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MISCELLANIES—FOREIGN AND DOMESTIC.

ERRATA.

P. 22, bot. l. dele "Walhouding or" and insert "the."—p. 27, l. 15 fr. top, for "shells," read "shales."—p. 38, l. 8 fr. bot. for "Monongahela," read "Maxahala." —p. 40, l. 15 fr. bot. for "leaves," read "covers."—p. 50, l. 4 fr. top, for "Another," read "Descriptions."—p. 71, l. 6 fr. top. dele "or Walhouding."—p. 102 l. 10 fr. top, for "poles," read "polls."—p. 274, l. 4 fr. top, and l. 10 fr. bot. for "28," read "27."—p. 315, l. 12 fr. bot. for "*ορνισ* and *τιχνοσ*," read "*ορνις* and *ιχνος*."

Dr. Hildreth does not consider it as quite certain, although highly probable, that the rock which he has called Lias, is identical with that of England; the opinion, that they are geologically identical, is ably maintained by another gentleman, whose observations will appear in our next number.—Ed.

Vol. xxviii. p. 111, l. 6 fr. top, for "W. W.," read "F. H."—p. 118, l. 5 fr. top, for "10.63," read "1068 grs."—p. 378, l. 7, 10, 16, 27, and contents p. 7. l. 8 fr. top, for "Brown," read "Bronn."

J. Bosworth Pinx.t Pendleton's Lith.y Boston.

The Grotto of Plants.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*Observations on the Bituminous Coal deposits of the valley of the Ohio, and the accompanying rock strata; with notices of the fossil Organic remains and the relics of Vegetable and Animal bodies, illustrated by a Geological map, by numerous drawings of plants and shells, and by views of interesting scenery;* by Dr. S. P. Hildreth, of Marietta, Ohio.

The region embraced in the following observations, extends over a space of four or five degrees in latitude, by as many in longitude, having the Appalachian range of mountains for its base on the south and east, and the termination of the sandstone rocks and coal, as its limit on the north and west; including the north west portions of Pennsylvania and Virginia, with the north east part of Ohio, and a small tract in the north east corner of Kentucky. It may be called the south east termination of that immense valley which lies between the Rocky Mountains on the west, and the Alleghany range on the east; and which, as appears from the vast profusion of marine fossils found imbedded in the rock strata, was at some remote period the bed of an ocean.

That the change was gradual, from the dominion of the waters to that of dry land, is inferred from the horizontal, and tranquil state of the rock strata, bearing few or no marks of violence, or sudden force having ever been applied, so as to break, or disturb the continuity of the beds, as is so often and almost universally seen, in transition and primitive regions, where the rocks are found lying in all degrees of inclination, from a vertical to a horizontal position. That this ocean rolled its waves and its tides over this valley for an immense period of time, is inferred from the great thickness of the rocky strata, which have been penetrated to the depth of more than a thousand feet, without reaching the primitive rocks. That the primitive rocks lie at a great depth may be inferred also from the *color* of the sandstone rocks, none of them being red, except where, in the mountain ranges, they are bordered by, or resting on the transition series; the color being probably produced by the heat imparted to the derivative rocks, by the primitive strata when in a state of fusion, which, as we have the best ground to believe, was once the condition of all crystalline rocks. Fragments of the sandstone rocks, through all parts of the valley are easily changed to *red*, by subjecting them to the heat of a strong fire, showing that they do not lack the chemical constituents of the old red sandstone, and that they have not been exposed to any great heat.

In the vicinity of "Flint ridge," which is evidently a deposit from hot water, I have seen sandstones highly colored with veins of red, but in every other place near the center of the valley, which I have visited, they are universally grey, ash colored, or brown, according to the tint of the silex, mica, lime, or clay, which entered into their composition.

That the change was gradual from the condition of an ocean to that of dry land, is also inferred from the slight inclination, or slope of the northern side of the valley, taking the present bed of the Ohio river for the center, or most depending part. The elevation of the surface at the heads of the Muskingum and other streams, which take their rise in the table lands between Lake Erie and the Ohio, being only about four hundred feet above the mouth of the former river, having a descent of a little over two feet to the mile. On the south side, the slope is equally gradual, until the ranges of hills connected with the mountains make their appearance at a distance of from fifty to seventy miles from the Ohio; the rise then becomes much more rapid, averaging, in some places, especially on the New river, above the mouth of Gauly, fifteen or twenty feet to the mile, for the distance of forty or fifty miles. Those portions of the ancient ocean's bed, lying near and on each side of the region now occupied by the Ohio river, were, doubtless, for many ages, covered by lakes of fresh water, after the more elevated parts, had become dry land, and were clothed with vegetation. We are led to this conclusion from the numerous deposits of lacustrine and fresh water shells found in the sandstones and marls in the hilly portions of the valley near the Ohio river; and after the waters had been so far drained off as to lay bare the bottoms of these lakes, it must have occupied a vast period of time to hollow out the local valley between the hills, in which the Ohio now meanders, and to deposit that vast bed of alluvial earth which constitutes its present fertile and rich bottoms. It is obvious that these were all formed after the currents of water had cut away the deposits of clay and earth, which the rains and small rivulets had washed away from the adjacent highlands into the bed of this vast fresh water lake or lakes, down to the sandstone rocks formerly deposited in the bed of the ocean; and after they had also cut away the sandstone rocks themselves down to the present bed of the Ohio, a depth of one hundred and fifty or two hundred feet, it is evident that little or no river alluvions could have been deposited, for they rest on the rock, which forms the present bed of the river. This cutting away of the sandstone rocks, must have occupied a long period of time; for, the operation, of necessity, commenced at some point below, at least as far west as the falls of the Ohio, giving at this outlet, an impulse and impetus to the waters above, that neither earth nor rocks could resist; enabling them to cut away the solid strata, and to form the present bed of the river in their bosom. That this was actually the fact, is made to appear from the mural walls of sandstone, seen in many places, at the same elevation, in the face of the river hills, on both sides of the stream; they are composed of the same materials with the same texture, for the distance of several hundred miles. Various other strata confirm this opinion; clay, limestone and coal, being found at the same level on both sides of the river, shew, as plainly as demonstration can speak, that these strata were all deposited in a tranquil state, and that, in the course of ages, they have been cut through by the abrasion and tearing away of the waters. The hills bordering the rivers and creeks have all been formed in the same way: the ridges corresponding to the course of the streams and not the streams to the ridges; and although there is a considerable descent from their heads to their outlets, yet the hills and ridges are considerably higher near their heads than at their mouths, which is evidently attributable to the greater abrasion and wearing away of the general surface, as we approach the Ohio, on account of the action of the waters which descended into the lower parts of the valley before the present channels of the water courses were formed. This is made evident from the wasting and wearing away of several of the deposits, which are found in the heads of the streams, at the depth of many feet below the surface, and which, as we descend, gradually crop out, and finally in a few miles disappear:

and this not from any dip in an opposite direction, for the inclination of the strata is with the course of the stream, that is, towards the Ohio river, or the center of the valley.

