when, in each case, the deviation was the same as when the solid substance was not there. In Experiments 9 to 12, the Compass and Magnets were both raised from 10 to 20 inches off the ground, so that the magnetic influence might be transmitted as nearly as possible through the very centre of the mass.

Now these experiments, with ordinary instruments, go far enough to prove that the method here suggested for determining distances, otherwise indeterminable, is capable of a degree of accuracy sufficient to render the method practically useful in mining operations; for we find, that, with a small pocket-compass, and two sets of bar-magnets (the largest only 2 feet in length), distances amounting to above 8 feet are capable of being determined to within 3 inches, or only $\frac{1}{35}$th of the whole; whilst in smaller intervals the proportion of error was often not more than $\frac{1}{52}$d to $\frac{1}{174}$th of the whole distance.

A single experiment, however, performed with the larger pair of magnets, and one of Captain Kater's azimuth or surveying compasses, will be sufficient to shew that this method of determining the thickness of solid substances, is capable of a much greater degree of accuracy. At the station in which the Liverpool and Manchester Railway Company have their fixed engines for drawing carriages, &c. through the tunnels, two excavations are cut in a solid freestone rock for the engine boilers. A trial was made to measure the thickness of the septum of freestone between the boilers, as a test of the degree of accuracy of which this method is capable. The compass being placed on one side, two feet from the outer edge of the septum or wall, and the two magnets (B), on the other (bearing east from the compass), the difference of the deviations produced by the opposite poles of the magnets was found to be 15° 20′. The magnets were then brought round to the west side of the compass, when equal deviations were obtained at the distance of 3 feet 5 inches from the centre of the compass. On measuring the front of the wall, its breadth was found to be 3 feet 1 inch, which, added to $3\frac{3}{4}$ inches, the distance of the centre of the compass from the wall, gave the total distance 3 feet $4\frac{6}{8}$ inches, indicating an error of $\frac{7}{8}$th of an inch. Being a good deal perplexed with the amount of this error, which, on repeating the experiment, was still the same, it occurred to me, that the thickness of the septum, which appeared to be so uniform, might possibly not be the same. To ascertain this, the lines formed by both sides of the wall were projected forward to the distance of 8 feet, when, instead of being parallel, they were found to approximate about 4 inches, or an inch in every two feet. Hence I found that the wall two feet within the front edge must be thicker by one inch than at the edge. This correction, then, being applied to the distance before measured, gives 3 feet $5\frac{6}{8}$ inches as the real distance, being only $\frac{1}{8}$th of an inch different from the result of the comparative experiment—an error of only $\frac{1}{331}$th part of the whole.

II. This, with many other analogous results, being so satisfactory, it next became an object of importance to ascertain—the distance to which the magnetic influence may be employed for the measurement of the thickness of solid substances.

For the satisfactory determination of this question, however, a number of distinct and particular investigations become necessary; such as the relation which may exist between the influence exerted by different magnets, and their quality, dimensions, and number; with the law of the directive power of straight bar-magnets at different distances.

1. In regard to *the effect which the quality, dimensions, and number of magnets have on the extent of the influence and the accuracy of the results*, a considerable series of experiments have been undertaken.

(1.) As to the *quality of the magnets*, I can only give the general results which my imperfect experiments on this point seemed to afford. Magnets constructed of steel made out of the best Swedish iron, *appeared to me*, in each case where I could compare them, to be susceptible of the greatest degree of power. And those which were tempered *throughout* their length (say reduced to a gold colour at the ends and gradually softer, or down to a blue in the middle), were more powerful than others, which were only hardened at the poles.

The latter result may be considered as fully established, being in accordance with all previous experiments by Coulomb, Biot, Kater, and other magneticians; but the former, as to the effect of the *quality* of the steel, I state hesitatingly, because of its being at variance with the conclusions of different careful experimenters.

(2.) *The comparative directive powers of magnets of different dimensions* was more carefully and fully investigated.

a. As to the THICKNESS *of bars in other respects the same.*—A set of straight bars, kindly furnished me by Mr Abraham of Sheffield, made out of the same mass of steel, and tempered in a similar manner, being of the same length and breadth, but differing as to thickness, afforded a satisfactory apparatus for the determination of this point. These bars were five in number, each twelve inches long and one inch broad, and of the several thicknesses of 0.55, 0.28, 0.20, 0.14, and 0.08 inch.

Each bar being successively placed between the different poles of a pair of good two feet bar-magnets, was magnetized, first, after the manner of Æpinus, and then, after their directive force had been tried, by Michel's method,—a single stroke of a powerful horse-shoe magnet being made from end to end of the series,—when the following results as to their action on a compass at the distance of eighteen inches, and in the direction of the west point of the compass, were obtained:—

Thickness of the Magnets.		Deviation by Æpinus' method.	Deviation by the method of Michel.		
			Immediately as the bars were magnetized.	Second Trial after a lapse of five minutes.	Third Trial after half an hour.
	Inches.				
a	0.55	32°	37½°	33°	33°
b	0.28	32½	36½	33½	33½
c	0.20	29	29½	29	29
d	0.14	29	29½	29	29
e	0.08	25	27½	27½	27½

Comparing the last three columns, it would appear that the bars being magnetized beyond saturation, were not able to retain the power that was given to them; hence, a diminution of intensity was discovered on the second trial, though, in the mean time, they were kept separate, and not allowed to touch any magnetic substance, lest their power should be altered.

These results were sufficient to verify the previous deductions of different magneticians, that little, if any, increase of power is gained by increase of thickness in magnets beyond a given minimum; for the intensity of directive force of the thickest bar above that of the others, is perhaps not greater than what is simply due to its greater extent of surface.

But the advantage of surface over mass was rendered peculiarly striking, by presenting the bars in combination (laid upon each other, a situation of much disadvantage), at the same distance from the compass as before, according to the following arrangements:—

Magnets in Combination.	Thickness of the mass.	Deviation produced.	Corresponding Tangents.
d, e	0.22	42°	90040
c, d, e	0.42	46	103553
b, c, d, e	0.70	48	111061
a, b, c, d, e	1.25	50	119175

Hence, comparing the tangents of the angles of deviation,—the measure of the relative directive forces as established by subsequent results*,—we find that the bars *d* and *e* in combination (being 0.22 inch in thickness), had a greater power than the single bar *c* (of nearly the same thickness), in the proportion of about 8 to 5. But if we take into account the injury done by the combination to the power of the bars, that proportion will be nearly as 2 to 1. For after the experiments were completed, the directive force of *c* was found to have diminished from 29° to 26°; *d*, from 29° to 27½°; and *e*, from 27½° to 23½°.†

b. The comparative directive force of bars of different lengths —increasing also proportionably in their other dimensions—was the next object of inquiry.

The design of this investigation, as also, indeed, that of most of the experiments in this section, was not so much to attain perfect results, as *practical* results, applicable to the method proposed for measuring otherwise indeterminable distances.

* Were the magnet presented to the compass at right angles to its deviated position (or the position the needle actually assumes under the influence of the magnet), then the force exerted in drawing the needle from its meridional position would be represented by the sines of the angles of deviation. But when the magnet is placed always at right angles to the *meridional position* of the needle, the force is correctly represented by the tangents of deviation.

† The greater loss sustained by bar *e* than the rest, confirmed me in an opinion previously formed, that its temper was less perfect than the rest.

Hence, instead of procuring a set of magnets expressly constructed for the inquiry, whose quality and temper should be the same, and whose lateral dimensions should be in proportion to their lengths, I merely employed such magnets as I happened to have by me, with a view of ascertaining principally this question, Whether the deviations produced by magnets of different lengths are similar, when their distances, in measures of their own lengths, are proportional ?

The following is a tabular view of the comparative deviations (being the sum of the actions of the two poles) produced by different bar-magnets, at proportional distances from the centre of the compass, in measures of their own lengths :—

No. of Lengths of the Magnets.	A, 36 Inches.		B, 24 Inches.		C, 12 Inches.		D, 4¼ Inches.	
	Distance from Compass.	Sum of Deviations.	Distance from Compass.	Sum of Deviations.	Distance from Compass.	Sum of Deviations.	Distance from Compass.	Sum of Deviations.
	Ft. In.		Ft. In.		Ft. In.		Ft. In.	
1	3 0	68°.22′	2 0	61°.0′	1 0	69°.40′	0 4¼	119°.10′
2	6 0	15.27	4 0	12.45	2 0	15.20	0 8½	16.0
3	9 0	5.28	6 0	4.30	3 0	6.0	1 0¾	5.50
4	12 0	2.36	8 0	2.15	4 0	2.45	1 5	2.45
5	15 0	1.26	10 0	1.15	5 0	1.40	1 9¼	1.25
6	18 0	0.49	12 0	0.45	6 0	0.50	1 1½	0.55

These results are sufficient to shew that the directive force of bars of different lengths—the other dimensions and magnetic energy being proportional, and their quality similar, is very nearly in the relation of their lengths. In each series of experiments, it will be perceived that the advantage is somewhat in favour of the shorter bars ; but in no case has the short bar, at six lengths' distance, the influence of the longest bar at five lengths' distance ; and although, at the first length, the differences are very great, yet part of the excess in favour of the shorter magnet, is to be attributed, as will hereafter be shewn, to the greater proportional nearness of the attracted pole of the compass, than when this approximation of the pole bears a less proportion to the distance of the magnet.

(3.) The last inquiry belonging to this part of the subject is the effect of the *number* of magnets on the deviations produced.

If the tangent of the angle of deviation be the measure of the directive force of a magnetic bar, then, we might infer, that the combined action of two or more equal and similar magnets, ought to be equivalent to the *amount* of the tangents of their several deviations. But, although the results of many experiments are found to approximate the ratio indicated by this corollary, yet in almost every instance the tangent of the angle of deviation produced by different bars in juxtaposition, falls short of the amount of the tangents of their individual deviations. This general fact suggested the idea, that, notwithstanding the bars were not placed in contact, when their combined influence was tried, yet their very proximity might operate to the diminution of their influence. And this, on trial, was found to be the case, especially with the pair of two feet magnets (B), tempered only at the ends. The deviations produced by the two bars separately, at a given distance from the compass, were 6° 15′ and 6° 30′, amounting together to 12° 45′, or, reckoning the sum of their tangents, to 12° 36′. When the same bars were presented simultaneously to the compass, (at the same distance as before), parallel to each other, and 12 inches asunder, their combined action was 12° 20′; at 3½ inches asunder the deviation produced by them was 12° 0′; at 1 inch, 11° 30′; at ¼th of an inch 11° 0′. Being again separated to 3½ inches apart, their action was now 11° 30′; and to 12 inches it increased to 11° 55′,—indicating, however, a loss of power by their proximity from tangents 12° 20′ to 11° 55′, or of about $\frac{1}{28}$th part of their force. Their separate action was now found to be 6° 5′ and 6° 0′, amounting to 12° 5′. The amount of the tangents of these two deviations observed separately, is 21168; whilst the tangent of the two, taken in combination at 12 inches distance, is 21104, being very nearly the same. Part of the loss of power in this experiment, is to be ascribed to the imperfect tempering of this pair of magnets, which, as I have stated, were not tempered throughout, but only at the poles. Still we find, that, when placed very near, though not in contact, their united action was considerably diminished, but not permanently, so that their power in juxtaposition, at the distance of ¼th of an inch from each other, was less than when they were a foot asunder, in the proportion of the tangents of 11° 0′, and 11° 55′,—indicating a temporary diminution in their energy, by mere proximity, of nearly $\frac{1}{12}$th of their power.

With a pair of three-feet bars (A), tempered throughout, and magnetised some weeks previous to the experiment, not any permanently deteriorating influence by juxtaposition, without contact, was perceptible; and the temporary or local deterioration appeared to be considerably less. When these two bars, at the distance of nearly 9 feet from the compass, were arranged parallel to each other, 4 inches apart, they produced a deviation of exactly 5°, whilst only $\frac{1}{4}$th of an inch asunder (edge from edge), the deviation was not perceptibly different; but, when placed over each other, but still $\frac{1}{4}$th of an inch asunder, the power diminished to 4° 50′; and, when placed *in contact* upon each other, it was reduced to 4° 45′. When the magnets were again separated to the distance of 4 inches, their deviating power was 4° 58′, indicating a very small loss of magnetic energy.

The following Table exhibits the action of these magnets separately, and also in juxtaposition, 4 inches asunder, at different distances from 1 to 6 yards:

No. of Lenths.	Bar. A. 1.		Bar. A. 2.		Sum of A and B*			Both bars, in juxtaposition at distance of 4 inches.	
	Mean Devia.	Tangent.	Mean Devia.	Tangent.	Sum of Devia.	Sum of Tangents.	Corres. Angle.	Mean Devia.	Tangent.
	° ′		° ′		° ′		° ′	° ′	
1	36·0	72654	32·22	63380	68·22	136034	53·41	52·39	131031
2	8·19	14618	7·8	12515	15·27	27233	15·14	14·52	26546
3	2·56	5124	2·32	4424	5·28	9548	5·27	5·29	9600
4	1·23	2415	1·13	2124	2·36	4539	2·36	2·35	4512
5	0·46	1338	0·40	1164	1·26	2502	1·26	1·21	2357
6	0·28	815	0·24	698	0·52	1513	0·52	0·50	1455

With these well-tempered bars, placed in juxtaposition 4

* The first column of this division represents the sum of the mean deviations of the two preceding divisions; the second column the sum of the *tangents* of the two preceding divisions, while the third column exhibits the angles corresponding to these tangents.

inches asunder, we have an extent, it is observable, of influence very nearly equal to the sum of the forces of both bars taken separately. For all practical purposes, we may therefore infer, that two well-tempered magnets, placed parallel to each other, and a few inches asunder, will exert the same force as the sum of their separate influences; and that at all distances beyond twice the length of the bars, the *angle of deviation* produced by the two, so combined, will be almost precisely the same as the amount of their individual deviations, or twice as great as either separately.

By means of a set of ten equal bars ($13\frac{8}{10}$ inches long), belonging to a straight-bar compound magnet, I made a very extensive series of experiments on the relative influence on the compass of several bars in juxtaposition or contact, when arranged in a great variety of ways. I shall only state briefly the results obtained with six of these bars. Their separate directive power on the compass, at the distance of 4 feet, was 3° 45′, 4° 15′, 4° 30′, 4° 10′, 4° 30′, and 3° 50.′ When placed in the arrangement *a*, Fig. 3, $\frac{1}{4}$th of an inch apart, their united power produced a deviation of 15° 54′; in the manner of *b*, 16° 40′; in the manner of *c* (all at the same distance from the compass, as in case *b*, but disjoined), 15° 0′; of *d*, 16° 10′; of *e*, 16° 35′; of *f*, (the same form as *e*, but touching laterally), 16° 43′; of *g*, 13° 30′, &c. &c.

After the experiments, according to the arrangements from *a* to *n*, Fig. 3 Plate VI., were completed, the six bars were placed in lateral contact, as at *o*, when their power, which the instant before, in the arrangement *a*, was 15° 54′, was now reduced to 12° 30′ whilst in *contact*, and being restored to the position *a*, was 13° 54′, exhibiting a permanent injury by the contact equivalent to the difference of the tangents of 15° 54′ and 13° 54′. The powers of the different bars in juxtaposition, as in Fig. *a*, before and after contact, were :—

	Before Contact,	and	After Contact.
1,	3° 45′		3° 34′
1, 2,	6 35		6 14
1, 2, 3,	9 26		9 6
1, 2, 3, 4,	11 45		10 26
1, 2, 3, 4, 5,	14 4		13 0
1, 2, 3, 4, 5, 6,	15 54		14 30

The transient diminution of energy by contact and juxtaposition, was strikingly exhibited on separating the bars after the contact. Whilst they remained in contact, in the arrangement figured at *o*, their directive power was indicated by a deviation of 12° 30′, as just stated; but, when removed to position *a*, each bar being $\frac{1}{10}$th of an inch asunder, the deviation was 12° 54′; $\frac{3}{4}$th of an inch asunder, it was 13° 54′; an inch asunder it was 14° 15′; and two inches apart it was 14° 48′.

From these, and several other series of analogous experiments, it appeared, that in all cases there was an advantage gained as to power, whenever *dissimilar poles* were placed in contact, over the corresponding arrangement with the bars separated, as a comparison of experiment *b* with *c*; of *h* with *i*; of *m* with *n*, clearly exhibit;—and that a loss of power was sustained, by bringing into contact *similar poles* under a like form of arrangement, as appears from the comparison of *a* with *o*. And it was further ascertained that the advantage *gained* by favourable contact (that of dissimilar poles), was the greatest with the *softest bars*; whilst the *loss* sustained by unfavourable contact (that of similar poles), was also the greatest in such bars,—the hard tempered bars being, on the one hand, less susceptible of benefit from *induced* magnetism, and, on the other hand, less liable to injury from the contact of similar poles.

(*To be concluded in next Number.*)

Register of the Thermometer kept at Wanlockhead during the Summer of 1828. By Mr Lang. Communicated by the Author.

Latitude 55° 28′ North. | Height of Ther. above the Sea 1386 feet.
Longitude 3° 50′ West. | Distance from Leith 48 miles, from Dumfries 29.