This fact is finely illustrated in a deposit of coal, lying on the heads of Duck creek and in the ridge, which divides these waters from those of Will's creek, in Ohio. The hills are about three hundred feet in height, and the place here spoken of is about thirty eight miles north of Marietta. A bed of coal, five feet in thickness, appears on the face of the hills at an elevation of two hundred feet above the bed of the creek, and is also found for many miles around in the adjacent hills on the opposite side of the valley, and at the same elevation. The roof of the coal is composed of bituminous shale, upon which rests a coarse sandstone of nearly eighty feet in thickness. As we descend the creek, the coal approaches the surface and the sandstone becomes more thin, until at the distance of twenty five miles, the coal wholly disappears, with the stratum of sandstone rock, and the strata below come to the surface in nearly the same order in which they appear at the distance of twenty five miles above. The inference is, that this coal deposit had been laid bare by the wasting away of the superincumbent strata, and had finally itself been decomposed by the action of the atmosphere and frosts, and washed away by the rain. The operation is still going on; and rock strata and coal, are daily laid bare and are found wasting away in the beds of streams, and torrents in the elevated parts of the valley. The same process which cut away the sandstone rocks in forming the bed of the Ohio, is still in force in the small streams and rivulets which run into it from the hills. If it is a considerable stream, the strata of rock are cut away, at the mouth, as low as the bed of the river, and as you approach the hills and ascend towards its head, the bottom of the stream is composed of sandstone rock, with occasional cascades, over which the water, as it falls, acquires force in proportion to its elevation, and finally wears away the solid rock till all obstructions are removed. Examples may be seen in all the hill and mountain torrents. The process now pursued by the smaller streams, is doubtless the same with that of the larger in by-gone ages.

It appears probable that before the growth of trees, shrubs, and grasses had commenced, or had made any great progress in clothing the hills, and face of the valley "as with a garment," debacles were more efficient, and the abrasions of the surface by rains and torrents, were much more rapidly accomplished than after that period. While a part of the valley was yet covered with water, evaporation was much more abundant and the rains more like those of tropical climates; tearing up and wearing away the surface with great facility, and effecting greater changes in the features of the valley in one season, than can now be accomplished in many years. The roots of the trees, and the plants, after they had taken possession of the surface, giving firmness to the soil, and defending it from abrasion in the same manner that the trees, where they are suffered to stand undisturbed by the officious interference of man, now defend the banks from the encroachments of the Ohio. They not only protected the newly clothed surface on the hills; but in the valleys, and near the beds of rivulets and brooks, when the streams overflowed, they arrested the soil and fragments of rocks that were urged onward by the turbid waters, and thus these periodical deposits gradually raised up the bottoms or alluvial soils, to their present height. That this was actually the fact, and that the surface of the soil in narrow vallies and bottoms, was once much below its present condition, is proved from the presence of wood and trunks of trees, found at the depth of thirty or forty feet in sinking wells, shafts, &c. A single shower has been known to make a deposit of several feet in thickness on the borders of small streams. No longer since, than the month of June, A. D. 1834, a few miles from Marietta, a cloud, in the course of fifteen or twenty minutes, poured its watery contents on the hills, to an average depth of eight or ten inches. No accurate measure was taken of the water, but a half bushel measure and a common pail, or bucket, in separate places, were filled to overflowing; and several rail fences on the sides of hills, were moved a number of feet by the column of water, rushing down their declivities. In Licking and Knox counties, during the same season, a much greater amount fell, doing great damage to the Ohio canal and to mills on the small streams. If in these days, such torrents fall in places remote from any great collections of water, or from ranges of mountains, what might they not have been, when this great valley was one vast wet and marshy plain, affording an immense expanse of watery surface to evaporation.

At what period after the creation of the earth, this change, from an ocean to dry land took place, we have no data to determine; but it is not impossible that future geologists may, by their researches, arrive at some tolerable approximation. That the change was gradually produced, is certain from the nearly horizontal position of the rocky strata, so far as they have fallen under our observation; and it is also certain that it was preceded and accompanied by the occasional subsidence, or sinking, or occasional flooding of lands, probably islands, abounding with tropical plants, and trees, which were deposited in the coal measures of the valley. There is a degree of probability, little short of certainty, that these trees and plants grew on, or near the spot where their remains are now found, for they are universally in a horizontal position, as if laid tranquilly down by water; in general, their delicate forms are perfectly preserved, indicating gentle deposition, and when they are mixed together in confusion, it of course implies a correspondent agitation of the water. That they are the growth and deposit of remote periods of time, is inferred from the specific difference of many of the fossil plants, in the different beds, compared with those of modern times, and from the vast deposits of sand and clay, which separate them; these are frequently not less than one and two hundred feet in thickness, as will be more fully shown in the sections of strata, at different places. It is the opinion of most geologists of this age, that the tropical plants, found in the coal beds, grew either on, or very near the spot where they are now inhumed; and that the climates which produced such plants, have been changed by the gradual alterations which have taken place on the surface of the earth by the changing of oceans into dry land; the same latitudes covered with, or surrounded by water, being from the known capacity of water to retain and equalize caloric, much warmer while in this condition, than after becoming dry land. Some attribute the greater warmth of the earth in the higher latitudes in the earlier periods, to the greater internal heat, which is supposed to have gradually declined. The deposits of sand, clay, &c. over the coal, and in alternation with it, must have been produced by aqueous agency in some form, either in lakes, or in bays, estuaries or lagoons of the ocean, or in gently flowing waters. Mr. Parkinson in his "Introduction to the study of Organic Remains," makes the following remarks. "By these facts we learn that at some remote period of the existence of this planet, it must have abounded with plants of the succulent kind, and as it appears from their remains in great variety of form and luxuriancy of size. These, from what is discoverable of their structure, were beset with seta and spines; were not formed for the food of animals, nor from the nature of the substance of which they were composed, were they fitted to be applied to the various purposes to which wood, the product of the earth at a subsequent period, has been found to be so excellently adapted by man. Their remains, it must also be remarked, are now found in conjunction with that substance which nature has in all probability formed from them, and which by the peculiar economical modification of its combustibility, is rendered an invaluable article of fuel. If this be admitted to be the origin of coal, a satisfactory cause will appear for the vast abundance of vegetable matter with which in its early ages, the earth must have been stored. This vast, and in any other view, useless creation, will thus be ascertained to have been a beneficent arrangement by Providence for man, the being of a creation of a later period."