May	7½ A. M.	8½ P. M.	June	7½ A. M.	8½ P. M.	July	7½ A. M.	8½ P. M.	Aug.	7½ A. M.	8½ P. M.	Sept.	7½ A. M.	8½ P. M.	Oct.	7½ A. M.	8½ P. M.
1.	...°	...°	1.	49°	48°	1.	70°	58°	1.	51°	53°	1.	56°	58°	1.	47°	45°
2.	49½	46	2.	46	...	2.	58	58	2.	55½	53	2.	57	58	2.	45	41
3.	52½	52	3.	48	49	3.	58	...	3.	...	53	3.	52	55	3.	47	41
4.	52	51	4.	48	46	4.	56	55	4.	54	55	4.	58	61	4.	46	42
5.	53	48	5.	57	...	5.	56	52	5.	57	...	5.	59	59	5.	44	43
6.	44	43	6.	52	46	6.	...	52	6.	55	56	6.	55	57	6.	43	40
7.	44	45	7.	54	49	7.	57	56	7.	58	58	7.	51	59	7.	40	48
8.	48	50	8.	...	51	8.	...	56	8.	59	57	8.	63	65	8.	47	46
9.	50	50	9.	51	49	9.	58	56	9.	55	...	9.	61	55	9.	48	50
10.	49	47	10.	52	50	10.	68	58	10.	...	57	10.	56	58	10.	50	46
11.	48	47½	11.	56	51	11.	59	58	11.	56	...	11.	55	59	11.	52	51
12.	48	47½	12.	53	53	12.	57	...	12.	57	58	12.	58	55	12.	53	47
13.	49	41	13.	56	53	13.	...	55	13.	53	52	13.	47	48	13.	56	48
14.	49	57	14.	57	54	14.	56	57	14.	56	52	14.	43	48	14.	50	47
15.	56	52	15.	...	51	15.	56	58	15.	52	57	15.	53	47	15.	48	44
16.	52	46	16.	60	58	16.	55	56	16.	58	49	16.	49	47	16.	49	51
17.	53	46	17.	54	55	17.	60	55	17.	55	54	17.	50	49	17.	41	48
18.	59	46	18.	57	55	18.	53	55	18.	58	56	18.	49	50	18.	42	45
19.	49	48	19.	60	53	19.	57	52	19.	54	54	19.	50	53	19.	47	49
20.	...	42	20.	54	52	20.	54	55	20.	53	54	20.	54	56	20.	49	46
21.	49	43	21.	58	54	21.	56	53	21.	50	52	21.	56	56	21.	46	45
22.	47	47	22.	56	...	22.	57	53	22.	51	57	22.	55	57	22.	47	42
23.	49	45	23.	58	52	23.	58	59	23.	58	57	23.	43	54	23.	45	36
24.	47	48	24.	54	52	24.	56½	55	24.	57	58	24.	55	56	24.	37	38
25.	53	49	25.	56	56	25.	58	59	25.	58	60	25.	61	56	25.	48	39
26.	49	50	26.	58	...	26.	60	60	26.	61	...	26.	56	57	26.	46	38
27.	57	53	27.	58	...	27.	51	...	27.	62	62	27.	56	53	27.	...	...
28.	56	52	28.	...	62	28.	...	50	28.	64	...	28.	...	49	28.	...	..
29.	49	48½	29.	68	63	29.	46	50	29.	56	57	29.	49	47	29.	...	...
30.	53	49	30.	68	63	30.	49	53	30.	58	54	30.	46	47	30.	...	...
31.	55	49	...	...	...	31.	53	49	31.	53	56	...	...	...	31.	...	...
Mean 49°⅔.			Mean 54° 3/14			Mean 55°½			Mean 56°			Mean 49½			Mean 45°		

Mean Temperature ½ year 51°.

Quantity of Rain that fell in June 3⅘ in.
... do. do. July 11 7/20 ...
... do. do. Aug. 10 7/20 ...
... do. do. Sept. 7 13/20 ...
... do. do. 26th Oct. 17⅗ ...

Total quantity—inches 50¾

The Rain-Gauge was erected in an exposed situation, and the quantity of Rain fallen was immediately measured after the shower.

{ The funnel was to the tube of the Rain-Gauge as 10 to 1.

N. B.—My brother is measuring what quantity falls during my absence, and if you, Sir, consider it of any value, I can at any time procure the Register from him.

As the above register was taken at Wanloćkhead, within a few yards of the highest inhabitated house in Great Britain, on that account I hope it may be of some value. Admitting the Company's house at Leadhills to be 1280 feet above the level of the sea, by my measurement the situation of the gage was 106 feet higher, or 1386.

I beg leave also to add, that I had last summer measured, by means of a theodolite, the height of the Lowthers, and found that it rises 1129 feet above the Agent's house at Leadhills, and consequently 1129 + 1280 = 2409 feet above the level of the sea.

Abstract of the Meteorological Journal of the Banff Institution, kept at Banff Castle, from 1*st November* 1830 *to* 1*st November* 1831.

The Observations were made daily at half-past 9 A. M. and half-past 8 P. M.; the Instruments employed being 60 feet above the medium height of the Sea, and at the distance of about one furlong from the high water-mark.

	Mean of Barom.	Mean of Therm.	Rain.	Number of Days the Wind blew from								Days Clear.	Days Cloudy.
				N.	NE.	E.	SE.	S.	SW.	W.	NW.		
1831.													
Nov.	29·61	45·01	1·95	1	0	4	0	14	9	2	0	16	14
Dec.	29·46	36·96	2·55	6	1	6	5	5	0	4	4	3	28
1832.													
Jan.	29·82	37·13	0·48	7	1	3	5	2	4	5	4	8	23
Feb.	29·56	38·80	2·35	2	0	3	2	5	12	3	1	10	18
Mar.	29·52	43·45	2·42	0	3	0	5	10	9	3	1	11	20
April,	29·54	46·53	1·16	4	10	2	3	4	1	0	6	5	25
May,	29·86	49·99	0.69	8	10	0	2	4	1	3	3	9	22
June,	28·83	57·93	0.39	9	0	1	2	9	5	1	3	4	26
July,	29·88	61·49	1·71	4	12	0	1	8	1	0	5	8	23
Aug.	29·83	60·93	2·08	5	8	5	3	6	2	1	1	8	23
Sept.	29·82	55·96	2·13	3	6	1	2	11	5	1	1	6	24
Oct.	29·53	53.83	2·54	1	1	4	0	9	12	1	2	3	27
	Annual Means 29·69	49·04	Total 20.45	50	52	29	30	87	61	24	31	91	273

Greatest observed height of the Barometer, April 1,	.	30·45
Lowest observed height of the Barometer, March 13,	.	28·70
Greatest range of Barometer,	. . . . .	1·95
Greatest observed heat, 29th July and 5th August,	.	70°
Greatest observed cold, 31st January,	. . .	17
Greatest range of the Thermometer,	. . .	53

On the Action of Iodic Acid and of Iodine on Vegetable Colours. By Arthur Connell, Esq. F. R. S. E. Communicated by the Author.

In the account which I lately gave of a method of converting iodine into iodic acid, by the agency of nitric acid *, I mentioned that the solution of the iodic acid, thus prepared, reddened litmus paper permanently, a circumstance which seemed inconsistent with Sir H. Davy's statement, that that acid ultimately bleaches vegetable blues. I have since investigated this matter more particularly, and have found that iodic acid, whether prepared by means of euchlorine, or by the process which I have proposed, reddens litmus permanently, both in the state of infusion, and in that of stained paper. This permanency, however, of the reddening action, appears to be peculiar to this colouring matter. If the blue infusion of cabbage is treated in the same manner, it will be found to be at first reddened by the acid prepared in either way, and afterwards to become yellow, and a reddish-brown matter to precipitate to the bottom, the effect being complete in a few days. Paper stained with the same infusion is first reddened, and soon afterwards bleached. It is probable, therefore, that the general rule of Davy holds good, that vegetable colours are first reddened, and then bleached or made yellow by iodic acid, however prepared, the exception as to litmus being peculiar to that colouring matter, which, as is well known, has the additional peculiarity of not being acted on by alkalis.

In the course of these experiments, I had occasion to examine the action of iodine itself on vegetable colours, which, it is singular, is differently stated by different chemical writers. Most English authors have been satisfied with repeating the observation of M. Gay-Lussac, in his memoir on iodine, that that substance bleaches vegetable colours, but with much less energy than chlorine, and have not entered into any particulars as to how this action may be shewn. On the other hand, M. Rose, in his late valuable work †, has stated that iodine does not

* See this Journal for July 1831.

† Handbuch der Analytishen Chemie, i. 366. 2[te] Auf.

destroy vegetable colours; and even Berzelius has said that the aqueous solution of iodine does not bleach vegetable colours*. From the experiments, however, which I have made, it appears that the aqueous solution of iodine, notwithstanding the very small quantity of iodine which it contains, destroys vegetable colours to a very great extent, when added in sufficient quantity, although the bleaching is not absolutely perfect. The solution employed was prepared in two ways; *first*, by boiling distilled water on the iodine of commerce, until it became of a decided yellow colour; and, *secondly*, by dissolving freshly sublimed iodine in alcohol, precipitating it by water, washing it largely with the latter fluid, and then allowing water to stand on the finely divided iodine thus obtained, in which case it readily becomes yellow by dissolving the iodine even in the cold. The second method was followed with the view of purifying the iodine, but the results are the same whichever method is followed. When blue cabbage infusion was treated with five or six times its bulk of the solution of iodine, the blue colour entirely disappeared, and a very feeble reddish or yellowish tint only remained. The effect is best seen by diluting a corresponding portion of the infusion with a quantity of pure water, equal in bulk to that of the iodine water used, when the difference of result becomes abundantly manifest. When the infusion of litmus was treated in the same way, the effect was just the same. No colour remained except an extremely feeble blackish tint. The bleaching action of iodine may also be exhibited in the solid way. If a piece of this substance be dropped into a little of the infusion of cabbage in a tube, the liquid will be found to become gradually yellow, and, in the course of a few days, the effect is completed. The colour of infusion of litmus is also gradually destroyed by similar treatment, although more slowly. These facts, tending to confirm the original statement of M. Gay-Lussac, may perhaps not be deemed superfluous, since that statement was made only generally, and the matter has subsequently been differently stated; and it cannot be a matter of indifference to establish that two bodies, allied together by so strong analogies as chlorine and iodine, agree also in possessing the remarkable property of destroying vegetable colours.

* Lehrbuch der Chemie, i. 255.

I have made several attempts to effect the acidification of bromine by a process similar to that which succeeded in regard to iodine. I poured a few drops of bromine into a glass-tube, about eight inches long, and closed at the lower extremity, and then added a little nitric acid. The liquid was heated in some experiments to ebullition, and in others to a temperature short of that point, the upper end of the tube being kept cooled by moistened bibulous paper, and the mouth loosely stopped. The bromine, as it rose in vapour, was condensed in the upper part of the tube and fell back in drops into the acid, and as the process went on, the tube was occasionally inclined, to absorb the vapour which filled it. This process was continued till little bromine appeared either in the liquid or in the state of vapour. The fluid was then poured out into an evaporating basin, and concentrated by heat, but I could get no evidence of the existence of bromic acid in it *.

The fact, that iodine may be acidified by the agency of nitric acid, independently of affording a ready method of procuring iodic acid, seems not without interest, as illustrating the nature of iodine. Many substances of the class of simple inflammable bodies, both metallic and non-metallic, may, as is well known, be acidified by means of nitric acid. Iodine, like chlorine and bromine, was long thought to have so little affinity for oxygen as to be incapable of directly uniting with it. But the recent experiments of Sementini † have rendered it extremely probable that iodine may be oxidated by simple contact with oxygen at a high temperature; and the fact, that at the temperature of ebullition iodine takes oxygen from nitric acid, and becomes iodic acid, appears to point out another link of connection, in addition to the many already known, between iodine and the class of simple combustible substances, although, of

* Since this paper was written, I have repeated the experiment of boiling together nitric acid and bromine in a longer tube, the upper extremity of which was bent and terminated in water, with the view of condensing any volatile products; the adjoining portion of the tube being kept cool as before. The aqueous liquid was then gently heated till all the free bromine which had passed over appeared to be expelled. Even then it was largely precipitated by nitrate of silver, but the precipitate, from all its properties, appeared to be merely bromide of silver; and I have not yet had time to ascertain why the precipitate was so abundant.

† See Journal of Royal Institution for August 1831.

course, its analogies with bromine and chlorine greatly preponderate *. On the other hand, the non-action of nitric acid on bromine marks a more feeble affinity for oxygen, and is not inconsistent with our preconceived ideas of a body more nearly allied to chlorine than iodine is. The distinctions between the subordinate classes into which simple bodies have been divided, are evidently vanishing before the progress of discovery, and we seem fast approaching to the establishment of an unbroken chain of elementary bodies, differing from one another by gradations of qualities which are continually approximating to each other. The discovery of selenium nearly destroyed the class of metals as an exclusive division. That of lithia, and its metallic base, went far to annihilate the distinctions between alkalis and alkaline earths and their respective bases; and it is extremely probable that between iodine and sulphur one or more bodies will one day be found to exist, combining many of the qualities of both these substances, and serving to unite them more closely. In the mean time, the more humble task of pointing out new facts in the history of already known substances, tending more closely to ally them, will not be devoid of interest, as contributing in a less degree to the same general result.

Critical Observations on the Ideas of M. Alexander Brongniart, relating to the Classification and probable Origin of Tertiary Deposits. By A. Boue', M.D. Concluded from page 172.

M. Brongniart, wishing to assist the geologist in the discrimination of deposits by means of the zoological characters, details the peculiarities by which we may distinguish the *proteique* or upper tertiary soil from the *tritonien* or the under. We must, however, confess, that the zoological distinctions in this case are not more satisfactory than the mineralogical differences,

* It is singular that, according to the recent experiments of M. Gualtier de Claubry (Annales de Chim. et de Phys. xlvi. 221.), the nitrous acid, or hyponitric acid as it is sometimes called, is capable of depriving iodic acid of oxygen, and of being converted into nitric acid under the influence of the presence of water, and at ordinary temperatures; and thus the relative forces of affinity for oxygen possessed by iodine and nitrogen or its oxides, would seem to be influenced by the temperature.

and that, on applying these to the various basins, the exceptions to the rule are nearly as numerous as are the cases in which it proves true. The upper part of the *proteique* formation does not, as M. Brongniart contends (page 152), contain a great mass of rolled pebbles and sandstone, that mass occurring in its median part. M. Brongniart also forgets the sands, and we see that he is describing only the Paris and London basins, when he indicates flint pebbles; besides, the Paris marine limestone, with its plastic clay and marl, contains also conglomerate and sandstones.

The shells of the *tritonien limestone*, in the upper tertiary soil, would be a good character, if they were not, like bones, of rare occurrence. If the fossils enumerated by M. Brongniart, as characteristic of the upper tertiary deposits, did not exist in the *tritonien group*, we would again have a good geological horizon, because these shells are very abundant everywhere, at least in particular beds; but unfortunately this is not the case, and then their greater and less abundance in one deposit than another is of no use. In that case are " *les cerithes* cordonnes les Cytheres, le pectunculus pulvinatus et quelques autres petites huitres," (p. 152). The indications in the inferior parts of the upper tertiary soil, " de beaucoup de paillettes de mica, de lits de marne argileuse et calcaire à grand huitres, d'os de cetacées, notamment de lamantin, de clypeastres et de peu d'autres echinides," are useful but subordinate characters. Besides, if molasse and subappenine clay are micaceous, mica occurs also in sands which are superior to these rocks. Bones are of great value to the cabinet geologist, but of comparatively little importance to the geologist studying the science in the field; and the more so, as M. Brongniart is careful not to assert that *lamantin's* bones do not also occur in other deposits. This may be said of the *clypeasters.* If great beds of oysters are important, why not also mention great beds of pecten or balanus, &c.? The species alone can establish some zoological differences amongst the upper and under tertiary deposits, as M. Brongniart thus confesses: " Au moyen de listes aussi complettes qu'il sera possible de les faire, on pourra arriver à obtenir du caracteres tires de rapports numeriques au defaut de caracteres absolus," (p. 369).

If that desideratum can be filled up, it will be with very great difficulty, for M. Brongniart has united under the same head the fossils of both these periods. If we take into account the species which are not accurately classified, and which are arranged under the head *terrain thalassique* in general, (p. 380), and then set aside the species from Plaisantin not classified in the upper tertiary soil, and also the species from Bordeaux, Dax, the Roussillon, Turin, Anjou, Brittany, and Mayence, arranged erroneously under the tritonian group; and lastly, those of the green-sand of Trauenstein and Diablerets, reckoned, in our opinion, erroneously amongst tertiary fossils, we can construct fossil tables which, taken together, will help us in the determination of the age of a tertiary deposit, at least if it contains many fossils, and if we have collected them there ourselves. On the other hand, it is to be regretted that M. Brongniart has omitted in his lists of fossils some very important ones, viz. the crania abnormes in the Bordeaux upper tertiary, the vaginella in the subappenine clay, &c. We would also wish to know the reasons for distinguishing the Bolca deposit and that of Salado from the nummulite tertiary limestone, with shelly tufaceous volcanic rocks. If this last belongs to the *tritonien* or inferior group, the first rocks are also of this class, for the slates with fishes and plants are only an *accident* in that nummulite limestone, as the lignite clay in the marine limestone at Paris. A moment of hesitation must have given rise to that singularity, to see the fishes of Bolca in the *proteique* group (382), and the fucoides, and all the plants excepting the *Tenopteris Bertrandi*, which is associated with the last, in his *tritonian class* (p. 393). In short, M. Brongniart will readily acknowledge, that the imperfections of his still useful tables of fossils, would conduct to strange results, if we were to take them *à la lettre*, as the sole basis for the determination of tertiary deposits. I regret I cannot agree with M. Brongniart in the characters he gives to his *proteique system*, viz. that it contains few madrepores and no nummulites (p. 153), because the upper tertiary limestone of Austria, Hungary, and Transylvania, contains thick beds entirely composed of a variety of nummulites, while the sands abound in coralline bodies, as is the case at Eisenstadt in Hungary. In the subappenine clay marl, madrepores are rather unfrequent, excepting the genus turbinolia, &c., but they abound in the upper tertiary sand and limestone. We may add, that M. Brongniart is wrong in not admitting nummulites in molasse (p. 148), for some have been found in that rock in Gallicia, and also in Hungary.

Lastly, we may notice the manner in which M. Brongniart conceives the tertiary basins were successively filled. No one, as far as we know, maintained that these basins were Caspian or inland seas; and, in general, M. Brongniart's ideas on this subject have been adopted (201). These basins communicated with the ocean, or they were only great gulfs, which received various deposits, according to their locality and geographical distribution. According to this view, a basin may be called a Mediterranean basin, if it communicates with the ocean by a narrow channel, and a gulf would be exemplified by that of Gascony. Now if, during the tertiary period, the Mediterranean communicated with the ocean through the south of France, and with the Baltic Sea by the Black Sea and Russia, these peculiarities will not hinder us from saying, that the Mediterranean deposits took place in a nearly enclosed basin, while the tertiary rocks of Bordeaux would have been deposited in a great gulf. On the other hand, there were in Europe during the tertiary period some other basins, with still smaller outlets than the Mediterranean; for instance, that basin which extended from Grenoble or Chambery through Switzerland and Bavaria to the extremity of Hungary. It is evident that this great basin could not have had any outlets (supposing things as they are at present) unless by Grenoble, through the rent of the Fort L'Ecluse, by that of Bingen near to Mayence, and that between Sanchova and Orschova in the Bannat. If it seems probable that two or three of these outlets were formed during the alluvial period, we at once perceive that there would have been then a nearly inland sea. The Bohemian basin appears also to have had, during a long tertiary period, only one outlet, and that towards the North Sea; or it was, in fact, during that period a true inland sea, and hence the tertiary deposit it contains is merely a lignite clay without marine shells. It is even possible that, like the Allier and the Loire basins, it may have been during the tertiary period not only an isolated basin, but one on a higher level than others.