General Topography of the Valley in relation to the Coal Measures.

Sandstone, in all its varieties, being the prevailing rock in the coal deposits, the general surface of the region presents great similarity in its features, especially in those portions that lie within fifty or sixty miles of the Ohio river; these regions exhibit long sloping ridges, running parallel with the river, and are often faced with mural precipices of sandstone to the height of one hundred feet above the base of the hills. In other places, there are cone-shaped, isolated hills, especially where creeks make their debouchure, having in the course of ages worn down the sides of the hill, both above and below into beautiful slopes. This is frequently seen in the heads of creeks, that take their rise in a loose rich loamy soil. The tops are then crowned with sandstone, covered with trees, while the sides are clothed with the richest productions of the forest, growing in a loose black soil, formed of decomposed leaves and the remains of the rocks which have wasted slowly away before the wintry frosts and the summer rains. In any part of this region the view from the highest hills, presents one vast plain filled with hollows, and affording no spot much, if any more elevated, than the one on which the spectator stands,—bringing forcibly to the mind, the reflection, that this now hilly and broken region was once, at some remote period, a level, and nearly horizontal plain. Scattered through this hilly and broken region, tracts of tolerably level land, are found embracing many miles of square surface. In sinking wells in such places, it is not uncommon to find, at the depth of thirty or forty feet, fragments of the trunks and branches of trees, with water worn pebbles, indicating the scite of a pond or lake, which existed before the present water courses were formed, for the more perfect drainage of the country. Within the boundaries of such places, beds of argillaceous iron ores are sometimes found of considerable extent. On the north side of the Ohio, this broken country continues, until it is gradually lost in the table lands and plains on the heads of the Muskingum river, or terminates in abrupt precipices on the prairies of the Scioto. On the south side at the distance of fifty or sixty miles, the hills gradually become larger and more elevated, until they rise into mountains.

The country on the Kenawha river affords one of the finest specimens of these changes in elevation. Near the mouth, the hills are about two hundred feet in height—at the Salines, sixty five miles above, they are five hundred feet—at the falls of Kenawha, one hundred miles up, their elevation is increased to eight hundred feet, and at " Marshal's pillar," in the cliffs of New river, they attain the height of fifteen hundred feet and are called the Gauly mountains; beyond which point, to the valley of the Green Brier river, the country is a mountainous table land composed of successive ranges lying in parallel ridges, taking a N. E. and S. W. direction. The more elevated of these are known as the Sewell and Meadow mountains, the slopes and sides of which afford good farming lands. From the tops of the Sewell, we have a fine view of the valley of the Green Brier, which lies extended at its feet, and spreads its broken and undulating surface, dotted with farms and cultivated spots, to the base of the Alleghany range, a distance of thirty or forty miles. This valley is based on limestone, superincumbent on sandstone, and in it, rise the celebrated sulphur springs, whose waters annually revive the drooping energies and restore the health of the invalids from less favored climates. The cool and pure air from the mountain tops, free from pestilential miasmata, without doubt, contributes much to the healthfulness of this delightful valley. Vast caverns have been scooped out of the limestone rock in different parts of the valley, by the streams which circulate beneath the surface, many of which abound with interesting fossils. The celebrated relics of the megalonyx, described by Mr. Jefferson, were found here in a saltpetre cave. The Green Brier, the Gauly, the Little Kenawha, the Monongahela, and the north fork of the south branch of the Potomac rivers, all take their rise from the high lands at the head of this valley; and from the opposite courses which they pursue we are led to conclude that the dividing ridge at the heads of these streams is the highest land west and north of the Alleghany range. Between the head branches of several of these streams, are considerable tracts of "Glade" or table lands, affording from their elevation a soil and temperature suitable to the growth of trees and shrubs of a more northern climate. Large tracts of tolerably level lands, covered with a heavy growth of forest trees, are found in this elevated region between the head branches of the Gauly, the Elk, and the western forks of the Monongahela. The ranges of mountains, although members of the same family, have received different names, and are the interrupted portions of the Laurel, Chesnut and Cheat mountains; while the same ranges farther west are called the Sewell mountains. On the tops of the mountains themselves, there is sometimes a considerable extent of level land. One of the branches of Cheat river runs for a distance of fifty miles on the top of a mountain ridge, through a tract of level land, six or eight miles wide, clothed with hemlock and laurel. On the heads of some of the western branches of the Monongahela river, are found beautiful and fertile valleys. Tygart's valley is one of the most extensive, and will be more fully described when we speak of the topography of the valley of the Monongahela. The stream is here called the "valley river," and affords many valuable scites for mills. It is of the most permanent character, having its sources in the mountains, and it is fed by never failing springs. The face of the country on the Monongahela, to its junction with the Alleghany, is hilly, but affords vast tracts of fertile and arable lands. On the Youghiogany and Conemaugh it rises into mountains, with fine tracts of land between. The region on the Alleghany river is hilly and broken, and on all the streams which run into the Ohio on the north, the same uneven surface is continued.

Topography of the Valley of the Muskingum.