These obvious facts M. Brongniart seems to forget, when he remarks, "Qu'il ne peut admettre des bassins entoures de maniere à en faire autant de Caspiennes, dans lesquelles les phenomenes et les productions auront été differens, qui se seront trouvée à differentes hauteurs, dans lesquelles les phenomenes geologiques auront eu des durées tres-diverses," (p. 202). The structure and form of the tertiary deposits do not, according to this geologist, support that idea, yet what a difference does not M. Brongniart point out between the basins of Paris and of Switzerland, those of London and of Auvergne, &c. As he does me the honour of quoting my geological map of Europe as a proof of the extent of tertiary deposits, I use the liberty of requesting him to compare their geographical distribution with our idea, and to see the conformity of both. The actual state of things, far from being unfavourable to our opinion, is, on the contrary, much in favour of it, as we observe seas, as the Mediterranean and Red Sea, the Caspian and Black Sea, the Pacific and Atlantic, near each other differing but little in their levels. Now, supposing these seas to be dried up, we would have in each of them peculiar deposits of limited basins. The differences of level have been formerly greater, while the actual upraising of continents are trifling in proportion to what formerly took place. We must believe that M. Brongniart starts from the principle of Von Buch, that the chains have been produced during the alluvial period, and that Europe has been thus unequally elevated; at least M. Brongniart tells us positively that, during the saturnian or old alluvial period, "les plupart des montagnes on été elevées, et les couches ont été soulevées, inclinées, courbées et brisées," (p. 64). The works of Steno, of Heim, of Jobert, of E. Beaumont, and our own, contain proofs enough that, on the contrary, the number of hills elevated has been less in the alluvial period than in the preceding one.

On this supposition of M. Brongniart, it is evident that the basins would have had every where the same level, but then the tertiary soil, in place of being distributed in basins, would have covered the whole of Europe. M. Brongniart does not go so far as Mr Martin *, who forms the tertiary basins after the deposition of the tertiary deposits. M. Brongniart admits the existence

* On the Denudation of Sussex, 1828.

of basins after the chalk period, and even before it; but if basins and gulfs existed at that time, these should also have been separated by ridges, or at least by *plateaux;* and what circumstances can have prevented the local existence of true Caspian or inland seas?

When we examine the European tertiary basins, we become convinced that they were nearly enclosed on all sides. If it had been otherwise, the Jurassic chain not existing, the Swiss molass would have extended into Franche-Comté. Without the German Jura or Alb, and the Black Forest, the valleys of the Necker and the Upper Maine would not be deprived of tertiary rocks; without the circular zone of Bohemian mountains, that country would offer a mixture of the tertiary deposits of Austria and of northern Germany. Without the Carpathians, the basins of Austria, Hungary, and Gallicia would be identic. Without the Alps, we could not explain the difference between the tertiary rocks of the northern and southern sides. Without the hills in northern Germany, the mineralogical difference of the basins of that country with those of the southern part of Germany, would remain unexplained. Without the chalk ridges of England, we would be astonished to see the London clay deposited at the same time with the Paris limestone. We cannot be answered by saying that the alluvial matter brought down by rivers must have been different in different gulfs, because we quote examples like that of the Necker, where nothing whatever was deposited, and Bohemia and Auvergne, where there is only a single deposit. Still we would have the unexplained fact of the Paris limestone on the southern foot of the Alps, and the molasse on the northern side.

On the other hand, the study of the upheaving of strata has led Humboldt, Jobert, De Beaumont, and ourselves, to acknowledge that elevations have taken place at different times, so that there have been at all times different levels, and hills, and chains, and, consequently, the more the number of elevations has increased the more the chains and levels become numerous, and also the cavities or basins. Amongst these last, those which remained at the level of the ocean, or of which the bottom was still lower, were then gulfs or bays more or less separated during the time that the inland seas were occupying those of which the bottom was higher than the ocean, or which, with a lower bottom, were separated from the ocean by a chain affording only exit to a small stream of water. Probably the elevations during the alluvial period hastened the change or conversion of the salt-water basins into fresh-water lakes, or their drying up entirely. It is also evident that in some countries the elevation of the country has been followed by a sudden retreat of all the sea-water. and then streams were established; or, in favourable circumstances, a bank has permitted the accumulation of water, and one or more fresh-water lakes have been formed, as in Auvergne If that district had not had, during the deposit of the Paris marine limestone, a different level from that of the neighbourhood of Paris, marine limestone would also have been deposited there. M. Brongniart will be convinced of it, as soon as he renounces his opinion that at Montmartre there is a fresh-water deposit, a theory long ago rejected by Professor Jameson (in 1816), for his theory admitted the finding of true fresh-water rocks in Auvergne. M. Brongniart was naturally led to the conclusion that both basins had the same level. We think that many things tend to shew that Beaumont is right in placing the tertiary limestone of Auvergne as parallel with that of Fontainbleau, and with the gypsum of Montmartre, a proposition which is in concordance with the opinion which maintains that there existed a difference of levels. Such, then, are the considerations suggested to us by M. Brongniart's opinions. We may be wrong in many things, but we are right in some. Our observations are not to be viewed as depreciating the incontestible merit of M. Brongniart, who has formed at Paris a particular school of geology, and has in this way given a new direction to geological science.

On the Consumption of Gold and Silver in Britain in the Twenty Years between 1810 *and* 1829, *but especially on the application of them to other purposes than Coin.* By WILLIAM JACOB, Esq. F. R. S.

THE greater part of the application, both of gold and silver, to other purposes than the fabrication of money takes place in

London; but in Birmingham much gold and some silver are annually applied to various ornamental purposes. In Sheffield there is much use of silver, chiefly for plating. In Liverpool and Chester many watches and some jewellery are produced, and those articles which are liable to the duty are assayed at the latter place. At Derby there are several manufacturers of jewellery and gold articles, who produce goods of a quality superior in the fineness of the metal to those made commonly in Birmingham, but perhaps inferior to the best London jewellery. At Newcastle, York, and Exeter, are manufacturers of gold and silver goods, and of jewellery. In Scotland and in Ireland the goods they make, which are not liable to duty, bear probably the same proportion to those chargeable with it, as is found in the manufacturing towns in England.

There are few towns in the kingdom where there are not to be found some gold and silver smiths, who use greater or less quantities of the two metals. Plain gold rings, and gold chains from wire of appropriate size, are commonly made by such workmen, and though the quantity by each individual is small, yet the consumption of the whole number must be of considerable, though unknown, amount.

It would have been impossible to have obtained from so many and such various quarters, whatever pains may have been taken, exact returns. It was thought proper to limit the personal examination to the three principal places—London, Birmingham, Sheffield. In the author's inquiries among the persons connected with the several branches of the trades that use gold and silver in those three places, he has found so much readiness to communicate information, so much accuracy generally in the accounts rendered by some, verified by similar accounts supplied by other individuals, and so much desire to point out other sources of information, that he looks back to the time spent among those persons with much satisfaction.

In each branch of the trade a certain number of persons were so kind as to furnish exact accounts of their own consumption of both gold and silver, and their opinions as to the quantities consumed by others in the same branch. By this a clue was furnished, when these several accounts were compared with each other, which led to calculations that approximated as near to accuracy as could be expected in such an inquiry.

In some cases the trade of a *refiner* of gold and silver is combined with another, technically distinguished by the name of *sweep-washers.* The persons employed in this branch purchase whatever refuse is obtained from the floors of the various descriptions of workships in which the divisions and subdivisions of the trade in gold and silver are carried on. These sweepings, as they are termed, are first, by stamping, crushed into a minute dust. The mass is then amalgamated with mercury, which takes up the precious metals. This composition afterwards undergoes a kind of distillation, in the course of which the mercury is evaporated by heat, is then condensed and preserved, and the precious metal parted for future application to the purposes for which it is needed.

In pursuing our inquiry, the first step appeared to be to ascertain the quantity of gold which is annually produced by the whole of the refiners and sweep-washers. Whatever that quantity might be found to be, as the whole is applied to manufacturing purposes, it would be a guide to the knowledge of the remainder. There are certain branches of trade in which refined or pure gold alone is used. The gold-beaters, the water-gilders, the gold-lace makers, the china-gilders, the gilders of buttons, and of toys, and of trinkets, use only fine gold, or gold with such minute particles of alloy in it as are necessary to make it adhesive. The jewellers, too, who are the great consumers of gold, use partly refined gold, or at least a considerable number of the trade do so. The case, however, of that business will be presently considered more at large.

As the reports of the quantity of the gold which the refiners and sweep-washers furnished to the several branches of the manufacturers of gold articles were very discordant, and varied, according to the persons who supplied them, in the proportion of one to four, or even one to five, and as all further calculations must, in some measure, depend on the degree of correctness which could be obtained on that first step, it appeared necessary to attend to it most scrupulously.

The business of a refiner requires a large capital. From the high value of the smallest particles of their commodity, a minute attention to every detail is indispensable. It is impossible to conduct the delicate operations on which they are engaged, without some considerable knowledge of the chemistry of metallic substances, which is, in many instances, extended far beyond the bounds of their own trade. Traders of this description are open and accurate in their communications with those from whom they fear no rivalry, and suspect no improper or underhand intention; and, except in one instance, every individual applied to frankly stated his own product of refined gold, and gave his opinion of the product of other houses with whose transactions he had any means of being acquainted. Out of twenty-three or twenty-four houses in the country and in London, in these branches of trade, eleven supplied to this inquiry the real quantity of gold which on the average of the last years they had refined. This was done under an assurance of secrecy as to each individual, but with full permission to state the collective result in any manner that might be deemed advisable. A small number of these houses refine more than 13,000 ounces yearly, most of the remainder from 6000 to 8500; and the produce of the whole eleven amounts to 108,500 ounces. There are twelve or thirteen others, of which three may be calculated to refine about 4500 ounces each, four about 3500 each, and the remaining four about 2500 each.

The whole may be brought under one view thus:

Product of pure gold from eleven houses,	108,500 ounces
.... three houses,	13,500
.... four houses,	14,000
.... four houses,	10,000
	146,000

From the time that has been spent in this branch of the inquiry,—from the number of persons from whom communications have been received,—and from the consideration which has been since paid to all the circumstances connected with the subject,—the degree of confidence given to the result arrived at is greater than can safely be bestowed on the future stages of the examination.

The mode in which these 146,000 ounces of pure gold are disposed among the several manufacturers becomes now a topic for consideration. The several modes have been attentively inquired into among the chief persons employed in the several seats of the manufactures in this kingdom, and, on a great part of them, the information obtained has been tolerably definite.

The various branches of gilding cause a great annual consumption of the finest gold, or of gold with such minute proportions of alloy as do not lessen its value more than 1 per cent., it being not more than two or three grains in the ounce.

The gold-beater's trade is chiefly carried on in London; to an inferior extent in Birmingham, Dublin, Glasgow, Edinburgh, Liverpool, and some other places. The numbers of this branch are about eighty in London, and twelve or fourteen in the other places. One of the largest makers of leaf-gold stated his weekly use of that metal to be twenty ounces; another, who may be considered a medium manufacturer, shewed, by reference to his accounts, which were kept with apparent regularity, that he had used sixteen ounces and a quarter weekly. Several were conversed with, who did not use weekly more than three or four ounces, and some who worked up still less, and that chiefly by their own family, with the help of one or two apprentices. It cannot be very incorrect, considering that the greater numbers engaged in this branch of trade, are of a class that can scarcely earn more than the wages of a good journeyman, if we estimate the average rate of the whole ninety gold-beaters at three ounces weekly. A corroboration of this estimate has been obtained by calculating the rate of wages, and comparing it with the given quantity of gold.

The leaf-gold, when finished, is placed between paper, in leaves of three and three-eighth inches square, twenty of which form a book. These books are sold by the thousand, at various prices, according to the thickness of the leaves. It was found that eight pennyweights of gold could be converted into a thousand books of the cheapest, that is, the thinnest, kind. The cost of the gold, at 87s. per ounce, amounted to 29s., and the cost of the labour on it amounted to 23s.; and the thousand books thus produced were sold at L. 2, 15s.; thus leaving an apparent profit of no more than 3s. to the manufacturer. He derives another, and, perhaps, his chief profit, from the portions of gold that are saved as clippings, in reducing the leaves to the proper form and extent. In beating the gold, it is, by repeated operations with a hammer, brought to the required thin state; but it is in large leaves, of an irregular shape, and these, when reduced to the prescribed form and size, necessarily leave much clippings, all of which are carefully preserved for future applications, and contribute some addition, perhaps 10 per cent., to the gains of the manufacturer.

The account here given, of the gold-beater's operations, applies more especially to the trade as carried on at Birmingham, where the chief leaf-gold is of the thinnest kind, and in which, consequently, the wages bear the highest proportion to the value of the gold. In London, though some little leaf-gold is made, chiefly for the use of painters, as low as L. 3, 10s. the thousand books, the greater part is of a thickness which makes it worth from L. 4 to L. 4, 10s., and from that price upwards to as high as L. 9. It thus appears that the proportion of the wages to the gold varies excessively; in the thinnest leaves amounting to more than two-fifths, and the thickest, which requires less hammering, to less than one-tenth.

This disquisition may appear too minute, and may, perhaps, be tiresome to the reader; but it was made, among other inquiries, to verify the calculation, framed in another way, on the quantity of gold used by the gold-beaters. Having ascertained the number of hands, the rate of wages earned, and the weight of gold weekly used in a particular shop, and then learning the number of workmen in the other similar shops, an estimation was made, which came sufficiently near to that produced by the relations of the several persons conversant in that branch of business, to satisfy the inquirer that his view could not be far removed from the truth.

We arrive thus at a conclusion, that the annual consumption of all the gold-beaters in the British kingdom is about 17,500 ounces of fine gold.

Another description of gilding requires annually a great portion of pure gold. This trade is sometimes distinguished by the name of *water-gilding*, and a considerable branch of it by that of *toy* or *button gilding*. The gold, in the form of dust or fine powder, is mingled with quicksilver, and, in a consistency like paste, is applied to the metals that are to be gilt.

The mercury causes the gold to adhere to the other metals, when, by the application of heat, it is evaporated, and leaves the gold on the surface of the object. The application of gold in this way may be distinguished by the two principal branches of the manufactures in which it is used. The trade in gilt buttons is chiefly carried on in Birmingham, but extensively also in London. In the first town, there are upwards of fifty large, and many small establishments; in the latter a much smaller number, but these are calculated to expend about three times the same quantity of gold on the same number of buttons. From the influence of fashion within the three or four last years, the number of gilt-buttons fabricated has somewhat declined, though the whole produced is still very large. Many of those for the use of the officers of the navy and army, and other gentlemen, are made at Birmingham, as are those destined for foreign markets, whilst the trade in London supplies a portion of them to the higher classes, and has an almost exclusive monopoly of such livery buttons as have arms or crests stamped on them.

Communications received from ten of the largest manufacturers in Birmingham led to the conclusion, that their weekly consumption of fine gold had, till within the last three years, amounted to 200 ounces weekly, and that the several smaller houses, from their greater number, might use about 300 ounces. Within the last three years, the demand has declined, and the consumption of gold is estimated not to exceed 360 ounces. The quantity used in London is not supposed to amount to more than one-sixth of that which Birmingham consumes, and on these grounds we are led to the conclusion, that the whole trade in gilt buttons has, during the last twenty years, required a supply of gold of about 650 ounces weekly, or about 21,800 ounces yearly.

A larger portion of gold is used by the manufacturers of gilt toys, a branch of trade which is followed in more than 100 establishments in Birmingham, and several in London. The vast quantity of wares of this description, of which almost every part of the world receives a supply from England, would require an enumeration of all the personal and domestic ornaments and utensils that are known, whose value singly may be very minute, but, when the whole mass is included, comprehends a great amount.

The gilding of these toys and trinkets is in part executed by the makers of them; but a very large part of such goods is formed by one class, and afterwards sent to another branch of trade called gilders, who execute only that part of the work. Among those who gild their own goods, it was found, in individual instances, that several had used from six to ten ounces of gold weekly; that others, and those the most numerous body, used from three to four ounces weekly. With those who gild the goods of other people, the consumption of gold is much larger: in one case, it was found to have been from twenty to thirty ounces, and in some others from fifteen to twenty ounces. It was impracticable to visit and obtain accurate returns from a number of tradesmen, amounting, in the two classes here treated of, to more than 150 in Birmingham only, besides some in London. It was deemed sufficient to see some of the most respectable and intelligent, and, from their accounts, to frame the most probable average of the whole. In this way, and considering, that, especially in London, a large portion of silver goods is gilded, either internally or wholly, we have been induced to calculate the weekly consumption of gold in the gilding of the description here noticed, at 600 ounces weekly, or 31,200 ounces annually.

The plating of gold, which will be further noticed in the subject of jewelleries, under consideration, is supposed, by those well acquainted with the trade, to employ about fifty ounces of fine gold weekly, or 2600 ounces yearly.

The use of gold in the potteries has very much increased of late years, as must be obvious to any person of observation who notices how profusely it is applied to tea, to table, and ornamental china. From the great number of manufacturers of that commodity, and from their not being very much concentrated, for, though they abound most in Staffordshire and Shropshire, there are large establishments at Worcester, Derby, in Yorkshire, and other parts of the kingdom, it has been difficult to make such particular inquiries as have been directed to other branches of trade. From the imperfect view we have been enabled to take, and from the opinion we have obtained from some of the larger dealers in china-ware, we feel disposed to consider the whole consumption to be about 100 ounces weekly, or 5,200 ounces annually.

The china manufacturers use only the fine gold. Some is supplied to them by the refiners of Birmingham and Sheffield, but the larger part probably from those of London. It has been stated, that some of the manufacturers have bought as much as twelve or fourteen ounces a-week; but it could not be clearly shewn that such was the regular demand, or, taking the number of them into calculation, the estimate would be much greater than is here assumed. In this state of great uncertainty, it has appeared more proper to take the opinion of those most conversant in the trade, than to adopt any estimate on imperfect materials. We have now arrived at the end of the calculation of that portion of refined gold which is applied to all the purposes of manufacturing, except to that in which the far larger proportion is annually consumed, the fabrication of those elegant ornaments collectively, denominated jewellery.

According to the best information that could, from the nature of the case, be obtained, we have arrived at a conclusion that, of the gold rendered pure by refining in the kingdom, amounting to 156,000 ounces annually, the application of it in the various ways that have been examined, amounts to about 88,000 ounces, leaving nearly 60,000 ounces yet to be accounted for.

It may be here remarked, that, with the exception of that gold which is used by the gold-beaters, the whole of the portions we have noticed may be said to be not merely applied but absolutely consumed. Of the best gold, it is supposed one-fifth may be again recovered by the burning of picture-frames and such other substances, except the metals and the pottery, upon which the leaves have been laid.