The general aspect of the country through which the Muskingum river passes, is hilly and broken, especially all that portion where sandstone rock prevails. On the head branches the surface is more level, with occasional ridges of hills. The water is limpid, being more highly charged with carbonate of lime than that of the Ohio river. Its bottom is, in many places, covered with quartz pebbles and gravel of various hues, but mostly white, giving, with the open valves of bivalve shells, a rich and beautiful appearance to its bed, especially in low stages of the stream in the summer and autumnal months. The alluvial lands along its borders are composed of a rich but rather arenaceous soil, formed, in the course of ages, from the debris and washings of the uplands, mixed with decayed vegetable matter. The early or ancient alluvions, which form bluffs in the bends, and elevated plains back of the bottoms, where they are not washed away by changes in the bed of the river, are composed of gravel and pebbles, with a very light or thin soil on the surface. The elevation of these plains, is, in many places, more than one hundred feet above the present bed of the river, from which we are led to infer, that when the superabundant waters took the course now followed by the river, the hills, if formed at all, were very low, as in many places they are now not more than seventy five or a hundred feet above the surface of these ancient plains. On these elevated alluvions, almost without exception, are seated those ancient ruins of fortifications and cities, so long the wonder of antiquarians. Much of the gravel and many of the pebbles composing these plains, are the remains of disintegrated primitive rocks; being composed of greenstone, gneiss, varieties of granite, mica slate, &c. intermixed with fragments of fossil organic remains, and with some perfect forms; amongst which are distinguished, numerous species of alcyona, madreporites, corallines, and shells, the tenants of the antediluvian ocean.

Broken remains of fossil trees are also found, the vegetable structure being easily recognized. The latter are generally in an agatized or quartzose state, many of the former are also, siliceous, and may have been torn, at an early period from those abundant deposits of organic fossils, found in Flint ridge, and many other places on the streams which pour their tributary waters into the Muskingum. The country, on the head waters of the Muskingum, although not very hilly, is, without doubt, the most elevated portion of the northern side of the valley. The streams from this region taking, a northerly, a southerly, and an eastern direction, furnish their perennial tribute to the ocean, at very remote points, finding their outlet either in the gulf of Mexico, or the bay of the St. Lawrence.

A number of small lakes and ponds repose in the hollows of these elevated table lands.

The summit level of the Ohio canal is three hundred and ninety three feet, above low water mark at the mouth of the Muskingum, while the tops of some of the adjacent hills are at an elevation of nearly one hundred and fifty feet more, making the highest lands between Lake Erie and the Ohio river to be four hundred and fifty three feet, above the water at either of those places; there is a difference of only two feet between the level of the mouth of the Muskingum, and the lake; the latter being lower by two feet. When compared with the ocean, the hills on the heads of the Muskingum, are at least one thousand feet above its tide; a meridian line from the mouth of the Muskingum, would pass a little east of the summit level, from which spot, there is sufficient descent to cause a rapid current in the water, and when urged on by an accumulation of power from the sudden rise of the streams, the torrent becomes capable of levelling all obstructions that may oppose its course, tearing up the sandstone rocks, and shales down to its present deep and tortuous bed, amongst the hills which cluster along its borders. From the termination of the sandstone rocks, to the westerly heads of the river, a distance of not less than sixty miles, boulders and fragments of primitive formations are found scattered over the surface of the earth. They are however, not confined to the surface, but in sinking wells, at the depth of seventy feet, the same varieties of water worn and rounded fragments are found. They are of all sizes, from a pound weight, to that of several tons; and they are found through the tertiary deposits from the N. E. line of the Ohio, to the Mississippi river. I have now before me a fragment of a large boulder from the "Grand prairie" in Illinois. The early settlers of these regions observing their singular appearance, and entire dissimilarity to that of any local or known rock, gave them the very appropriate name of "the lost rocks." They are most commonly seen in solitary masses, but sometimes in groups of several hundreds, as if deposited from powerful currents, or streams of water suddenly arrested in their course. The fragment before me is composed of feldspar, mica and hornblende. The feldspar is nearly white, and is the most abundant material. The mica is in plates of from one eighth to a twelfth of an inch in diameter, color, black, or that of very dark smoke, and it composes one eighth part of the mass. The hornblende is in grains, from the size of a mustard seed to that of half a grain of wheat, and very uniformly diffused, and its cohesive power is rather weakened from long exposure to the atmosphere. Other masses have red, or purple feldspar. There is also very beautiful sienite, and porphyritic granite, with hornblende rock, containing large crystals; greenstone, jasper and mica slate, are also found. These, in company with other hard materials, are, uniformly, in rounded masses, with the angles completely abraded, as if transported from considerable distances. Primitive rocks, in place, are abundant on the northern shores of Lake Superior, but they are not known much south of that point. With proper attentention and time, I have no doubt the origin of these "lost rocks" could be discovered. They evidently, have been brought from the N. west, and remarkably concur in this respect, with the course of the boulder rocks, described by Prof. Hitchcock in his Geology of Massachusetts.

The dividing ridges between the water courses on the east side of the Muskingum, and especially those between the head waters of creeks, are composed of the remnants of the bottom of the ancient ocean, and afford the highest lands in this part of the valley. Where their direction accords with the position of settlements and towns, they are chosen for roads and highways, as they are very dry, and sometimes, for miles in succession, they are barely wide enough for a road, and they are, by the hand of nature, regularly rounded and shaped to the form of a modern turnpike. In other parts, where spurs put off into the head branches of small rivulets, they spread out to considerable breadths, affording level lands for farms. As these dividing ridges have been formed by the streams, so their direction is governed altogether by that of the water courses.

The tributary streams on the west side of the valley, above the mouth of Licking river, rise in a supercretaceous or tertiary region. The surface is flat or undulating, with here and there a hill of considerable elevation, crowned with sandstone; while the general surface and the earth, beneath, so far as it has been penetrated in digging wells, are composed of alternating beds of loam and clay, gravel and sand, water worn pebbles, and boulders of primitive rocks.

The boulders, so far as I have observed, are confined chiefly, to the *tertiary* portions of the valley, and are rarely if ever, found in the hilly *secondary* or sandstone formations. The northern part of the valley contains many wet prairies and swamps, in which the common cranberry flourishes; numerous small lakes and ponds in this region, give origin to several of the head branches of the Muskingum.

The white cedar is said to grow in some of these swamps, with a shrub which bears a berry similar in taste to the cranberry, and is called the "high cranberry." It is a fruit-bearing viburnum.

In very wet seasons, the swamps between the waters of the branches of the Cuyahoga and Tuscarawas, were formerly passed by canoes, and this was the mode of communication between the waters of the lake and the Ohio river, anterior to the construction of the canal. The streams which rise in the table lands and tertiary portions of the valley, are much more permanent and durable than those in the hilly and sandstone formation. All of them, in proportion to their length and the elevation of their heads, afford scites more or less favorable for mills, as the water in its passage over the strata of rocks has a gradual or precipitous descent. The most celebrated of these falls, are those of the Vernon, Licking and Muskingum rivers.

Several of the eastern branches of the latter river, take their rise within a few miles of the Ohio, especially Wills creek, and Still water creek, and both flow in a northerly direction in opposition to the general course of the Muskingum, as may be seen by looking at the map. A westerly branch of the former creek rises within a short distance of the Muskingum, at a spot forty miles below its mouth, and runs more than a hundred miles to pass the same place on its way to the Ohio, demonstrating that the dividing ridges between the Ohio and Muskingum, are of considerable elevation. One ridge, a few miles south of Barnsville, is estimated at five hundred feet. The region occupied by the valley of the Muskingum, is nearly two hundred miles in length, by one hundred or more in breadth at its central and northern portions; while its southern extremity below Zanesville is but little over fifty miles, having its narrowest portion on the Ohio river. All the north east part of the valley, and the hilly sandstone region south and east, between it and the latter stream, belong to the carboniferous group and coal measures, and nearly all the streams that flow into the Ohio, in some part of their course, pass over deposits of bituminous coal, while those which flow northerly into lake Erie, passing over calcareous rocks, are without the margin of the great basin through the most depending part of which the Ohio takes its course, and no coal has been as yet found on the northerly side of this anticlinal line. Although the Cuyahoga, which is a lake stream, and runs for many miles, parallel with the table lands, in its most southerly bend, touches the sandstone deposits, and discloses fine beds of coal at the great falls in Portage county. It is the only instance yet known, although, from the fact of petroleum being abundant, it is probable coal may be found at a considerable depth below the surface, near the lake in several places north of this line.

Forest Trees.

As these interesting and valuable productions of the soil depend so much on the exposure and geological composition of the earth in which they grow, a short description of them may be very appropriately introduced in company with the topographical history of the region in which they are found. The whole valley was, a few years since, clothed with immense forests of the most beautiful trees, which are fast disappearing before the hand of cultivation. On the higher ridges, the soil of which is composed of disintegrated sandstone, the favorite abode of the chesnut and chesnut oak is found. The elevated flats and tops of broad ridges whose soil contains considerable sand mixed with yellow loam, slightly tinged by iron, are the spots in which the yellow oak, hickory, black walnut and butternut are found most abundantly. A soil of this composition parts with heat slowly, and those regions that are furnished with it are noted for the protection they afford against late spring frosts, so often ruinous to the fruits in the valley of the Ohio. The steep declivities of the northeasterly and northern side hills, where the earth is composed of sandstone and decayed leaves, is the favorite spot for the yellow poplar, or Liriodendron tulipifera, and Magnolia acuminata, or cucumber tree. The yellow poplar may be called the monarch of the hills, as the sycamore is of the bottoms. It is often seen of the height of one hundred and twenty feet, and from three to eight feet in diameter at the base, with a perfectly straight shaft of eighty feet without a limb. This tree is extensively used for boat gunnels, and the manufacture of boards, and is to the west what the white pine is to the north. Where the soil on the side hills is formed from decomposed limestone and leaves instead of sandstone, the timber is principally sugar tree, interspersed to the top of the hills, with spice wood and beech. The less elevated hills and flats, whose soil is formed from decomposed argillaceous sandstone and clay of the ancient diluvium, are clothed with white oaks, dogwood, (Cornus florida,) sassafras, various species of hickory, Cereis Ohioensis, or Judas tree, yellow pine, and shrubs of many kinds. In these situations, the wild grape grows in great abundance and makes an excellent wine. The laws of climate, soil, &c. are so beautifully and so certainly adapted to vegetable life, that the geology of a country is intimately connected with the trees which clothe and beautify its bold and rugged features; and he who is acquainted with the rock formations of a country, can describe, before he has seen them, the species of trees most natural to its soil. The bottom lands, or recent alluvions, are clothed with different species of forest trees, suited to their elevation. If low and wet, sycamore and beech prevail, with red and sweet elm, and the over cup, white oak, or swamp oak; if high and dry, sugar trees, poplars and walnuts, with the low land hickory, often intermixed with groves of acacia or black locust, honey locust, and solitary trees of hackberry—on the dry plains back of the bottoms, the Persimon, or *American date tree,* grows in great luxuriance; its rich, glossy leaves emulating the orange in beauty. If the soil is gravelly, the red cedar springs up, and along the rocky sides of the creeks the hemlock spreads its rich green branches and tapering top. The rocky cliffs are ornamented with the rosebay and kalmia latifolia. While the red men possessed the country, and every autumn set fire to the fallen leaves, the forests presented a most noble and enchanting appearance. The annual firings preventing the growth of shrubs and underbrush, and destroying the lower branches of the trees, the eye roved with delight, from ridge to ridge and from hill to hill; which, like the divisions of an immense temple, were crowded with innumerable pillars, the branches of whose shafts interlocking, formed the arch work of support to that leafy roof which covered and crowned the whole. But since the white man took possession, the annual fires have been checked, and the woodlands are now filled with shrubs and young trees, obstructing the vision on every side, and converting these once beautiful forests into a rude and tasteless wilderness.

Geology of the Muskingum Valley.

The northern and western portions of the valley belong to the tertiary, or the supercretaceous of De La Beche; the southern and eastern, to the carboniferous series of the same writer; while a portion on the extreme southerly borders is identified with the new red sandstone group. As the valley approaches within twenty or thirty miles of the Ohio river, the limestone rock becomes more sparry, and retains no traces of organic remains, or fossil shells, but in many places, abounds in cubic crystals of sulphuret of iron. Some of the calcareous deposits are dark colored and decompose into a marl on exposure to the air, and all have a tendency to crack and break into rhombic fragments, as they lie in their beds. The sandstone rocks are more coarse, and are also destitute of the casts of fossil trees, found so abundantly in the strata of rocks in the vicinity of Zanesville, and on the waters of Moxahela creek in Perry county. Coal deposits are more rare, and the beds thin and shaly. There are numerous beds of red and light blue marl of a schistose structure, lying under thick deposits of sandstone; they are filled with the impressions of fossil plants, generally of the genus Sphenoptera, affording decisive evidence of a concomitant and exuberant vegetation, analogous to that of the carboniferous group; although from some cause, the materials for coal were furnished much less abundantly than in many other parts of the valley. The strata of red marl are in many places from ten to forty feet in thickness, and on exposure to the air and frosts, decompose into a red clay highly charged with iron, disclosing nodules of the red oxide of iron in considerable quantities; and occasionally fossil shells of the genus Unio, completely changed into the same material. From this fact, we are led to conclude, that these deposits were made in fresh water, and probably in a calm and tranquil condition, as the texture of the marl is very fine and smooth. Several shells, taken from the red marl, a few miles west of Marietta, are figured on page No. 1 of the wood cuts, and numbered 17, 18, 19, 20 and 21. Below the surface of the earth, beds of the red marl are found of much greater thickness.