The application of gold to jewellery must now be considered, in the course of which it will be seen that the quantity so appropriated very far exceeds in amount all the other modes in which that valuable substance is made use of.

Without being minute observers of fashion, or without being constant frequenters of those circles in which its changes are most observable, it is impossible not to remark how great, though gradual, has been the increased introduction of gold ornaments in the decorations of females. This has been especially remarkable within the whole of the last twenty years, but, perhaps, much more so within the last than the first ten years of the period.

Only a junta of jewellers, dressmakers, and ladies' maids, could give a complete catalogue of the numerous ornaments of gold and silver which have of late been added to the dress of our females in the higher circles of society. Ornaments for the head, including large combs of gold, necklaces, and brooches of extended size, clasps and buttons of gold to fasten the bodies of the gowns, bracelets and armlets additionally, numerous rings on the fingers, gold hooks-and-eyes for the drapery of the gowns, eye-glasses set in gold, and secured by chains of gold, and a watch with gold seals, and trinkets too numerous to be mentioned by one not professionally a master of dress. Such are the additions recently made to the application of gold to purposes of ornament.

Whatever effect may be produced by such fashionable changes when confined to the higher classes, it is not bounded by their consumption alone. The ornaments of this kind are first fabricated of fine gold, and commonly in London alone. They are, however, soon imitated, by other workmen, in gold of inferior quality, in some degree, of inferior workmanship, at Derby and Liverpool, but more especially at Birmingham. At the latter place much gold is so mixed with alloys, in the combination of which so much chemical knowledge is applied, that it can be sold at all prices from a half to even a quarter the cost of standard gold. From metal of these several degrees of fineness, ornaments are made which enable the more numerous class, a little below the fashionable world, to rival their superiors in fashion, and with no danger of their inferiority being detected, except by the very small number who are critical judges of the metal.

Another step has been made in the progress of suiting ornaments to the finances of a still more numerous class of lovers of dress. Of late years the practice of plating with gold, in a manner similar to that long practised with silver, has been introduced. A thin plate of gold is fixed on a thicker one of inferior metal, and then, by means of the powerful flattening mills, the substance is extended to the space desired, and presents a sheet, on one side of thin gold, and on the other of inferior metal. From this metal, thus compounded, great numbers of seals and other small articles are made, which are gold to appearance, and will retain that appearance, even when constantly worn, during ten or twelve years.

The gilding of metal, by applying to it powder-gold, combined with quicksilver, so as to leave only the gold on the surface, is another mode, by which toys and trinkets are furnished at a cheap rate to those whose purses do not admit of their buying ornaments of either fine gold, alloyed gold, or gold plating. There are millions in every part of the world, each of whom obtains and disperses a certain quantity of gold; which, though minute individually, amounts to a sum of high value when the whole of the human race who consume such articles is comprehended in the calculation. If among the male part of the public, the use of gold ornaments has not been adopted to the same additional extent as among the females, yet some progressive increase is very apparent. The use of gold chains for eye-glasses, the increased number and size of seals, brooches, and breast-pins, and the small waistcoat buttons of gold, or of gilding or plating, have caused a great consumption of that metal. Whoever has travelled much on the Continent must have been struck, particularly with the size of the seals, the great number of trinkets, and the weight of the gold chains usually appended to the watches both of the ladies and gentlemen. The fashions of Europe extend their influence to every civilized part of the world. In America, in the different colonial establishments founded by Europeans in the West and East Indies, in Africa, Asia, and Australia, besides their domestic manufactures, they are supplied with ornaments, consisting in a greater or less degree of gold and silver, some portions of which are again used by even the savage tribes which are in contact with them.

From this extensive spread of ornamental as well as of useful articles, it must be obvious that no calculation, with whatever care or research it may have been preceded, can be of such a nature as to be more than an approximation to accuracy. The task, however, must be undertaken, and the reader be left to give that credit to the result that shall be presented to him which in his judgment it may merit.

As the only fields of minute investigation at hand on the subject of the trade of the jewellers were London and Birmingham, what refers to that trade in the following pages is chiefly confined to those places, though they may, perhaps with justice, be extended to Liverpool, Derby, and the other towns where jewellery is fabricated. In London, the most costly articles of jewellery are devised and completely finished by the same persons; and, exclusively of the precious stones, which, in some of the ornamental products, are the chief costs, the greatest expenditure on them is the gold. That metal is rarely used in a pure state, though, in some of the more delicate parts, such as the filigree work, it is mixed with but a very small portion of alloy. This fine gold is commonly supplied to the jewellers by the refiners, and that worked up by them consists of the 58,000 ounces, which, according to the estimate before framed, remains, after the part appropriated to various other purposes has been deducted. It forms, however, but the minor portion of that used by jewellers. The gold used by the first-rate London jewellers is commonly of sixteen carats fine, or with two-thirds of its weight pure gold. As that gold which can be purchased consists, for the greater part, of light guineas, light sovereigns, doubloons, Portugal pieces, and other foreign coin, it may be considered as of twenty-two carats fine, or as two parts in twenty-four, or one-twelfth less fine than the refiner's gold. The price of this standard gold is L. 3 : 17 : 10½ per ounce, and such gold is always a ready money article. The price of the pure gold of the refiners is L. 4 : 7 : 6 the ounce, and is sold on credit. The difference of price is thus 9s. 1½d. the ounce, whilst the difference in the real quantity of pure gold is one-twelfth part of L. 4 : 7 : 6, or 7s. 3½d. The cost of refining, and the loss of weight by that operation, may be taken at sixpence the ounce. The difference in price, then, between the standard gold and the pure gold will appear to be 1s. 10d. more on the latter than the difference in real value.

It must then be the interest of those jewellers whose capitals are sufficiently large to enable them to buy their gold with ready money, to purchase standard rather than fine gold, with the exception of what is required for such delicate parts of the work as can only be executed with fine gold.

In conversing with some of the largest manufacturers of jewellery, whose trade consisted chiefly in making what are called heavy articles, such as mourning rings, snuff-boxes, chains, plain bracelets, and similar ornaments, it was ascertained that they used no refined gold. Two houses, especially, whose use of gold weekly exceeds 100 ounces, asserted that they never purchased any refined gold, but bought old English light guineas and sovereigns, or foreign coin by weight, and lowered the quality to the degree of fineness most applicable to the particular objects for which they were designed. Another informant, who paid the highest amount of duty at Goldsmiths' Hall, affirmed that he purchased no refiner's gold; and another, whose trade consisted in making the more delicate, as well as the heavy articles, stated, that "on taking an account of the various qualities of gold used in their manufactory during the last four years, it was found that the proportion of fine gold was nearly six-tenths, and of standard gold, consisting of light guineas, ports, and doubloons, four-tenths."

Among eighteen of the largest manufacturers of jewellery in London, the fact was ascertained, as nearly as such kind of facts can be, that their weekly consumption of standard gold amounted in the whole to 1000 ounces, whilst the fine gold they used did not amount to more than 300 ounces. This information is certainly very imperfect, when the master manufacturers in that trade, including those on a moderate scale, are more than ten times as numerous, and whilst the smaller manufacturers who work in obscure garrets, or in other lodgings, and use perhaps not more than two or three ounces of gold monthly, are known to be many hundreds. Among this latter numerous description of workmen, some, to whom a short credit is an object, repair to the refiners for their small portions of metal; whilst those who have a little money beforehand, will prefer buying a light guinea, a napoleon, a moidore, or some other foreign piece of money, the weight of which may be best adapted to their finances and the articles on which they are employed.

In calculations of this kind, an inquirer should be constantly apprehensive of exaggerated statements and reports, and that feeling has induced us rather to trust to our own collection of facts, imperfect as it may be, than to any opinions or calculations of individuals. The method here adopted has been attempted to be explained, as far as can be done, without disclosing the names of individuals or manufacturing firms, or without communicating the extent of the dealings of each respectively. The conclusion to which we have come is, that, in the jewellery manufacture of England, including London, Birmingham, and the other places where gold is used, the consumption of standard gold is four times as much as the weight of that which is used in that manufacture in pure gold, as sold to the jewellers by the refiners.

We could then state the actual conversion or application of gold in Great Britain to be,

Fine gold used by gilders of the several kinds, and by platers,	88,000 ounces.		
By jewellers of all kinds, -	58,000		
	146,000 oz.	at L. 4 : 7 : 6,	L. 638,750
Standard gold used by jewellers,	232,000	L. 3 : 17 : 10½	L. 902,270
Gold watches, viz. in London annually 13,820; in Birmingham 600; in all the other places about 300; in the whole 14,720 watches, which average two ounces each, being 29,440 ounces, which being only of 18 carats, may be valued at L. 3, 5s. per ounce,		L. 3 : 5 : 0,	L. 95,680
			L. 1,636,700

This amount, considerable as it may appear, falls very far short of the communications of opinion made by several intelligent persons connected with the various branches of the manufacture of gold,—that of one gentleman, on account of his extensive practical use of gold, of his habitual accuracy, and his general knowledge, is entitled to attention. A variety of queries were proposed to him on the several branches of the gold-trade, with which he was conversant; among others, the following, viz.: "What quantity of gold is used by the jewellers in such small portions as are not liable to the stamp-duties?" The answer in writing was as follows:—

"An amount which at first sight appears incredible, certainly not less than from 450,000 to 480,000 ounces of standard gold, or in pounds Sterling, a sum of about L. 1,900,000 Sterling, but more probably L. 2,000,000 than less.

"It would be inconvenient to give here the process by which that result is obtained, but there are several ways by which it has been tried, and little doubt, if any, exists as to its correctness.

"There are an innumerable number of articles, which, from their delicate texture, cannot be assayed and stamped; and others are made of such inferior gold as scarcely to deserve the name of gold; and yet the quantity is so large, that a very great portion of gold is consumed in the manufacture. Let any one look at the trinkets and personal ornaments of himself and his family, and he will see what an immense disproportion exists between the stamped and the unstamped gold. The quantity used is certainly not over-stated in the first part of this answer."

It will thus appear, that the result at which we have arrived is about 100,000 ounces less than what is estimated by this intelligent manufacturer, to be annually consumed by the jewellers alone, with which branch of the application of it he is most intimately acquainted.

We come now to the consumption of Silver in the several manufactures of this country. In those of gold, from the value of the metal, and the high duty which is imposed upon it, a very small proportion of that which is used is liable to be charged with the duty; but on silver it would appear probable, that the quantity which does pay the duty is nearly equal to that which is not chargeable with it. In articles purporting to be gold, there is commonly so much of the inferior metals combined, that it cannot legally be considered as gold, and the duty, which is 17s. per ounce, cannot be enforced; but on silver, as the duty is but 1s. 6d. the ounce, and what is purchased is expected to be of standard purity, almost every article heavier than five penny weights is carried to the assay-officer, to be stamped, and to pay the duty. In fact, very few gold articles, except most mourning and some wedding rings and snuff-boxes, pay any duty; but spoons, forks, and other silver goods, exceeding five pennyweights, are charged with the tax.

We shall class the consumption of silver in England under four several heads.

The first division is that on which the official returns give the quantity of silver with a degree of exactness that entitles it to the fullest confidence. It appears that the consumption from 1810 to 1829, both years included, amounted in London and in Scotland to 23,055,082 ounces; in the country places in England, supposing the whole of the duty in them to have been paid on silver, to 911,750 ounces; and in Ireland to 1,539,517 ounces; thus showing the consumption of the United Kingdom for the twenty years to have been 25,506,339 ounces, or at the average annual rate of 1,275,316 ounces. The next division of the use of silver is into that for watches, the cases of which are stamped at the assay-offices, to determine the fineness of the metal, although they are not subject to any duty. It is seen that the number of watches stamped in London in the same twenty years, was 2,015,461, or 100,773 annually; each being $2\frac{1}{4}$ ounces, would give an annual use of 226,740 ounces. The average number assayed at Birmingham, but chiefly made at Coventry, was about 60,000, weighing two ounces each, or 120,000 ounces. In Edinburgh, Glasgow, York, Dublin, Newcastle, Exeter, Sheffield, and Liverpool, those of which last place are assayed at Chester, the number may be taken together at 80,000, of 2 ounces each, or at 160 ounces, thus making together 506,740 ounces.

Another mode in which silver is used is that of making plated goods, chiefly manufactured at Birmingham and Sheffield, and in no inconsiderable degree in London. The rolling of silver in contact with the inferior metals, is performed by extensive and powerful flatting mills, at each of these three places; but the largest portion, as regards extent of surface, is executed at Birmingham. The lowest kind of these rolled sheets produced by the Birmingham manufacturers, does not contain more than between 3 and 4 pennyweights of silver to each pound of the inferior metal on which it is plated. Much of this lower plate is sent from Birmingham to Sheffield, and there manufactured into goods, which, by its inferior quality when sold, as it frequently is, as Sheffield plates, injures the reputation of the productions of the latter town, and is a subject of complaint with the respectable manufacturers there.

The Sheffield plate generally contains more than 5 pennyweights of silver to the pound of copper or other metal, and much of it is plated on both sides; besides which, the small beading which surrounds the edges of the plated goods, is formed of silver alone, which, though from its weight not chargeable with the duty, yet in the whole manufacture consumes a large portion of silver. The plated substances rolled by the flatting mills in London, have commonly more silver applied to the surface. Much of it is used by the platers to form ornaments for coaches and for coach-harness. As these ornaments suffer by friction from the frequent cleaning they require, it is necessary to have a much thicker coating of silver than is required for some other purposes. As far as can be ascertained by inquiries of the platers, of the owners of flatting mills, and of the manufactures of plated goods, we are disposed to estimate the silver used for that particular purpose in Birmingham and Sheffield, including with it that used at Walsale and its neighbourhood, chiefly for the saddlers, and ironmongers, at about 750,000 ounces annually. That which is for rolling in London, though of much better quality, being far less in quantity, may be safely estimated at 150,000 ouuces.

There is another application of silver to which only conjecture can be applied. Many articles are fabricated of that metal below the weight which is amenable to the assay and the duty. Silver thimbles are annually made by hundreds of thousands, all below the accountable weight. Silver chains, either for eye-glasses or for watches, or for any part of the dress, are formed of links, each of which as a single object is below the taxable weight; pencil-cases, necks of smelling-bottles, locks to pocket-books, to instrumental cases, to portfolios, and small portions to the handles of pen-knives and razors, and other personal and domestic ornaments, when added together must form a large annual amount of silver consumed, but not liable to the stamp tax. The gold-beaters use some large portions of that metal for making leaf silver for gilding. According to the best account we have been able to collect, silver in leaf can scarcely be made thinner than two and a half times the substance of leaf gold; as eight pennyweights of gold will make a thousand books, whilst it requires one ounce of silver to make that number. The use of leaf silver is certainly much less extensive than that of leaf gold, but considering the greater weight of each leaf of the same size, perhaps the consumption of one metal in this particular way may be nearly equal to the other. There is another application of silver by an inferior, but numerous class of artizans, denominated washing with silver, but it has been found difficult to obtain any clew to this branch of trade, by which even a conjecture could be formed of its extent.

Taking the opinion of experienced dealers, and considering the observations here stated, we should not be disposed to estimate the quantity of silver annually used in the several ways noticed in the preceding paragraph at less than five hundred thousand ounces.

Our estimate, then, of the annual quantity of silver applied in the British kingdoms to other purposes than that of coin, appears thus :—

	Ounces.
That paying duty, ...	1,275,316
That used in watch-cases, ...	506,740
That used in plating, ...	900,000
That used for other minor purposes, . .	500,000
	3,182,056
At five shillings per ounce, ...	L. 795,514

If to this be added the quantity of gold as before detailed at L. 1,636,700, we may consider the two metals as demanding L. 2,457,221 annually.

The view here taken of the consumption of the precious metals in England receives some corroboration from the best accounts that can be collected from the other parts of Europe. The general peace which prevailed in the greater part of the twenty years here under consideration seems to have had the gradual effect of extending indulgence in articles of ornament and luxury of every kind. This has been so marked that no traveller who has visited the Netherlands, France, Italy or Germany, at intervals, with a few years between, could have failed to remark the progress, from one date to another, of the great application of gold and silver to purposes of personal ornaments, and to the higher class of domestic utensils. This has been strikingly obvious in most of the capitals of the several countries, in all the commercial cities, and even among the middle classes including the inns and hotels. Even in the towns of inferior consequence, it has been remarked that the silversmiths, the watchmakers, and the jewellers, have increased greatly in their numbers, and have found the demand for their goods keep at least equal pace with the increase of their population.—*Jacobs' Historical Inquiry into the precious Metals, Vol. II.*

On the Utility of Early Elementary Instruction in the Natural Sciences.

By many, it has been long and anxiously wished that the study of the Natural Sciences were rendered more subservient to the every day concerns of life, and also a means of illustrating, not only the existence, but likewise the attributes, of the Great Creator.

The system of education of youth so long pursued in the public seminaries of this and other countries, is now generally admitted to be very defective, and to have had baneful effects upon society at large. The time and attention of the earlier period of life have been wholly engrossed with the languages and manners of people who lived many centuries ago, and whose customs are exhibited by the writers of those times as the pattern of honour and virtue. These languages, however, are of little or no utility to nine-tenths of those who are compelled to study them; and the customs, with very few exceptions, must now appear, to every enlightened and well constituted mind, brutal and barbarous in the extreme. Hence the ignorance, in regard to the practical concerns of their own times, which so generally exists among even the better educated classes of society; and hence also the imperfect state of our religious and moral institutions; and, consequently, much of the immorality and disease which now prevail.

It is not at present intended to trace the causes of any particular class of evils, but merely to state our decided conviction, that a great change is required in the general system of education. Towards this object much has lately been done, not only abroad but also in this country: words only are no longer taught in many of our schools, but likewise ideas; and these are illustrated by pictorial representations of the more familiar objects of nature.