In boring for salt water, on march run, a few miles N. W. of Marietta, a stratum was recently passed, of one hundred and fifty feet, resting on sandstone; tracts of tolerably level land, several miles in extent, are sometimes found near the heads of small streams. In these situations, diluvium, or earth deposited from water of very ancient date, forms the superstratum. It is composed of an ash colored, tenacious clay above, and deep blue, or dark colored below, resting on gravel or sand, in which is imbedded decayed wood; deposits of this kind have been passed through in sinking wells, at the depth of sixty or seventy feet. Marine and fresh water shells are sometimes found in the sand, lying side by side, as the following detail will more fully show. Six miles above the mouth of the Muskingum and one mile and a half north of the Ohio river, a well was dug by B. Racer, Jr. in October, A. D. 1834. It is situated on a small elevation near the heads of a rivulet, or small branch, about fifty feet above its present bed. The well is sixty feet in depth. The first forty feet passed through a tough tenacious clay, ash colored; such as is now found on the sides of some of the adjacent hills. The next ten feet were composed of a plastic clay, of a blue color, mixed with fine micaceous sand, and thickly sprinkled with small fragments of wood, leaves and seeds of monocotyledonous plants. Under this lay a bed of woody materials, composed of the fragments of trunks and branches of trees, grape vines, seeds and leaves. The last ten feet were chiefly fine silicious and micaceous sand; the upper part mixed with blue clay, such as is now found in the bottoms of fresh water ponds, or in eddies and lagoons of our large rivers. Scattered through these ten feet, and especially the upper portion, were found numerous individuals of fluviatile shells, apparently of the genera Unio and Anodonta, with one perfect form of a genuine oyster, and several fragments. Some of these are casts, and others petrifactions of hard calcareous materials, with the cuticle still adhering. Figures of the oyster, and one of Anodonta, are given on page 1, of the wood cuts, numbered 22 and 23. The clay in the vicinity of the shells, and amongst the fragments of the trees, after being exposed to the air for a few days, shows numerous fissures and cells, tinged with a rich blue color. The fragments of wood exhibit the same color in every fissure and crack laid open by the process of drying. It is evidently a phosphate of iron furnished by the animal and vegetable materials. Water having been procured at this depth, the process of excavating was discontinued, or, many more and probably other species would have been discovered. The ridge of river hills between this spot and the Ohio, is at least two hundred feet high and based on, or rather composed of sandstone rock. The appearance of the bed of sand, containing the shells, is similar to that deposited in running water, although other circumstances might indicate the bed of a lake or pond, drained through the outlet of the present run, or filled up by the sliding down of the adjacent hills, although the clay and its contents of vegetable matter, would rather indicate a running stream of considerable magnitude. The hills at the head of the run, which discharges its waters into the Little Muskingum, are equally high, and lie between the head branches and the Ohio, which here makes a large bend; and if the shells, sand, &c. were deposited by the river, it must have been at a period when the whole valley was covered with water, and before the present hills were formed. The annexed section will give a better view of its location.

Fig. 1.

Explanation.—*a*, Ohio river.—*b*, Alluvion or Ohio bottoms.—*c*, River hill.—*d*, Run and branches.—*e*, Well.—*f*, Adjacent hills, north.—*g*, Base of the hills on a level with the bed of the river.

Grotto of Plants.

At the southern outlet of the Muskingum valley, two miles below the mouth of the river, and forty rods from the bank of the Ohio, an interesting grotto, has been formed in the sandstone from the gradual disintegration of the rock by a chemical process. The rock is rather coarse grained, and is composed of siliceous sand, silver colored mica in minute scales, with lime as a cement, which probably by the aid of the elements of the atmosphere generating nitric acid has formed a nitrate of lime, as the rock itself for a considerable depth, as well as the surface is impregnated with these saline particles; thus it slowly effloresces, and at the same time crumbles away, dislodging and throwing down minute grains of the rock. Irregular veins of argillaceous stone, like hardened clay which are not so readily decomposed, are disseminated through the rock and stand out, in bold relief, from the surface, while cells of all sizes, from an inch, to six or eight inches in diameter, and as many in depth, are thickly scattered amongst these projecting portions. The roof of the grotto is particularly rich in this natural "fret work," giving it the appearance of an immense honey comb. In the center, the roof is about twenty feet high, and slopes gradually down to the floor on the back side, to both extremities; which are about one hundred feet distant. It is twenty feet in depth. The side next the river, for twenty five or thirty feet, presents a perpendicular face, on which the decomposing process is now most active. It is free from argillaceous fragments and is of a light ash, almost white color, and shows the formation and mechanical structure of the rock to great advantage. It lies in gently curved waves, such as are produced by a stream of water with a moderate current flowing over an uneven surface. So perfect is the illusion, that the observer easily imagines the actual living currents to be passing before him; and this is beautifully exhibited in the prefixed drawing of the grotto of Plants.* The rock itself or rather this stratum, is about fifty feet in thickness. It rests on a bed of argillaceous or slaty marl, two feet in thickness. The upper portion is ash colored and very heavy, and the lower portion of the bed, fourteen inches in thickness, is of a deep rich brown, or red. Its structure is slaty, and it splits easily in the line of stratification into thin layers. It is completely filled with vegetable impressions of the most perfect and beautiful structure; many of them appear to be aquatic plants, but the most abundant are of the genus Neuroptera. If the slaty matrix, were less fragile, very perfect specimens could be procured. As it is, they are, in the hands of any one versed in the botany of fossil plants, sufficient to determine the species. Several figures are given of the plants found here, from No. 23 to 26; (pages 10 and 11 of the wood cuts.) No. 23 is one of the most beautiful and perfect branches of the arborescent fern that I have ever seen. The foliage is similar to that represented by M. Ad. Brongniart in one of his antediluvian trees, as he supposed they appeared when living. I have seen no similar species, described in his work on fossil plants. No. 24, was probably a very porous, thick leaved, aquatic plant, termination ovate; as fragments of the extremities were found of that shape, cuticle scabrous. The leaf was replaced by a deposit of yellow ochre, one eighth of an inch in thickness, leaving the outlines and markings of the cuticle on the red shale. A large proportion of the plants at the grotto are replaced by yellow ochre. Several other species are impressed on the same fragment. No. 25, is a very rich fern. Each leaflet appears to have been composed of, or margined by rounded grains, too large and too uniform, for the fruit. The beautiful oblong leaf, No. 26, resembles "Neuropteris Scheuchzeri," but is not sufficiently acuminate. Its structure is similar to that of an oleander leaf—and is probably a new species. On the same fragment, are two species of Neuroptera. Pods and seeds of plants, are also common; with the leaf of a thick, aquatic plant, like that of the Nelumbium luteum, passing transversely

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* See lithographic Frontispiece.

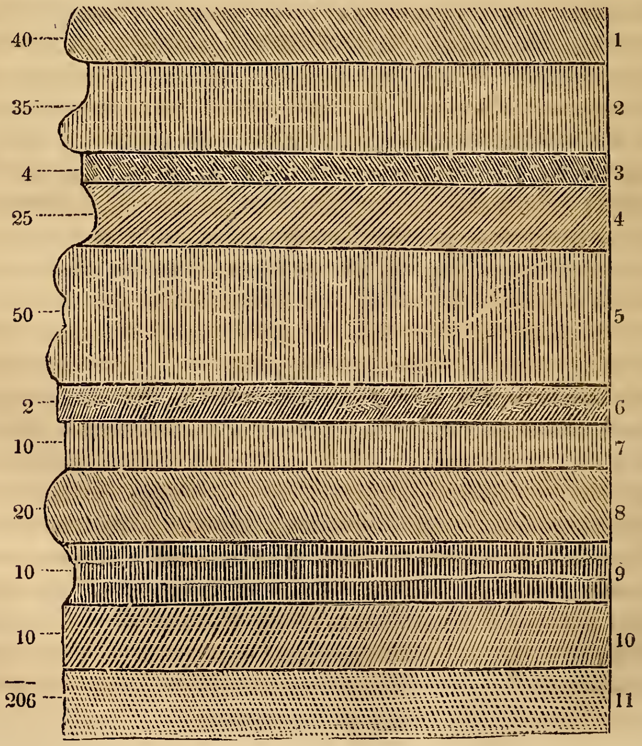
through the bed, as if they had been inhumed in their growing and natural position. From their undisturbed, and perfect condition, I am led to conclude that they lived and vegetated on the spot where they are now found. Had they been transported by currents of water, the leaves and branches would have been more confused and broken. The grotto is seated on the side of a deep ravine, which the water in running from the hills, has gradually worn in the rocks, at an elevation of one hundred feet above the bed of the river; of which and the distant hills in Virginia, the tops of the adjoining cliffs afford a beautiful view.

The prefixed sketch, exhibits the contour of the river hills, as they generally appear on the Ohio river. The following actual section and description of strata taken at the Grotto of plants, will give a general view of the rock formation near Marietta, and for some distance below.

Section of Rock Strata at the Grotto of Plants.

Order, descending.—Slight dip S. W.

Fig. 2.



1. Commencing on the top of the hill, above the grotto, which is here two hundred feet in height, above low water in the Ohio, there is a deposit of about forty feet, of an ash colored, clayey earth; a part of which has been formed from sedimentary precipitation, and part from the decomposition of the argillaceous sandstone rock.—40 feet.

2. Friable, loose, slaty sandstone—easily decomposing—containing considerable mica, and a large share of argillaceous materials, with some oxide of iron, giving it a light tinge of ochre, mixed with the prevailing ash color.—35 feet.

3. Yellow, ochrey marl, with nodules of red oxide of iron scattered through it. A few fresh water univalves, fossilized, and an argillaceous cast of an extinct species of cray fish, the head much more pointed than the recent species, have been found in this deposit.—4 feet.

4. Fine grained, compact sandstone, containing little mica, except in the horizontal seams, which divide the sandstone into layers of very uniform, but varying thickness, of from two inches to twenty four inches. The upper and the bed face of the sandstone, are very smooth, and require but little dressing to fit them for rounding into grindstones; to which use this deposit is found to be well adapted, and is very frequently applied. It extends for many miles along the face of the river hills, and quarries are opened in it at various places. Many hundreds of grindstones are annually sent from this deposit to the towns on the river below. The thinnest layers are on the top, and they grow gradually thicker as they descend. No organic remains have been found in this rock, so far as I can discover by repeated enquiries of the workmen, excepting a few fragments of what appeared to be fossil wood.—25 feet.

5. Compact, or but partially stratified, tolerably coarse grained sandstone, with fine silvery particles of mica imbedded; cemented by lime; color, light ash, approaching, in some parts of the rock, to white. Fracture very even, both in the line of its strata and in a vertical direction, splitting easily into blocks of the best building stone, of any dimensions, and, in the town of Marietta, it is extensively used for architectural purposes. The upper portion of the bed contains fragments of argillaceous stone, of irregular shape, scattered through it. In this deposit is hollowed out the Grotto of plants.—50 feet.

6. Red, or chocolate colored shale, or slaty marl. The upper portion of the deposit, for six or eight inches, directly under the sandstone, and on which the rock above reposes, is ash colored and

very heavy; composition similar to that species called "fire clay," and resembles the variety used in the manufacture of stone ware, and in making bricks for furnace hearths; breaking into irregular, but generally rhombic fragments, with no disposition to a slaty structure, and destitute of any traces of fossil plants. A similar clay is often found resting on the roofs of coal beds. The lower portion, for sixteen or eighteen inches, is of a fine, smooth, argillaceous material and of a slaty structure, and is filled with impressions of plants, between the contiguous laminæ. The leaves and stems are replaced by a yellow ochery matter, in some instances looking like the faded plant on a dark red ground. The figures of plants described above are from this bed. Many more species are found here, similar to those that will be described from another deposit a few miles from this.—2 feet.