But if so much has already been done by pictorial representation, how much more might be accomplished were familiar objects, as they really exist in nature, next presented to the eye; and were their various uses demonstrated and explained, before that period of life when youth must betake themselves to those professions in which they are afterwards to be engaged during life* ? It has been well remarked, that "all those secular pursuits which tend to augment the true happiness of the individual, while they contribute at the same time to the welfare of society at large, are resolvable, either directly or indirectly, into the control or resistance of the powers of nature, and to the acquisition of that degree of knowledge concerning them, which is necessary effectually to subdue them, or to counteract their injurious influence." Of how much importance, then, is it, that we acquire in youth some intimate knowledge of those natural objects by which we are surrounded, and upon the proper understanding and use of which, our comfort and happiness so much depend ? The divine would be thereby better enabled to explain and illustrate to all classes of his hearers, the works of creation and providence, the wonderful and beautiful laws by which these continue to be governed, and the inevitable consequences which must fall upon man, by his violating the very least of these laws. What is it that enables the physician to avert and cure so many diseases, but his study of the laws of nature, and the constitution of the animal frame, together with a knowledge of the properties of various gases and substances, which are either noxious or sanative when applied to the living body ? What is it that enables one artizan or mechanic to excel another in ingenuity of workmanship, but his superior knowledge and greater facility in the application of natural means to the objects wished to be attained ? And, lastly, What is it but the increased knowledge of the objects and powers of nature, which has from time to time been acquired, that enables man now to cultivate, increase, and improve, with so much success, the various products of the mineral, the vegetable,

* It is to be understood, however, that we are decidedly adverse to the *very* early instruction in physical knowledge advocated by some well meaning but inconsiderate persons.

and the animal kingdoms, which are more immediately intended for his use? In short, there is no situation in life where an early acquaintance with Natural History and the collateral sciences will not be of essential service; and no study can be better adapted for training to habits of reflection, morality, and exalted ideas of the great Author of all nature.

Much might be done were teachers in our academies to cultivate a taste for such pursuits, and attach to their seminaries a few specimens from the different kingdoms of nature. They could easily give demonstrations on these subjects, without at all interfering with the other studies of their pupils, or increasing the expense of education.

But there is one particular topic which, we think, has not been sufficiently noticed in relation to Natural History, and that is, the immense mass of misery, disease, and mortality, at present resulting from the great ignorance, among all classes, of the most obvious laws of nature, as applicable to the human race. It is lamentable to think, that while man is straining every nerve for the advancement of the arts and sciences,—for increasing the products of the ground, and for improving the breeds of our most common domestic animals;—yet that, to the organization of man himself, and its relation to external nature, surely by far the most interesting subjects for examination and reflection, so little attention has been paid. It has long been ascertained, that not above one-half of the population born in towns ever survive two years of age, and that a great proportion of the other half are involved in such diseases as cut them off either before or soon after reaching manhood, comparatively few, indeed, ever arriving at the period of old age. Notwithstanding of this frightful state of things, however, and all the miseries attendant thereon, seldom or never, it is believed, has any energetic attempt been made to ascertain and remove the remote or more immediate causes of such mortality among the various classes of the inhabitants in our manufacturing districts and large towns. Intemperance, and the want of proper nourishment, are known to be powerfully predisposing causes to disease among the labouring classes; but the noxious effects of the different substances used in various trades, of the vitiated atmospheres, and of the constrained and recumbent position of the body, have been all too much overlooked. A work *, however, has lately appeared, likely to attract some attention to these subjects, and which exhibits not only a comprehensive view of the diseases and premature mortality more peculiarly applicable to upwards of 150 specified trades and professions, but also the agents which produce them, with suggestions for their removal. The inhabitants of Leeds and its manufactures are those to which the inquiry relates. The following are some of the author's introductory remarks in regard to the objects of his investigation.

"Man, in his several relations, is assuredly the most interesting subject for examination and reflection. His external form, his internal structure, the number and complexity of organs, their harmony and mutual support, the surprising power which restores injured parts, the organs which, connecting man with his fellows and the world, are the agents of social relation,—these exhibit the first animal in the universe—the work of a Creator all-wise and benevolent.

"Though we cannot rival the agency of superior wisdom; though we can neither make man, nor improve his original organization; we *may* reduce his character, weaken his frame, and bring on him premature decay and death. It is one thing, indeed, to view this being, as God made him: it is another, to examine him in a state of moral and physical degradation."

"If we turn our view from man to his works, we see the wilderness converted into towns and cities, roads cut through mountains, bridges carried over rivers and even arms of the sea, ships which traverse the globe, lakes converted into corn-fields, forests made into pasture, and barren rocks covered with timber;—in a word, we see the face of the world changed by human will and human power."

"These, and works like these, are assuredly wonderful. But while we admire, let us examine. What are the effects of these surprising works—effects, I mean physical and moral? I say nothing of the wealth they produce or have produced, for wealth is good or evil according to its application: I refer to the health of fifty thousand persons, who spend their lives in the manufactories of Leeds and its neighbourhood, or in allied and dependent occupations. I ask, if these fifty thousand persons enjoy that vigour of body which is ever a direct good, and without which all other advantages are comparatively worthless? I ask, if the duration of life is as great here as in the agricultural districts?

"To come more immediately home, let us compare the mortality in Leeds with that of a town destitute of manufactures; and afterwards with that of a merely agricultural district. I take at random Ripon and Pickering Lythe. In 1821, the population of the town and borough of Leeds was 83,796, and the burials were 1516, or one death in 55 persons. In the liberty

* "The Effects of the Principal Arts, Trades, and Professions, and of Civic States and Habits of Living, on Health and Longevity; with a particular reference to the Trades and Manufactures of Leeds: and Suggestions for the Removal of many of the Agents which Produce Disease, and Shorten the Duration of Life. By C. Turner Thackrah. London, 1831."

of Ripon at the same time, the population was 12,131, and the burials were 180, or one death in 67½. But Ripon being subject in a degree at least to the evils of a town, we are required to compare the mortality at Leeds with that of an agricultural district, where the people and their habitations are not crowded. Pickering Lythe returned in 1821 a population of 15,232, and the number of burials 205; one death consequently in 74 persons. Taking, then, the mortality at Pickering Lythe as the natural one, there was an excess of 321 deaths in the borough of Leeds in 1821. And allowing for the increase of population since that period, we may fairly say that at least 450 persons die annually in the borough of Leeds, from the injurious effects of manufactures, the crowded state of population, and the consequent bad habits of life! We may say that every day of the year is carried to the grave the corpse of an individual whom nature would have long preserved in health and vigour;—every day we see sacrificed to the artificial state of society one, and sometimes two victims, whom the destinies of nature would have spared."

"The destruction of 450 persons year by year in the borough of Leeds cannot be considered by any benevolent mind as an insignificant affair. Still less can the impaired health, the lingering ailments, the premature decay, mental and corporeal, of nine-tenths of the survivors, be a subject of indifference. Assuredly, an examination into the state of our manufactures has long been demanded, alike by humanity and by science."

"Either diseases are artificially multiplied, or they are not. If inquiry prove the affirmative, surely self-interest, as well as benevolence, demands a full investigation into the causes of the evil:—if the negative, we shall rest contented, gratified with the idea that our employments are not baneful, and that the excess of mortality is the infliction of Providence, not the agency of man.

"Most persons, who reflect on the subject, will be inclined to admit that our employments are in a considerable degree injurious to the health; but they believe, or profess to believe, that the evils cannot be counteracted, and urge that an investigation of such evil can produce only pain and discontent. From a reference to fact and observation I reply, that in many of our occupations, the injurious agents might be immediately removed or diminished. Evils are suffered to exist, even where the means of correction are known and easily applied. Thoughtlessness or apathy is the only obstacle to success. But even where no adequate remedy immediately presents itself, observation and discussion will rarely fail to find one. We might even say, that the human mind cannot be fairly and perseveringly applied to a subject of this kind, without decided effect."

Mr Thackrah has divided the inhabitants of Leeds and its neighbourhood into four great classes, viz. Operatives, Dealers, Master Manufacturers and Merchants, and Professional Men; and in examining the state of these severally, has adverted to the atmosphere they breathe, the muscular exercise taken, the postures of body maintained, the variations of temperature and humidity to which they are exposed, their diets and habits of life, and finally, in some classes, the state of mind. The circumstances in which these are favourable, as well as those that are unfavourable to health, are likewise pointed out, in order to remove unfounded apprehensions, as well as to expose the real agents of disease.

The circumstances which are favourable to health, in the present state of society, are of course very limited, and are applicable only to persons whose employments are chiefly out of doors, and to such professional men as are engaged in mental or literary pursuits, conjoined with considerable exercise in the open air. These two classes, however, form a very inconsiderable portion of the community; while the great majority, again, of operatives, dealers, merchants, and manufacturers, together with children at school, and many professional persons who have much mental application, without adequate exercise of the body, are all exposed to the pernicious influence of impure atmospheres, long continuance of labour, with constrained or unnatural positions of the body, of sudden changes of temperature, and various other agents destructive to health and life. Intemperance and irregular habits are likewise, as is well known, powerful auxiliaries to the general catalogue of predisposing causes of disease among all classes of men.

The appalling rates of sickness and mortality, which have been found to prevail among the different ranks of society, are, therefore, not at all surprising; but it must at the same time be obvious, that the excess is owing to the agency of man, and not to the immediate infliction of Providence. What have been called the Laws of Sickness and Mortality are not invariable, but are merely, at least before the period of old age, exceptions to the fundamental laws of health and longevity. These exceptions are no doubt numerous, but, in proportion as a knowledge of the works and laws of Nature become more general, the causes of these exceptions will be rendered more apparent, and means be speedily adopted for their prevention and removal *. These means, too, will be found

* Perhaps there are few if any works wherein the miseries of mankind referable to infringements of the laws of nature, are more familiarly or more forcibly illustrated, than in an Essay on the Constitution of Man, and its relations to external objects, by Mr George Combe.

extremely simple,—chiefly consisting of moderate labour, temperance, cleanliness, ventilation, muscular exercise, serenity of mind, and an elementary knowledge of the structure and functions of the principal organs of the human body. It is much to be regretted, however, as justly remarked by Mr. Thackrah, that subjects like these find no entry at present in the books of our merchants or tradesmen; they, intent on their avocations, strangely overlooking the very means necessary for pursuing them with pleasure and success; whereas, had they a taste for Natural History, its pursuits would be a recreation not only delightful, but likewise highly beneficial in every profession. "We may only add," says he, "that a man addicted to pursuits like these,—the various pursuits, I mean, of natural knowledge,—can scarcely be a bad man. A judicious parent would be far more anxious to give his family a taste for natural knowledge than for literature. They might gain neither present nor ultimate fame, but they would obtain that moderate and serene enjoyment, that '*tranquillitas animi*,' the '*animus sine perturbatione*,' to which Seneca repeatedly and justly refers as the greatest of temporal blessings."

On the Scenery of Italy, as contrasted with that of Germany; the Geognosy of Albano, near Rome; and the General Structure and Trachytic Rocks of Etna. In a Letter of Professor Friedrich Hoffmann to M. Gerhard at Berlin.

The indulgent attentions which you have always so liberally evinced on my behalf, encourage me to send you a few of the particulars which I have as yet been able to collect in the course of my scientific researches in Italy. For although these are far from realizing the ideal picture which I had formed of them previously, perhaps in a moment of too great exaltation, yet they are by no means so destitute of general interest, as to be unworthy of being submitted to your paternal inspection, or to the criticism of a mind so deeply imbued as yours with a taste for the science of Nature.

Italy is, in my opinion, very far from being so beautiful as it has been often depicted by enthusiastic travellers, amateurs and artists. Whoever has been accustomed, from his being a wanderer like myself, to satiate his eyes with the prospect of magnificent mountain scenery, where limpid streams, towering forests, and green meadows, unite their eloquence to inspire him with an indescribable serenity of feeling, amounting even in some cases to rapturous emotions; will often be inclined to give the preference to the enjoyments of our native country over all the luxuries of Italy. For although I cannot coincide with the insensibility of the hypochondriacal traveller, who asserted that he could only distinguish two characteristic trees on the Italian soil, the wide-spreading pine and the tall cypress; yet I have rarely felt that inward complacency in the contemplation of the beauties of nature, which has been described by so many travellers. How often are we not reminded of our distance from Germany, and of our proximity to Africa, particularly in the mountainous districts of Italy, by an aspect of aridity which characterises the vegetation, by the total want of water, and the absence of those green glades which everywhere abound in our native mountains! When at last we chance to light on a green patch, to relieve the eye from the monotonous aspect of bare rocky cliffs, or to refresh our thirst, but ill quenched by the fresh rain or insipid cistern-water, then we are told that we must not remain here, as the scourge of the malaria forbids sleep to the unseasoned traveller, and the bloated and pale visages which surround us, speak much more eloquently than the warnings of the *conducteur*, or the melancholy aspect of numerous deserted and half-ruined houses, which are so characteristic of this country, full of the remains of fallen grandeur.

Such were a few of my sensations when I travelled with my friend Repetti through the lonely hills of the Maremma Toscana. They continued the same at the aspect of the sun-burnt *Compagna di Roma*, and during my wanderings in the valleys of the *Teserone* and the *Turano;* and my numerous courses through the woody region of Etna, have hardly yet been able to reconcile me to the deficiencies of the Italian landscape. The traveller will certainly be disagreeably disappointed, if he interprets literally the words of the celebrated Ferrara, (in his *Guida dei viaggitori in Sicilia*), " that there are situations in the woody region worthy of Arcadian poetry,—pathless and gloomy woods, impenetrable copses, and refreshing shades." For a thinly scattered forest of oaks, neither remarkable for their size nor their magnificent forms, and a turf full of ferns, and entirely destitute of brushwood, which furnishes but a scanty subsistence for a few sheep, will hardly serve to redeem the accuracy of this picture. He will, on the contrary, be much more disposed to subscribe to the sentiments of our unprejudiced countryman M. V. Riedesel, who writes to Winckelman in 1767, that he was totally disappointed on seeing the woods of Etna, all the fine descriptions of which were utter falsehoods. All the trees are dwarfs compared with those to which we have been accustomed, and if we are disappointed by the almost total want of grass, our agreeable sensations are not increased by the deficiency of water, which reminds us at every step that we are treading the porous vault of a volcano. For not a single spring has yet been detected throughout the whole compass of Etna, fit for giving a standard temperature; and water-bottles always occupied a prominent place among the baggage of our mules on our tours through the mountain, which were carefully filled, whenever we came upon a patch of snow, or on a pool of water, in the fissures of the rocks; and without this entirely novel appendage to a European traveller's equipment, our progress would have been much impeded. Yet, notwithstanding all these minor faults, who is there whose recollections of this beautiful country will not be agreeably revived by many imperishable reminiscences? Whoever has once inhaled the balmy air, or cast his eyes upon the azure sky, so characterized by its eternal serenity in this climate, or has beheld its magic splendour, which communicates to a poor landscape a heavenly beauty, who is not sometimes seized with a chilling sensation when he recalls to his imagination our dull and stormy northern sky? and we can only place our beloved homes in competition with this foreign land, when we think of our most beautiful scenes, and the delightful changes of the seasons, which bring along with them their varied and interesting enjoyments. The simplicity in the mode of life, and the facility of subsistence, has no doubt something attractive to the northerns, and we could hardly suppose that the superfluities so abundantly lavished on this land by the bountiful hand of nature could ever appear monotonous or oppressive. Who, however, will compare the lot of the effeminate and ignorant *Lazuroni*, who, without shelter or clothing, drag on a listless and miserable life, with that of our robust husbandmen or artificers, forced to gain their subsistence with the sweat of their brow.

I fear that I have detained you too long with the picture of Italian scenery. But I hope that you will find it more interesting, if I give you a few particulars regarding the proper subject of my researches. As you may easily suppose the volcanic formations claimed the first place among the phenomena of this interesting country. The first point which I fell in with on my journey from the north was the Monte Amiata in Tuscany. It was, however, in the beautiful Alban Hills near Rome, in the Lake of *Bracciano*, and in the Hill of *Tolfa*, that I found the first distinct appearances of this character. The first is by far the most interesting and varied of these three mountainous districts, and I think that I have been so fortunate as to develope their structure and true nature more perfectly than my predecessors. If I mistake not, you are in possession of the excellent chart of the environs of ancient as well as modern Rome, which has been published by Dr Westphall, and which is by far the most complete and correct of any which has hitherto appeared. In it you will find a complete exposition of all the more remarkable facts in the Alban Hills, and I beg you therefore to follow on it the few observations which I am going to lay before you. You will find there this little mountainous district divided into two circles, the external and more considerable of which passes through *Frascati*, *Monte Porzia*, *Monte Compatri, and Rocca Priora*, and its most elevated point is in the Monte Artemisio, on the east side of *Nemi*. The inner and smaller ring has Nemi on its south side, and on the west side the little-hill town of the *Rocca di Papa*. So far the picture of this district is simple and easily understood, and I hope that you will not meet with more difficulty while I trace out the chief outlines of its internal constitution.

The outer circus is principally composed of the remarkable *peperino*, with which, of course, you are well acquainted, from the masterly description of M. Von Buch. This rock is a tuff which is distinguished from all other volcanic tuffs, and especially from those of the Campagna di Roma, by its greater solidity, and by the freshness and lustre of its imbedded minerals. Angular foliæ of mica, fragments of lava and slags, more rarely augite, but above all, the leucite crystals, so abundant in the Roman lavas, are heaped together in a light grey compact claystone basis, which often encloses blocks of white marble, or rather dolomite limestone, and fragments of rocks, consisting of glassy felspar, and black or green mica, with grains of Hauyne, exactly analogous to the matters which form the ejections of Vesuvius, which we find enveloped in the same way in the *Peperino of Monte Somma.*

The *peperino* of the Alban Hills is always regularly stratified, which, with the nature of its cement, go to prove its formation having been influenced by the presence of water; for it is not a tuff formed by simple aggregation and subsequent cohesion of its fragments, like what is so often found on Etna, but it is a true product of aqueous deposition. Interposed between its strata, we find here and there a few beds of slags, but more frequently rough layers of basaltic lava, the cavities of which display the same variety of crystals of nepheline and mellilite, for which the basaltic stream from the Tomb of Cecilia Metella, or from the *Capo di Bone* near Rome, is already so remarkable. But what is still more curious is, that these alternations of *peperino*, slags, and basalt, dip away with the utmost regularity from the centre of this outer circus, their outgoings being distinctly seen on the precipices of its interior; presenting an exact picture of the craters of elevation so beautifully distinguished by M. Von Buch. If, then, the outer circle is the margin of the crater of elevation, the interior one must necessarily be that of the crater of eruption. This, accordingly, is the fact, but as it is the first extinct crater which I had seen in Italy, I only arrived at this conclusion after some little attention. For the margins of the cavity are deficient in many points, and the inner walls of the crater have a very slight inclination and are thickly covered with woods. A portion of its western side is wanting altogether, and in the interval rises the *Rocca di Papa.* The highest point of its margin is the long ridge of the *Monte Cavo*, about 2800 feet above the level of the sea, and the bottom of the crater is about 750 feet lower, or 2000 above the sea. It is now covered with grass, and forms the *Campi d'Annibale* of the Roman citizens. Not merely the form, however, but also the internal structure, go to prove that this was formerly the site of a crater of eruption. We no longer meet with the *peperino*, with the basaltic plateaux of the outer circus, or the crater of elevation. Its principal mass consists of an accumulation of angular fragments of slags, and beds of ashes, as is very well seen on the fresh sections of the *Madonna del Tufo.* At intervals we find large coarse masses of rough leucite lava, so that the geologist can never hesitate a moment regarding the true nature of the internal mass of the Alban Hills, when once he has seen the fresh thrown up scoriaceous cones of Vesuvius and Etna. This mass is not, however, every where distinctly separated from the margins of the crater of elevation. On the south and south-west sides, towards *Nemi* and *Palazzola*, they are amalgamated together, and the nearly horizontal beds of *peperino* between *Aricia*, *Genzano*, *Palazzola*, and *Nemi*, form a sort of platform which is applied immediately to the sides of the Monte Cavo. It is here that we meet with the beautiful funnel-shaped cavities of the *Lago di Nemi* and the *Lago di Castello.* They bear much resemblance to mere sinkings of the earth, and have certainly never been craters, for the strata are not directed concentric to their margins. Their banks consist also chiefly of *peperino*, which sinks toward the south into the level tufaceous plains of Rome.

These views, which I have ventured to lay before you somewhat in detail, are perhaps not unworthy of your attention; but I beg your indulgence for having drawn them up merely from memory, without reference to the chart to which I have alluded. When I get my notes, which have been left behind at Naples, I will be able afterwards to give more minute particulars. I hope also, that it will be in my power to revisit these localities, in order to give sufficient completeness to my observations, that I may be able to form a geognostic chart with the necessary sections.

Allow me now to transport you to the memorable Phlegræan fields of Sicily. You may easily suppose, that ever since my arrival in the island, Etna has claimed my especial and almost exclusive attention. In fact, the investigation of this mountain, and of the volcanic phenomena in the neighbourhood, has now occupied upwards of two months of the time allotted to us in Sicily. But I hope that this time has not been unprofitably employed, and I flatter myself that even now, we have arrived at results, the full importance of which will only be developed by future inquiries. No sooner had we recovered from the first impression of astonishment excited by the magnificent phenomena before us, than we applied ourselves to the investigation of the basalts which form a circus surrounding the mountain in a sort of semicircular amphitheatre; for these basalts have always attracted the attention of observers, and they have been carefully distinguished from the modern lavas which cover the sides of the mountain. If I mistake not, M. Von Buch himself, in his general sketch of volcanoes, has directed our attention to them in an especial manner. But we were quite disappointed in our expectations, when we saw that these basaltic masses, were very inconsiderable, isolated and quite unconnected with one another or with the general physiognomy of the surface. This disappointment in their magnitude and extent was hardly indemnified by the interesting observation of numerous basaltic dikes which proceeded upwards from this principal mass into the chalk of the Cyclopean islands.

You may easily imagine what was our satisfaction when we found unexpectedly, in another part of the mountain, what amply repaid us for our disappointment at the sight of these basalts. During our earlier journeys, mention was made to us of a deep and spacious valley, the upper part of which was on its eastern side, and which went by the name of the *Valle del Bove.* It was said to be quite separate from the summit, and many travellers agreed in their accounts of its magnificence. Very few, however, had ever reached its interior, which lay remote from the ordinary routes, and was not very easy of access. These accounts naturally excited our curiosity, for the great cone of Etna is quite destitute of valleys of any consequence in its upper regions. We resolved, therefore, on visiting it, and were amply repaid for our trouble; for, instead of the lavas which we had every where met with on the sides of this valley, there were the most evident proofs of the existence of numerous varieties of trachytic rocks. Its principal mass is formed of horizontal coarse beds, alternating with slaggy conglomerates; another portion assumed the form of immense dikes rising up from below, and a third represented numerous veins which traversed perpendicularly, and in a great variety of contortions, the rocky walls of the valley.

But what was still more singular and surprising, these trachytic beds dipped away in all directions from the sides of the valley, and thus gave it the form of an amphitheatre, only that a part of its eastern margin was deficient where it formed a large gap. In fact, when once one has entered its interior, the idea at once occurs that we are standing in the bottom of the *caldera* of a crater of elevation. The dimensions of this crater of elevation are quite capable of including within its bounds the central volcano; but it is curious that the latter is planted upon one of the borders of this crater. For the diameter of this spacious amphitheatre, which impressed us so forcibly, is fully five miles; and, according to our measurements, the enclosing walls are 1000, and even 2000 and 3000 feet high. Their elevation internally was probably much greater originally, as, for thousands of years, the lavas which have been poured forth from the summit of Etna, have been accumulated in this valley; and even now the greater part of the caldera is covered by the rough lava-streams of the eruptions of 1811 and 1819, which renders it very fatiguing to traverse its interior. According to our barometric measurements, the surface of this lava is elevated 4760 feet above the level of the sea. The *Monte Zocclaro,* from which an excellent view is obtained of its interior, is elevated 5486 feet. The *Ciglione della Valle del Bove,* and the *Cima della Valle del Bove,* both of which are placed upon the margin, are elevated, the former 8628 feet, and the latter 8808. But the present summit of Etna towers to the height of 10212 feet. From these measurements, you may form some idea of the appearance of these rocky walls as seen from the interior of the Caldera.

CATANIA,
26th January 1831.

Analysis of a singular Substance found among the Products of the Eruption of Vesuvius in the winter 1830. By WILLIAM GREGORY, M. D. F. R. S. E. Lecturer on Chemistry, &c. Communicated by the Author.

THIS substance was put into my hands along with some other volcanic productions, by Mr R. Allan, accompanied with the following account of the situation in which it was found.

"During the month of November 1830, Vesuvius was in a state of considerable activity, throwing up from the small cone which occupied the centre of its crater constant showers of scoria and stones, to the height sometimes of 500 or 600 feet. These ejections gradually increased till the 3d of December, when they became so violent as for ten days to preclude the possibility of ascending the mountain. Much liquid lava from time to time flowed from the cone upon the surface of the surrounding crater, causing it, within the short period of six weeks, to be filled up nearly 200 feet, and raising the level of the crater to within 50 feet of its edge. In the middle of December, the volcano became suddenly more quiescent, and by the end of that month it was possible not only to descend into the crater, but even to mount the cone in its centre. During the month of January, its volcanic activity gradually subsided, and towards the end of that month presented no farther appearance of action, than emitting volumes of smoke, and acidulous fumes, from an infinity of vents within the crater. Several interesting sublimations were at the same time deposited on the rugged and broken surface of the lava, among which the sulphuric and muriatic salts seemed greatly to prevail. The fumes were in many places intolerable, and the pungency of the chlorine excessive."

"On the surface of a partial hollow, consisting of black volcanic lapillæ, occupying a space of perhaps eight or ten yards in diameter, and at the distance of 100 or more from the mouth of the cone, appeared an exceedingly beautiful, bright orange-coloured salt. Being merely superficial, it was collected with some difficulty; the muriatic fumes arising from it were most suffocating; and the ground around it was too warm to admit of keeping the feet in one position even for a few seconds. In some places, where it appeared to be thickest, the colour exactly resembled that of a dark Seville orange, while in others it had a more yellow hue, and, when taken up, appeared soft and claggy."

When I received the bottle, containing the substance in question, in September 1831, about a year after it had been collected, it presented the appearance of a mass of the consistence of butter, and of a bright orange colour, in some parts clean and pure, in others mixed with a considerable quantity of a dark sand. The bottle, when opened, had a smell which led me to suspect the presence of bromine or iodine; but in the course of a few hours this smell was gone, and I could not detect the presence of either of these bodies.

The orange substance, being very soluble in water, was easily separated from the volcanic sand with which it was mixed, and which amounted to from 8 to 10 per cent. The soluble part I found to be composed of metallic, earthy, and alkaline muriates, the proportions of which varied in different portions of the mass. One portion contained—

Water, - - - -	20.21
Muriatic acid, - - -	39.61
Peroxide of iron, - -	12.66
Alumina, - - - - -	9.04
Lime, - - - - -	6.14
Magnesia, - - - - -	1.22
Potash, - - - - -	9.25
Soda, - - - - - -	1.34
	99.47

It is obviously a mixture, and not a definite compound, but I am not aware that any such mixture has hitherto been observed. I should conjecture that it has been formed by the passing of gaseous chlorine over metallic matter at a red-heat, from the resemblance it bears to the sublimate obtained when chlorine is passed over red-hot iron-filings in a tube. The colour is rendered paler, however, by the presence of the colourless muriates.

We may expect much light to be thrown on the theory of volcanic eruptions, if those who have the opportunity will follow the example of Mr Allan, and collect the products of such eruptions, before they are decomposed by the atmosphere, or washed away by the rains.

Notice of Captain Alexander's Journey in America. In extracts of a Letter to Professor JAMESON.

ON the 7th of April last I left the port of London for South America, and after encountering the usual perils of the ocean, arrived at Guiana. There I wandered "in the Bush," among various Indian tribes, on the banks of the mighty Essequebo River, the Mazeroony, and Pomeroon; their fertilizing streams descending from the Andes, and pouring through a rich, but almost untrodden country, towards the Atlantic. You are well aware, that Guiana is not only rich in a productive soil, but also in splendid objects of natural history. Forests of vast extent, composed of majestic trees, linked together, and anchored to the ground by parasitical plants twining round their stems, and hanging in festoons of flowers from their branches, first arrest the attention of the traveller. Then each tree supports one immense colony: by means of the Bajna or wild vine, the opossum and other quadrupeds who would be unable to ascend the smooth cylinder of the shrub, mount to the loftiest branches, and drink from the cup of the wild pine the purest water. The black nests of the comagen, or wood-louse, are attached to the forked limbs of the tree, and from them proceed their covered rings of clay to the ground. Humming birds, with the metallic lustre of their plumage, glistening in the sunbeams, sip the honey from the flowers; and other birds, decked in the gayest colours, hang like blossoms among the leaves. The solitary cock of the rock, resplendent in a coat of orange, is seen at rare intervals; the Campanero or bell-bird is heard in the deep recesses of the forest, sending forth its peculiarly romantic note. Then, on the top of "the towering and majestic moro" sits the king of the vultures, spreading out its wings, wet with the night-dews, to dry in the noon-day sun; and as the shades of evening begin to close, screaming parrots, in pairs, are seen hastening from their feeding grounds to their favourite perches; and the obscene vampire leaves his retreat, and flits away up the shady banks of the deep river.

The river bears on its bosom leaves, seeds, and nuts, from the far off wilderness, and is inhabited by numerous strange and often hideous looking creatures. The Eldorado of Sir Walter

Raleigh is on the Mazaroony, Lake Parima, and the fabled region of gold. The scene of Waterton's adventures was also on that and on the neighbouring rivers. There are few springs of good water near the sea. I only noticed a few insignificant ones in the woods, which oozed out of the vegetable mould from swamps above them, and their temperature always corresponded (nearly) with that of the atmosphere. In May, the thermometer commonly stood in the forests of Guiana at 74°. I heard no sounds in the woods during the day, but the occasional falling in of the river's bank; and at night darkness was made horrible, by the howling baboon, the jaguar, the ominous note of the goatsucker, and the sighing of the alligators.

At Gengeteron, on the Demerara River, a gentleman was boring for water, and I subjoin a note of the result.

To the depth of	44	feet blue clay.
	10	fragments of wood partly decayed.
	19	compact whitish-grey clay.
	31	yellow sand mixed with clay.
	6	violet coloured clay when first brought to the surface, afterwards it changed to greenish.
	10	white sand and clay mixed.
	2	quartzose sand. Water.
	112	feet.

After a month's sojourn in Guiana, I visited in succession seven of the West India Islands: Barbadoes, then smiling in tropical beauty, now waste and desolate, since the great hurricane of the 10th of August; Tobago, where Defoe laid the scene of the life and surprising adventures of Robinson Crusoe; Trinidad, that most valuable, though little appreciated possession of Great Britain, containing virgin soil of unrivalled fertility; Grenada, that gem of ocean, fair to the senses as Eden; St Vincent's, with scenery of the most sublime and awful grandeur, and with the crater of a volcano recently extinct, horrible to look upon, and fitted for an entrance to Pandemonium; Jamaica, with its Blue Mountains, hills verdant with the coffee-plant, and valleys fruitful with sugar; and, lastly, Cuba, that bright jewel in the diadem of Spain. I was literally pursued by hurricanes and yellow-fever; but, thanks be to Providence, escaped unscathed.

I sailed in a Spanish brig from the Moro (Havannah) to New

Orleans. The hurricane of the 10th of August had swept from the S. E. across Barbadoes, the Island of Cuba, and New Orleans. We felt it severely at Havannah; four vessels were wrecked in the noble harbour itself, and I found at New Orleans thirty vessels driven on shore, and great damage done to the houses. On the 25th of August we had another hurricane at New Orleans, which laid the whole city under water, from the bursting of the banks of Lake Portcharlaim behind it, and more vessels were driven on shore, and many lives lost; fishermen with their boats swept away, boats upset, &c.

Truly it is most wretched to be domiciled in New Orleans during the months of August and September. Nothing is to be seen in the melancholy streets of the "Wet Grave" (as it is termed), in these months, but hearses, coffins, and coloured people; all the whites who can, flee in July, to avoid the season of yellow-fever; the city is consequently a desert. I was compelled to remain a fortnight in it before I could move up the river. The soil of New Orleans is so swampy, that, in digging a grave, at the depth of 18 inches below the surface water rises; coffins are therefore sunk by boring holes in the bottom of them, and a couple of black men stand on them, and away they go under water. Those who are particular, and dislike drowning after death, have ovens of brick built on the surface of the ground, 7 feet by 4, in which they are properly baked by the heat of the sun. It is said that at least 600 of the Irish, who come down to Louisiana from Charleston, New York, &c. in search of work, die annually of yellow-fever at New Orleans.

You are perhaps aware, that, on the banks of the Mississippi, the elevated ground is more unhealthy than the river's bank itself; the miasma seem to collect about elevations, and they are therefore avoided by old residents. The banks are higher generally than the country for some distance behind them; so that, at the commencement of the annual inundation, the river flows in three channels. After a while it rolls on in one individual and vast torrent, sweeping through the trees, and carrying many with it, with masses of the bank. The banks of the Mississippi are thinly settled, from their instability. The squatters retain their flat-bottomed boats always made fast near their log-hut, to escape with their cattle and sheep in case of accidents. I was very glad to ascend the Father of Rivers, and leave New Orleans. We progressed for eight days in a steam-vessel; but she got snagged on the 9th. Running along at the rate of seven knots, with the water as smooth as a mirror, she struck heavily on a concealed tree, in the middle of the stream, where it was about 60 feet deep; quivered from stem to stern; the water rushed in like a mill-race, she hung on the snag for a time, and then dropped off. She sunk; the crew, passengers, and their baggage were saved, but the cargo entirely lost. I left, before the catastrophe landed, at Memphis, and journeyed through Tenessee and Kentucky to Somerville, Falls of Ohio. You may inquire, "Why do they not try to clear the endless rivers? Is it not possible to get rid of the snags and sawyers?" A New Englander has got a contract to clear the Mississippi, which he does not fulfil as he ought to do. Thus, he has a steamer of a peculiar construction, which he runs over a snag, makes fast a hawser to it, and, *if he can*, drags it up, by setting on steam; if he cannot move it, he saws it off at low-water; and it was on one of these that our boat struck. Fourteen steam-vessels have been lost this year in the Mississippi and Ohio, and this besides sundry explosions. There are altogether 190 at present on the river. As is naturally to be expected, the roads in the back woods, with a scanty population, are very abominable; to mend them, they plough and harrow them in the fall of the year, and from the dreadful jolting, I expected every instant that the tilt would fly off the waggon. Miserable causeways, broken bridges, and stumps all impeded our progress; but we arrived safe and sound on the level banks of the Ohio, decked in the varied tints of autumn, and proceeded up the river to Wheeling.

Next I crossed the State of Ohio to Lake Erie, which I sailed down, and remained some time at the glorious Niagara. I was requested by the Secretary of the Royal Geological Society to note how much the water had lately worn away the rock, but I found that no great change had taken place in the Horse-Shoe Fall since Captain Hall visited it. The American Fall seems to be fast approaching the horse-shoe form. In standing under the Falls, one ever and anon hears the sound of falling rocks amidst the roar of the cataract; many of these may have rolled from a distance down the Rapid, and it may not be the rock of the cascade itself which is falling. I looked attentively for the water-rockets, which Captain Hall stated are projected upwards from the bottom of the fall, but I think he must have been under some strange delusion in making this statement. I saw nothing of the kind, and no one about the Falls, or acquainted with them, ever observed such a phenomenon. I visited several Indian tribes in Upper Canada, and then proceeded up the Ottawa to the Rideau Canal. It is certainly a stupendous work, and worthy of a great nation :—Dams 180 feet long by 45 in height, making still water for 20 miles, where formerly there were impassable rapids; locks 145 by 33, and all executed in the most masterly and substantial manner. Steam-vessels will pass through the canal from Bytown to Kingston in May next, distance about 170 miles. Yet I question if wooden rail-roads, with such an abundant supply of materials for their construction, would not have answered all the purposes of the Ridean, and might have saved a considerable part of the L. 700,000 which it cost.

Notice of an Eruption of Vesuvius last February, and some particulars in regard to the Geology of Italy. In extracts of a Letter to Professor JAMESON.

I HAVE hardly yet recovered the effects of an expedition I made to Vesuvius the day before yesterday; and which, though attended with considerable difficulty, owing to the particular circumstances in which we were placed, was certainly one of the most interesting I have hitherto made, or expect to make, in Italy. Since the *eruption* of last month, the crater had been nearly in a state of repose until last Thursday, when smoke was seen issuing from its summit. After waiting in vain for a day perfectly suited to our purpose, we selected Monday as the most favourable; for, though stormy, yet the atmosphere was clear. The party consisted of Mr Jackson, an American geologist, Mr Dulcuet his friend, and John Home, an English gentleman, and myself. After reaching the top of the cone, we had considerable difficulty in getting to the leeward of the crater, as the clouds of muriatic acid gas blown down were very dense and suffocating. However, we made good the circuit, and ascended to the mouth of the crater; and, as we were on the * , and as the wind

* The word is not legible in the MS.

was violent and steady, we were able, with little danger, to stand on the brink, while tremendous volleys of red hot stones were projected several hundred feet into the air. The explosion had a sound unlike any noise I ever heard,—something between the noise of artillery and the rolling of thunder. The phenomena were so very striking and violent, that, though unprovided with provisions and other necessaries, we resolved to spend the night amongst the lava of the summit of the outer cone, in order that we might again ascend the crater or inner cone, when it was completely dark. During the interval, while looking about us, we were astonished and delighted to perceive, at some distance from the crater itself, a stream of hot lava, which it turned out had but commenced that morning. Its movement was slow and sluggish; and, near the source, might be at the rate of a mile an hour. Even then, by stepping lightly across, we could pass some parts of it. After resting beneath a mass of old lava till seven o'clock in the evening, we with some difficulty (for the wind was tremendous), gained the brink of the crater a second time; and certainly no sight in nature can be more sublime and splendid than that we witnessed. The explosions and volleys of red hot stones were even greater than during the day, some of the masses being many feet in diameter, and the opposite side of the crater from where we stood (some hundred feet high), was literally strewed with them. A few of the masses fell near us, but generally they could be easily avoided. We were again obliged to retire to our shelter, as, until the moon rose, we could not cross the sea of old lava which surrounded the cone of the crater. At three o'clock in the morning we reached the foot of the mountain, and at four we returned to Naples, considerably fatigued, and in rather a pitiable condition as to habiliments, as my hat and handkerchief had been swept into the crater, and my clothes were literally reduced to a bundle of rags. Last night the stream of lava, as far as we could observe from Naples, had already reached the base of the great cone, and to-day we think it has now fallen into the course of the stream of last month, having, during its course down the side of the cone, been parallel to it. Just now (at night) I see it from my window like a bright stripe or bank of perpendicular fire in the atmosphere.

I had visited Albano previously to receiving your letter, and think, from what I saw there, that the opinion you mention as to the craters of elevation and eruption is correct. The section you sent me I find quite correct. I regret I have not received the copy of Turnbull Christie's memoir, and that I have not Daubeny's paper on Sicily. By great good fortune I just arrived a few days before Hoffmann, who is now on his road northwards, after a residence of seventeen months in Sicily. At first he intended to have remained but comparatively a short time, but he found so much that was novel and unknown, in the course of his investigations, that at last they were protracted to the period I have mentioned. Through his kindness and liberality I have seen his maps and sections, which are most complete and valuable, and, taken in conjunction with the monograph he intends to publish, will, I am sure, form a most important addition to geological science. He found some of Daubeny's observations incorrect, especially in regard to a great formation which the Professor thought tertiary, whereas it turns out to be secondary, a part of the great green-sand and chalk formation. Hoffmann remained six weeks nearly upon Etna, and his discoveries in regard to Von Buch's views as to craters are most curious; also his observations in another part of the island, in confirmation of the same geologist's theory of the origin of rock-salt and gypsum. I asked him about the Bone Caves, and mentioned to him the distinction Christie seemed to draw between caves containing simply bone-breccia, and those containing also marine shells; and he said, that though such was the case, yet *no line* could be drawn between them. Lyell's account of the high level at which the quaternary deposits occur is more than confirmed; for in the interior of the island Hoffmann found them abounding in shells, similar to those of the Mediterranean, nearly 3000 feet above the level of the sea. I am happy to say Sir Walter Scott is in great good health, and drives about continually, though I believe he enters but little into society. He is highly honoured by the King, and receives privileges granted to no one else. Sir Walter proposes taking a trip to Greece during the spring. I start for Sicily on Saturday, intending to complete my examination of the vicinity of Naples on my return.—Yours, &c. THOMAS JAMESON TORRIE.

NAPLES, 22*d February* 1832.

Description of several New or Rare Plants which have lately flowered in the neighbourhood of Edinburgh, and chiefly in the Royal Botanic Garden. By Dr Graham, Professor of Botany in the University of Edinburgh.

March 10. 1832.

Dillwynia cinarescens.

D. *cinarescens;* corymbis terminalibus sessilibus, foliis filiformibus erectis (compressis patentibus), mucrone innocuo brevissimo subrecurvo (pungente recto), ramulis calycibusque sericeis.

Dillwynia cinarescens, *Br.* in Bot. Mag. fol. 2247.

Description.—*Shrub* erect; *branches* slender, spreading, when young subsericeous, when older purplish, and at length naked. *Leaves* linear, spreading, subglabrous, compressed laterally, grooved along their upper edge, terminated by a straight hard sharp mucro. *Stipules* very minute, becoming black. *Corymbs* terminal, sessile, subcapitate (about 8-flowered). *Bracteæ*, one under the base of the pedicel, and two opposite above its middle, small, ovate, serrated, adpressed. *Calyx* bilabiate, silky, about as long as the pedicel, compressed laterally, and somewhat keeled on the upper side, upper lip slightly notched, lower lip trifid, segments ovate, acute, incurved. *Corolla* inserted near the base of the calyx, yellow, red-orange in the throat, with a yellow spot in the centre of the vexillum; vexillum twice as broad as long, reflected, notched, and showing a tendency to division into four lobes; alæ about as long as the vexillum, linear-spathulate, horizontal, curved outwards, their upper edges in contact, concave below, shortly and bluntly toothed; keel monopetalous, about half the length of the alæ, truncate, teeth blunt. *Stamens* included, free. *Stigma* capitate. *Style* hooked. *Germen* silky. *Ovules* 2.

The leaves being spreading, and the mucro early becoming hard and pungent, made me doubt whether this plant should be really considered the *Dillwynia cinarescens* of Brown; but I think it right to consider it such rather than run the risk of erroneously multiplying species. Perhaps " foliis erectis" is a misprint for " foliis rectis," in contradistinction to the species with twisted leaves. This will make the description agree much better with the figure by which it is accompanied in Bot. Mag. It is probable that the corolla might prove marcescent; but the whole flower, with the peduncle, falls so early with us, that I cannot be certain. The form of calyx leans to *Eutaxia.*

We received the plant from Mr Mackay of Clapton. It flowers most freely in February and March, and is a great ornament to the greenhouse.

This winter has been remarkably dry, and, excepting one severe and unusually early frost, and one or two transient frosts since, it has been remarkably mild. It is perhaps on this account that some plants which I have not before seen blossom in the open air in Scotland, are now in flower. In particular, may be noticed the following varieties of *Camellia Japonica.*

Single Red.
Middlemist's flesh-coloured.
Kew Blush Pompone.
Flavescent Hume's Blush.
Double White.

The first four are trained upon a wall with an aspect a little east of south, the last is on a standard five feet from the wall, in a sheltered situation. It is later than the others, the flower-buds being very large, but not yet expanded.

We have at present also in flower, on the same wall with the Camellias, *Acacia mollissima.* We find among the seedlings of this plant, great variety as to the power of resisting cold. Several are much cut in by the frost, but others, planted as standards in the open ground, scarcely have their upper leaves injured. The plants which have flowered on the wall, had the lower part of their stems covered with Broom twigs, but every other part has been completely exposed, and the leaves even have escaped unhurt.

Celestial Phenomena from April 1. *to July* 1. 1832, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Astronomical Calculator, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight —The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

APRIL.

D.	H.	′	″	
1.	4	53	18	● New Moon.
2.	1	12	51	☌ ☽ ν ♓
2.	1	54	12	☌ ☽ ☿
2.	22	24	17	☌ ☽ 2 ξ Ceti.
3.	5	48	5	☌ ☽ μ Ceti.
3.	19	44	–	♀ near ♃
4.	1	46	17	☌ ☽ f ♉
4.	5	24	57	☌ ♀ φ ♒
4.	22	18	23	☌ ☽ γ ♉
4.	23	33	25	☌ ☽ 1 δ ♉
5.	0	2	23	☌ ☽ 2 δ ♉
5.	4	58	37	☌ ☽ α ♉
6.	3	31	25	☌ ♀ φ ♒
6.	20	38	–	☌ ♂ ♅
7.	2	15	0	☌ ☽ ν ♊
7.	16	10	47	☌ ☽ ζ ♊
8.	1	38	42	☽ First Quarter.
9.	8	48	31	☌ ☽ δ ♋
10.	2	8	51	☌ ♂ γ ♑
10.	20	26	43	☌ ☽ α ♌
11.	16	50	36	☌ ☽ ♄
12.	10	8	34	☌ ♂ δ ♑
14.	12	42	–	☿ greatest elong.
15.	3	47	54	○ Full Moon.
17.	7	24	39	☌ ☽ γ ♎
18.	10	9	32	☌ ☽ φ Oph.
20.	2	21	43	☉ enters ♉
20.	10	50	10	☌ ☽ 1 μ ♐
20.	11	32	15	☌ ☽ 2 μ ♐
21.	13	23	40	☌ ☽ π ♐
21.	21	7	–	☌ ☿ δ ♈
23.	3	58	6	☾ Last Quarter.
23.	21	13	43	☌ ☽ ϑ ♑
24.	8	32	20	☌ ☽ ♅
25.	11	48	37	☌ ☽ ♂
26.	20	20	18	☌ ☽ ♃
28.	9	43	–	☌ ☿ δ ♈
28.	17	25	2	☌ ☽ ♀
29.	10	22	32	☌ ☽ ν ♓
30.	15	24	80	● New Moon.

MAY.

D.	H.	′	″	
1.	0	26	24	☌ ☽ ☿
1.	10	6	39	☌ ☽ f ♉
2.	6	6	28	☌ ☽ γ ♉
2.	7	19	25	☌ ☽ 1 δ ♉
2.	7	47	35	☌ ☽ 2 δ ♉
2.	12	33	22	☌ ☽ α ♉
4.	8	34	39	☌ ☽ ν ♊
4.	22	9	50	☌ ☽ ζ ♊
5.	11	36	–	Inf. ☌ ☉ ☿
5.	14	12	34	☌ ♂ λ ♒
6.	14	7	41	☌ ☽ δ ♋
7.	7	48	48	☽ First Quarter.
7.	14	9	8	☌ ♀ ο ♓
8.	21	2	50	☌ ☽ ♄
13.	8	44	17	☌ ♂ φ ♒
14.	14	52	40	☌ ☽ γ ♎
14.	17	7	30	○ Full Moon.
15.	17	43	36	☌ ☽ φ Oph.
17.	18	18	35	☌ ☽ 1 μ ♐
17.	19	0	35	☌ ☽ 2 μ ♐
18.	18	20	51	☌ ☽ ο ♐
18.	20	47	41	☌ ☽ π ♐
20.	1	16	–	☌ ☿ ♀
21.	2	37	46	☉ enters ♊
21.	4	46	41	☌ ☿ ϑ ♑
21.	18	38	9	☌ ☽ ♅
22.	21	4	0	☾ Last Quarter.
24.	12	7	9	☌ ☽ ♃
24.	14	4	48	☌ ☽ ♂
26.	9	17	23	☌ ♂ ♃
26.	20	12	4	☌ ☽ ν ♊
27.	17	18	55	☌ ☽ 2 ξ Ceti.
28.	0	37	38	☌ ☽ μ Ceti.
28.	6	0	–	☌ ☽ ☿
28.	17	51	18	☌ ☽ ♀
28.	20	6	37	☌ ☽ f ♉
29.	23	40	30	● New Moon.
30.	21	51	2	☌ ☽ ζ ♉
31.	17	9	30	☌ ☽ ν ♊

JUNE.

D.	H. ′ ″		D.	H. ′ ″	
1.	6 18 50	☌ ☽ ζ ♊	21.	4 2 54	☌ ☽ ♃
1.	11 20 –	☿ greatest elong.	21.	11 2 24	☾ Last Quarter.
2.	20 58 41	☌ ☽ δ ♋	21.	11 17 11	☉ enters ♋
5.	3 32 8	☌ ☽ ♄	22.	10 6 48	☌ ☽ ♂
5.	14 44 30	☽ First Quarter.	23.	5 14 42	☌ ☽ ν ♓
9.	14 18 27	☌ ♀ 2 κ ♉	24.	2 55 52	☌ ☽ 2 ξ Ceti.
10.	21 2 39	☌ ☽ γ ♎	24.	10 25 12	☌ ☽ μ Ceti.
12.	0 8 52	☌ ☽ φ Oph.	25.	6 19 0	☌ ☽ f ♉
13.	7 30 48	○ Full Moon.	25.	10 48 16	☌ ♀ 132 ♉
14.	0 56 3	☌ ☽ 1 μ ♐	25.	18 53 –	☌ ☿ 132 ♉
14.	1 38 3	☌ ☽ 2 μ ♐	26.	2 22 40	☌ ☽ γ ♉
14.	1 48 29	Im. I. sat. ♃	26.	3 35 10	☌ ☽ 1 δ ♉
15.	0 57 47	☌ ☽ ο ♐	26.	4 3 9	☌ ☽ 2 δ ♉
15.	3 24 25	☌ ☽ π ♐	26.	4 20 –	☿ near ♀
16.	1 12 –	☌ ☿ ε ♉	26.	8 46 32	☌ ☽ α ♉
17.	11 22 58	☌ ☽ ϑ ♐	27.	8 25 33	☌ ☽ ζ ♉
18.	0 44 37	☌ ☽ ♅	27.	17 1 36	☌ ☽ ♀
18.	4 15 33	☌ ☽ γ ♑	27.	19 33 30	☌ ☽ ☿
18.	7 43 40	☌ ☽ δ ♑	28.	6 48 18	● New Moon.
20.	2 17 17	Im. III. sat. ♃	30.	6 8 22	☌ ☽ δ ♋
20.	11 57 –	☌ ☿ ι ♉	30.	8 47 43	☌ ♀ η ♊

On the 11th of April there will be an Occultation of Saturn by the Moon:

	D.	H. ′		°
Immersion, *centre*, . . .	11.	15 25	at	99
Emersion, ...	...	15 51	at	151

On the 5th of May, there will be a Transit of Mercury over the Sun's Disc:

	D.	H. ′ ″		°
Ingress of Mercury, *centre*,	5.	8 48 26	at	293
Egress, ...	...	15 36 36	at	234

On the 8th of May, there will be an Occultation of Saturn by the Moon:

	D.	H. ′		°
Immersion, *centre*, . . .	8.	20 49	at	121
Emersion, ...	...	21 53	at	232

The *angle* denotes the point of the Moon's Limb where the phenomenon will take place, reckoning from the *vertex* of the Limb towards the Right hand round the circumference, as seen with a telescope which inverts.

Times of the Planets passing the Meridian, and their Declination.

APRIL.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	12 51	10 14 N.	10 16	8 25 S.	8 28	17 58 S.	10 24	7 16 S.	22 7	10 0 N.	8 41	16 16 S.
5	13 2	13 31	10 17	6 39	8 21	17 8	10 8	6 57	21 51	10 5	8 23	16 12
10	13 11	16 52	10 19	4 22	8 17	16 2	10 53	6 32	21 30	10 10	8 5	16 8
15	14	19 4	10 23	2 2 S.	8 11	14 53	10 38	6 7	21 10	10 15	7 45	16 5
20	13 6	20 1	10 26	0 19 N.	8 6	13 41	10 21	5 43	20 48	10 18	7 26	16 3
25	12 50	19 53	10 28	2 41	8 1	12 27	9 4	5 20	20 28	10 21	7 35	16 1

MAY.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	12 20	18 11 N.	10 30	5 30 N.	7 55	10 54 S.	8 48	4 53 S.	20 4	10 23 N.	6 47	15 59 S.
5	11 57	16 28	10 34	7 22	7 51	9 50	8 36	4 36	19 49	10 24	6 31	15 58
10	11 27	14 14	10 37	9 37	7 45	8 29	8 19	4 14	19 28	10 25	6 12	15 57
15	11 2	12 30	10 40	11 48	7 39	7 7	8 3	3 55	19 9	10 22	5 52	15 57
20	10 42	11 40	10 43	13 52	7 33	5 43	7 46	3 36	18 49	10 20	5 33	15 56
25	10 30	11 49	10 48	15 48	7 27	4 20	7 29	3 19	18 30	10 17	5 14	15 57

JUNE.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	10 21	13 27 N.	10 54	18 12 N.	7 17	2 23 S.	7 4	2 56 S.	18 3	10 5 S.	4 45	15 58 S.
5	10 23	14 58	10 59	19 27	7 13	1 16 S.	6 51	2 45	17 48	10 6	4 30	15 58 S.
10	10 29	17 9	11 5	20 46	7 8	0 6 N.	6 34	2 32	17 29	10 0	4 10	16 0
15	10 39	19 31	11 12	21 51	7 7	1 27	6 16	2 20	17 11	9 53	3 51	16 1
20	10 58	21 46	11 17	22 43	6 55	2 49	5 59	2 10	16 52	9 45	3 30	16 2
25	11 24	23 31	11 24	23 18	6 48	4 9	5 40	2 2	16 34	9 37	3 11	16 6

Proceedings of the Wernerian Natural History Society. (Continued from p. 192.)

1831, *Dec.* 24.—PROFESSOR ROBERT GRAHAM, V. P. in the chair.—Mr Neill read a notice regarding a specimen of *Siren lacertina*, which had been kept alive for more than six years past at Canonmills, near Edinburgh. (See the present number of this Journal, p. 298). Mr James Wilson made some remarks on the allied batrachian reptiles; and Professor Necker of Geneva, being present, mentioned his having kept one of the animals from the caves of Carniola, in a well at his garden at Geneva for about six years, where it increased in size, but became dark coloured, instead of flesh-coloured as in its native recesses.

1832, *Jan.* 28.—ROBERT STEVENSON, Esq. V. P. in the chair.—The Secretary read a notice regarding some of the more rare plants found native in the counties of Dumfries and Galloway, communicated by Mr Lloyd. The Reverend Dr Scot of Corstorphine read an essay on the species of dog mentioned in the Bible. Professor Jameson then laid before the meeting certain meteorological observations made at Inverness, and the description of a simple rain-gauge, calculated to measure the fall to the ten-thousandth part of an inch; communicated by Mr Matthew Adam, rector of the Royal Academy of Inverness. (See the present number of this Journal, p. 281, *et seq.*). Mr Blackley, who had spent a considerable time in Greenland, exhibited to the meeting some curious drawings of Greenland scenery, taken by him on the spot.

—— *Feb.* 25.—DAVID FALCONAR, Esq. formerly V. P. in the chair. Professor Jameson read a letter from Captain Alexander, containing interesting notices regarding his late extensive journeys through North and South America. The Professor also read a letter by Arthur Connell, Esq. on the action of iodic acid and of iodine on vegetable colours. (See the present number of this Journal, p. 337 and p. 380). The Secretary read a communication from W. C. Trevelyan, Esq. regarding a Roman monument found in the county of Durham, the inscription on which commemorates the capture of a remarkable wild boar.

1832, *March* 10.—David Falconar, Esq. formerly V. P. in the chair. Professor Jameson gave an account of the very interesting collection of fossil bones received by him from Wellington Valley in New Holland, and communicated the result of an examination of these bones by Baron Cuvier, for whose inspection they had been sent to Paris. (See the present number of this Journal, p. 301, *et seq.*) The Professor also communicated an analysis of a peculiar product of a recent eruption of Vesuvius, made by Dr William Gregory, lecturer on chemistry.—The Secretary read a notice by Mr Macadam of Plymouth Dock, regarding the very indestructible quality of the timber of the *Zygophyllum arboreum* of Carthagena. A stuffed specimen of the Gazelle of Africa was exhibited; and Professor Jameson mentioned that this specimen had died at the seat of Lord Rothes in Fifeshire, where two or three gazelles still survived, having been sent to his Lordship from Tripoli. A parrot and a humming-bird from Terra del Fuego were also exhibited, proving that Bougainville was correct when he reported, in his Voyage, that birds of these tribes were to be found in that inhospitable climate, though his accuracy had been impugned.

NEW PUBLICATIONS.

1. *Fauna Boreali-Americana; or the Zoology of the Northern Parts of British America.* Part Second—The Birds. By William Swainson, Esq. F. R. S., F. L. S., and John Richardson, M. D., F. R. S., F. L. S. 4to. Murray, London, 1831.

The numerous and varied objects in the different departments of Natural History, collected by the last overland Expedition to the Polar Sea, under Captain Sir John Franklin's command, could not be fully described or worthily illustrated within the limits of an ordinary Appendix; and hence the necessity arose of devoting separate works to the more complete elucidation, both of the zoological and botanical collections of that important journey. Two volumes have already appeared on Zoology, under the title of *Fauna Boreali Americana.* Of these, the first, written solely by Dr Richardson, contains the

Land Mammalia, or Quadrupeds, and is illustrated by twenty-eight plates, drawn and etched by Mr Thomas Landseer. It is the most valuable addition which has been made to our knowledge of American animals since the publication of Pennant's "Arctic Zoology," and presents the most ample and accurate picture which we yet possess of that department of natural history in the New World. While the precision of science is in no way sacrificed to the affectation of what is called a popular style, neither are the more interesting facts in natural history overloaded by a too cumbrous mass of scientific detail; and thus, while those skilled in systematic zoology will find both pleasure and instruction in Dr Richardson's writings, the general reader will be equally amused and enlightened.

A perusal of the volumes of Franklin and Richardson, will shew the great extent of territory traversed by our adventurous countrymen, and that Dr Richardson must have passed seven summers and five winters in the central and northern regions of North America. To those who are acquainted with that excellent man's talents and assiduity we need scarcely point out the value of this fact, nor the important conclusion to be deduced from it, namely, that his works must necessarily contain a rich mass of valuable information regarding those branches of natural science of which they profess to treat.

The beautiful volume now under our more immediate consideration forms the second part of the Fauna Boreali-Americana, and is devoted exclusively to Ornithology. It is the joint production of Mr Swainson and Dr Richardson. The lithographic illustrations are drawn by the former with great skill, accuracy, and elegance, and are carefully and beautifully coloured. That gentleman has contributed a curious body of information regarding what he considers as the natural arrangement of the different groups of birds, especially of those belonging to the Insessorial order; and, in his introductory observations, he has explained his views of the natural system in general, which are in accordance with those of some Continental naturalists. These may be briefly stated in the following propositions :

1. Every natural series of beings, in its progress from a given point, either naturally returns, or evinces a tendency to return, again to that point, thereby forming a circle. 2. The contents of such a circle or group are symbolically represented by the

contents of *all* other circles in the same class of animals; this resemblance being strong or remote, in proportion to the proximity or the distance of the groups compassed. 3. The primary divisions of every natural group, of whatsoever extent or value, are *three*, each of which forms its own circle.

Dr Richardson, whose mind seems more inclined to the practical than the theoretical, has limited his labours to the task of clear and accurate descriptions of the species, with occasional observations on their history and habits of life, their migrations and geographical distribution. In illustration of the last-named topic, he has also constructed several valuable tabular views of the species, exhibiting their extreme northern range, their greater or less extension over the Fur Countries, their winter and summer habitations, and other particulars of great value and interest. The eleventh table contains a list of species common to the Old World and the Fur Countries of America, under which term may be comprehended generally the whole country north of the 48th parallel of Latitude. The analogous list given by Pennant in his Arctic Zoology, though a valuable contribution for the period, is vague and inaccurate in relation to the knowledge which has been more recently acquired, and hence the high importance of the information now communicated by Dr Richardson. It may, in truth, be said that the Ornithology of North America is almost as well known as that of Europe. The works of Wilson, Audubon, and C. L. Bonaparte, conjoined with the kindred labours of the authors now under review, form a mass of ornithological information not excelled in interest by that supplied by the writers of any other country.

It appears, from a comparison of tables furnished, that the number of ascertained birds in Europe and North America is at present nearly the same. There are from 390 to 400 described species in each continent *. As, however, a greater portion of North America than of Europe remains to be yet more minutely explored, we may infer that, eventually, the European species will form the smaller number. The European land birds appear to exceed the water birds and waders

* If the investigations of Brehm, as explained in the Isis, and detailed in his valuable "Handbuch der Naturgeschichte aller Vögel Deutchlandes," shall prove correct, the number of European species of birds will be much increased.

by about ninety species; while in the United States the former class exceed the two latter by not more than fifty. We may add, that in Great Britain (probably from the conjoined effects of its northern latitude and insular position) the land birds prevail over the water birds and waders by not more than seven species. The ornithology of Great Britain and Ireland yields at present 277 different kinds of birds, of which 142 are land birds, and 135 are water birds and waders. The Continental countries of Europe possess about 120 species of birds which do not properly belong to Britain, and a vast proportion of which have never yet been known to visit our shores; while the common grouse, or moor-game, is our only exclusive possession.

The present volume of the Fauna Boreali-Americana contains descriptions of 240 species. To these we may add twenty-seven native to the north-west coast, as described by Pennant, or more recently observed by Captain Beechey (but which did not fall under the observation of the Land Expeditions); and C. L. Bonaparte has enumerated thirty-six additional species, which migrate northwards, from or through Pennsylvania, in the spring, and may, therefore, though not observed by Dr Richardson, be fairly inferred to breed in the Fur Countries. Thus, the total number of birds hitherto ascertained to inhabit these countries, that is to say, the American territories lying to the north of the 48th parallel, may be stated as amounting to 303 species.

We shall conclude by recommending very zealously to all who take an interest in ornithological pursuits, a careful and continued study of this very beautiful and scientific work.

2. *Principles of Geology.* By CHARLES LYELL, Esq. F. R. S. Vol. II. Murray, London, 1832.

This volume, like the preceding, is very amusing, and although not entirely or principally geological, cannot fail to be read with much pleasure by those who take an interest in the beautiful subjects so well discussed by our intelligent author. The first eleven chapters are devoted to Zoology, in which are considered the vicissitudes to which *species* are subject. After an ample view of the opinions entertained in regard to species in the animal kingdom, Mr Lyell concludes, that species have a real existence in nature, and that each was endowed, at the time of the creation, with the attributes and organization by which it is now distinguished. The laws which regulate the geographical distribution of species, are next brought under review, in which very interesting discussion, our author considers the distribution, both physical and geographical, of plants and animals, in a manner which, although it shews his thorough acquaintance with this department of natural history, does not afford us any new views. The remaining half of the volume relates to the effects produced by the power of vitality on the state of the earth's surface, and on the material constituents of its crust, which is illustrated by numerous interesting observations on the nature of soil,—peat,—bone-caves,—imbedding of organic remains in alluvium, the ruins caused by land-slips—imbedding of organic remains in sub-aqueous deposits,—imbedding of the remains of man and his works in subaqueous strata,—and the natural history of coral reefs.

3. *The Fossil Flora of Great Britain, or Figures and Descriptions of the Vegetable Remains found in a Fossil State in this Country.* By Professor LINDLEY, and Mr WILLIAM HUTTON of Newcastle. Ridgway, London, 1831, in 8vo. numbers.

Botanists have done but little towards the advancement of subterranean botany, owing, we believe, to their attention having been directed chiefly to the external forms of plants, internal structure being generally disregarded. We have always maintained, that an accurate knowledge of the internal structure of plants would lead to important results in the arrangement and determination, not only of the living, but also of the fossil species. Many of our pupils have been fully impressed with the accuracy of this view; and lately two of them, Mr Witham and Mr Nicol, have embarked keenly in this investigation, and have already laid before the public interesting comparative results. Mr Witham's beautiful volume on Fossil Plants, which the author states owes so much of its value to the kind assistance of his friend Mr Nicol, and the papers of the latter gentleman read before the Wernerian Society, and partly published in the Edinburgh Philosophical Journal, afford ample proofs of the light that may be thrown on Fossil Botany, by the examination of internal structure. Professor Lindley and Mr Hutton are following out the same view. In the three numbers of their interesting work now before us, there are, besides figures and descriptions of external form, also sections representing internal arrangement.—Professor Lindley displays his usual acuteness in the determination of the species; the portion of geology the numbers contain is creditable to Mr Hutton; and the artist has in general done his work accurately and distinctly. On a future occasion we may offer some remarks on Professor Lindley's descriptions, particularly of those species found around Edinburgh, of which Mr Witham, with his usual liberality, communicated not only specimens, but also drawings.

4. *Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne,* Vol. i. part 3. Newcastle, 1831.

We have much pleasure in again recommending to the attention of geologists this interesting work, of which the present *part*, completing vol. i., will be found not less valuable than those which have preceded it. The Provincial Geological Societies in other parts of the island, would do well to imitate the example set by their northern brethren of Newcastle.

5. *A Geological Manual.* By Henry T. Delabeche, F. R. S. F. G. S. Member of the Geological Society of France, &c. Second edition, corrected and enlarged. Treuttel & Wurtz, London, 1832.

We formerly recommended this excellent little volume to the student of geology. The present edition contains much new and useful information.

List of Patents granted in England from 3d February to 2d July 1831.

1831.

Feb. 3. To W. Summer, Hose, Leicestershire, for "improvements in machinery for making lace, commonly called bobbin-net."

11. To G. Gardner, London, for "an improved roving-machine."

To W. W. Richards, Birmingham, for "improvements in the touch-holes and primers, suitable to percussion-guns, pistols, and all sorts of fire-arms fired upon that principle.

Feb. 11. To J. GUNBY, Birmingham, for an improved method, or methods, of combining glass with metals, or other substances, applicable to various useful and ornamental purposes."

To C. GUILLOTTE, Spittalfields, for "an improvement in the rack applicable to the battons of looms, or machinery for weaving plain or figured ribbons."

14. To J. THOMSON, London, for "improvements in making printing-types."

15. To T. and C. BAYLEY, Leicester, for "improvements in machinery for making lace, commonly called bobbin-net."

To W. PAYNE, London, for an improved pedometer for the waistcoat pocket, upon a new and very simple construction."

21. To J. GRIME, Bury, Lancashire, for "a certain method of dissolving snow and ice on the trams or railways, in order that locomotive steam-engines and carriages, and other carriages, may pass over rail-roads without any obstruction or impediment from such snow or ice."

To Dr R. BURGESS, Northwich, for "a drink for the cure, prevention, or relief of gout, gravel, and other diseases, which may also be applied to other purposes."

To S. DUNN, Southampton, for "improvements in, or a method of, generating steam."

To R. TREVETHICK, Cornwall, for "an improved steam-engine."

To W. SNEATH, Ison Green, Nottinghamshire, for "improvements in machinery for making, figuring, or ornamenting lace or net, and such other articles to which the said machinery may be applicable."

To R. ABBEY, Walthamstow, for "a new mode of preparing the leaf of a British plant for the producing a healthy beverage by infusion."

To. W. FARNIBALS, Wharton, Cheshire, for "improvements in evaporating brine."

To J. PHILLIPS, Arnold, Nottinghamshire, servant-man, for "improvements on bridles."

28. To R. WILLIAMS, Lambeth, Surrey, for "certain improvements in steam-engines."

26. To D. Seldon, Liverpool, for "improvements in machinery used to give a degree of consistency to, and to wind on to, bobbins, barrels or sporls, roving of cottons, and the like fibrous substances."

Mar. 14. To D. Napier, London, and J. Napier and W. Napier, Glasgow, for "certain improvements in machinery for propelling locomotive carriages."

9. To A. PELLATT, glass manufacturer, London, for an "improved mode of forming glass vessels and utensils with ornamental figured patterns impressed thereon."

11. To R. STEPHENSON, Esq. Newcastle-upon-Tyne, for an "improvement in the axles and parts which form the bearings at the centre of wheels for carriages which are to travel upon edge railways."

21. To W. PEEKE, Torquay, and T. HAMMICK, for certain "improvements in rudder hangings, and rudders for ships or vessels."

To G. W. TURNER, London, for certain "improvements in machinery or apparatus for making paper."

To P. PHILLIPS jun. Bristol, vinegar maker, for certain "improvements in manufacturing sulphuric acid."

To. J. POTTER, and J. POTTER, Spiedly, near Manchester, spinners and manufacturers, for certain "improvements in machinery or apparatus applicable to the spinning or twisting of cotton, flax, silk, wool, and other fibrous materials."

To G. ROYL, Walsale, Staffordshire, for an "improved method of making iron pipes, tubes, or cylinders."

28. To T. BRUNTON, Esq. London, for an "improvement in certain apparatus, rendering the same applicable to distilling."

Mar. 29. To T. Coleman, St Alban's, training groom, for an improved roller for horses."

31. To A. Ure, Finsbury Circus, M. D., for an "improved apparatus for distilling."

To J. Wallace, Leith, brazier, for an "improvement or improvements upon the safety-hearth, for the use of vessels."

April 2 To James Slater, Salford, Lancashire, bleacher, for "improvements in the method of generating steam or vapour applicable as a moving power, and to arts and manufactures, and also for improvements in vessels or machinery employed for that purpose."

14. To W. Rutherford jun., Jedburgh, Scotland, writer and bank-agent, for a "combination or arrangement of apparatus or mechanism to be used by itself, or applied to locks and other fastenings, for better protecting property."

To S. Morand, Manchester, for an "improved stretching machine.".

To T. Brunton, Esq. Park Square, Regent's Park, for an "improvement in certain apparatus rendering the same applicable for making or refining sugar."

To T. Gaunt, London, and G. F. Eckstein, London, for an "improved fire-grate."

21. To W. Dixon, Walsale, for an "improvement on the cock or tap applicable to fluids, liquids, and gases."

30. To S. T. Beal, London, engineer, for an "improvement in certain apparatus for separating a portion of aqueous vapour from the vapour of alcohol in the process of distilling and rectifying spirituous liquors."

April 30. To Mr G. Stephenson, Liverpool, civil engineer, for an improvement "in the mode of constructing wheels for railway-carriages."

May 18. To W. Gutteridge, Clerkenwell, civil engineer, for certain improvements "in apparatus for distilling and other purposes."

To R. B. Cooper, London, for an improvement "on a cock or tap applicable to fluids, liquids and gases, and for applying the said improvement or improvements to other useful purposes."

23. To J. P. Westhead, Manchester, for certain improvements "in the manufacture of small wares."

To T. Knowles, Charlton Row, Lancashire, for certain improvements "in machinery, by aid of which machinery commonly called Mules, are or may be rendered what is termed self-acting."

To G. Barnard, Bristol, for improvements "in locks and other spring fastenings for doors and other places."

24. To T. Westrup and W. Gibbins, of Bromley, for improvements "in converting salt or other water into pure or other water."

To R. Wood, London, for "an inking apparatus, to be used with certain descriptions of printing presses."

To R. Fell, London, for improvements "in machinery or apparatus for raising water, and in the application thereof to certain useful purposes."

To S. Hobday, Birmingham, for an improvement "in a machine to be worked by steam, that may be applied for the moving of ships' boats and barges on the water, and to carriages either on the road or tramways, and in a fixed position may be applied to all the purposes that steam-engines are used for."

31. To N. H. Manicler, for "a new manufacture of useful products from a certain oleaginous substance."

June 2. To S. Lambert, gold-lace-man, for an improvement "in throstle-spindles for spinning and twisting silk, cotton, wool, flax, and other fibrous substances."

4. To. T. Spinney, Cheltenham, for certain improvements "in apparatus for manufacturing gas for illumination."

7. To J. Pearse, Tavistock, ironmonger, for certain improvements "on wheeled-carriages, and on apparatus to be used therewith."

June 20. To E. A. Fourdrinier, Hanley, Staffordshire, paper-maker, for a "certain machine for an improved mode of cutting paper."

22. To J. L. Stevens and P. Waycott, both of Plymouth, for "certain improvements in mangles."

20. To W. G. Kneller, Hackney, for certain "improvements on stills, or apparatus for distilling."

July 2 Vo J. Perkins, Fleet Street, engineer, for "improvements in generating steam."

List of Patents granted in Scotland from 22d December 1831 *24th February* 1832.

1831.

Dec. 22. To Malcolm Muir of Hutchinson Town, Glasgow, in Scotland, engineer, for an invention of "certain improvements in machinery or apparatus for preparing boards for floors, and other purposes."

Dec. 23. To Arthur Howe Holdsworth of Dartmouth, in the county of Devon, Esquire, for an invention of "improvements in the construction of rudders, and in the application of the same to certain descriptions of ships or vessels."

To Abraham Adolphus Moser of Canterbury Row, Kensington Road, in the County of Surrey, engineer, for an invention, in consequence of a communication made to him by a certain foreigner residing abroad, of "improvements in certain descriptions of fire-arms."

To John Christophers of New Broad Street, in the City of London, merchant, for an invention of "an improvement in clothes' buttons."

1832.

Jan. 26. To William Hale of Colchester, in the county of Essex, machinest, for an invention of "a machine or method for raising or forcing water, for propelling vessels."

Feb. 10. To Pierrepont Greaves of Chorley, in the county of Lancaster, gentleman, for an invention of "a method or methods of making ornamental cotton, yarns, and threads applicable to the making, sewing, and embroidering of cotton and other fabrics."

17. To Samuel Hall of Basford, in the county of Nottingham, cotton-manufacturer, for an invention of "an improved piston and valve for steam, gas, and other engines; also an improved method of lubricating the pistons, piston-rods, and valves or cocks of such engines, and of condensing the steam, and supplying water to the boiler of such engines as are wrought by a vacuum produced by condensation."

20. To Moses Teague of Parkend Iron-works, near Colford, in the county of Gloucester, iron-master, for an invention of "certain improvements in making and smelting of pig-iron."

To William Sneath of Ison Green, in the county of Nottingham, lace-maker, for an invention of "certain improvements in machinery for the manufacture of bobbing-net lace."

24. To Alexander Beattie Shankland of Liverpool Street, in the city of London, in consequence of a communication made to him by a foreigner residing in America, of an invention of "a new method of cutting, working, and planing of wood, minerals, and metals, by means of machinery."

To Correspondents.

The Memoir on the Mosaic History is under consideration.—The account of the Russian Baths, transmitted by Dr Trail, through a private channel, has never reached us.—The Chemical Memoir from Greenock, having at length cast up, is now under consideration.

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