7. Hard, and fine grained, argillaceous rock; bluish color; breaking into irregular fragments; when fresh broken, imparting a sulphureous odor. It was probably formed from marsh mud.—10 feet.

8. Ash colored, slaty sandstone, in thin layers, containing a large share of mica. Texture loose and friable.—20 feet.

9. Dark brown, slaty marl, alternating with thin beds of ash colored marl; the lines of separation, plainly shewing its deposition from water. It is very friable and crumbles on exposure to the air and frosts into a dark red, or brown argillaceous soil, producing fine crops of wheat and small grain. The brown portions of this deposit are filled with impressions of the sphenopterous class of plants, the foliage of which is more coarse, and larger than in the bed described above. It also contains a vast many impressions of the thick leaved plant like Nelumbium luteum.—10 feet.

10. Hard slaty sandstone, very fissile, color inclined to brown, splitting into folia of from one eighth of an inch to an inch in thickness, contains a large proportion of mica, especially on the surface between the layers. It has the appearance of having been subjected to considerable heat.—10 feet.

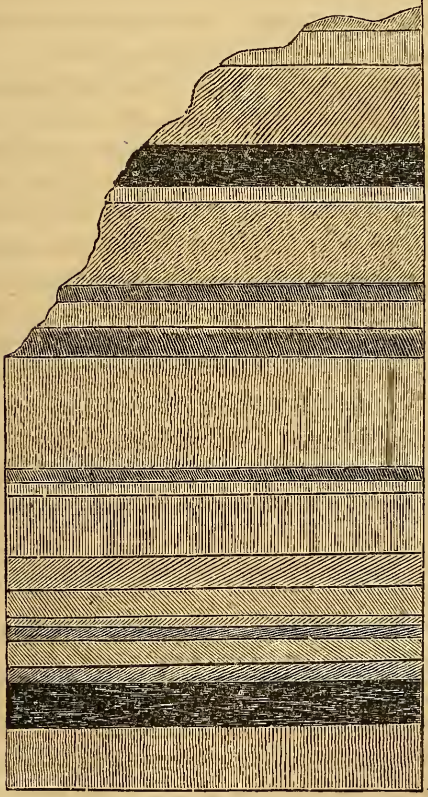
11. Bed of the Ohio river.

Many of these deposits are very extensive and cover a great many square leagues—apparently dipping towards the Ohio river, both on its right and left banks, so that, this river, although wending its way amidst a wilderness of hills, yet flows in the most depending portion of the valley. The red shale, or brown marl deposits appear, so far as I have observed, to be confined chiefly to within forty or fifty miles of the Ohio, on either side, from the mouth of the Guyandott to the mouth of Walhouding, or Big Beaver river, and probably much farther east. It is characteristic, and forms one of the series, of the saliferous group, which underlies the whole of the Ohio valley. It is most abundant in the vicinity of salines, except on the Kenawha, where it terminates at the mouth of the Elk, a few miles below. A trace of its general outlines, is given on the map of the coal region. At all the places in which I have examined this rock, (and they are many, and at remote points,) it has contained vegetable impressions, and more or less imbedded nodules of the red oxide of iron, which mineral, probably, imparts to it the rich brown, or red hue.

Section of Rock Strata at Indian Run.

Order, descending.—Slight dip to S. W.

Fig. 3.



No. of stratum.	Thickness in feet.
1	2
2	10
3	50
4	20
5	2
6	50
7	6
8	9
9	10
10	75
11	2
12	3
13	19
14	9
15	12
16	3
17	3
18	9
19	7
20	13
21	45
	359 feet.

The above section with the following description of strata, will give a connected view of the order of superposition of rocks, near the outlet of the Muskingum valley, from the surface of the hills to the depth of two hundred feet below the beds of the streams. It is taken at a point two miles west of Marietta, where a search, recently made, for salt water, was abandoned from a want of means in the operator to continue the work.

1. Hill top. Ash colored earth, in some places mixed with yellow sand—clothed with yellow pine, yellow oak, chesnut oak, &c. —2 feet.

2. Light blue sandstone, in thin beds, from one inch or two to eight or ten in thickness; mica between the layers; texture of the stone very suitable for grindstones, being compact and sharp grained.—10 feet.

3. Light colored, coarse grained sandstone, with but little mica, and cemented by lime. Compact and splitting into good building stone; lower part of the bed much finer grained and stained with veins of dark carbonaceous matter.—50 feet.

4. Bituminous shale, with thin veins of coal of a few inches in thickness near the bottom of the deposit.—20 feet.

5. Grey limestone—containing nodules of brown oxide of iron; no impressions or casts of fossil shells.—2 feet.

6. Argillaceous sandstone, in beds of from one to two feet in thickness—contains no fossil casts of trees, or plants.—50 feet.

7. Brown marl, with nodules of red oxide of iron; many of the nodules and flattened pieces contain, when broken, fine impressions of arborescent ferns. Portions of the trunks, two or three feet in length, and three or four inches in diameter, much flattened, are also found on this branch, and probably from this bed. I have fragments, completely replaced by iron ore, in which the woody fibre is very distinct in its large longitudinal fracture. The bed of the run contains numerous fragments of various rich iron ore, scattered over its bottom. Figures are given at Nos. 27 and 28, (page 12 of the wood cuts,) in iron ore from this place. They are both of the genus Neuropteris, but are probably undescribed species. No. 27 resembles Anomopteris, rather more than Neuropteris.—6 feet.

8. Slaty sandstone, very fine grained in the lower part of the bed, containing impressions of fossil plants—upper part of the bed mixed with considerable mica, and free from impressions.—9 feet.

9. Brown slaty marl, upper part of the bed ash colored; lower part, nearly that of Spanish brown, compact and heavy, filled with casts of a thick leaved plant, generally vertical as if buried in a liv-

ing state. They are too much broken to give any definite outlines of their form, sufficiently correct for a drawing. The middle portion of the bed abounds with impressions of several species of Neuroptera. A figure of one of these species, is given on No. 29, (page 12 of the wood cuts.) The plant is replaced with yellow ochre, and belongs to the arborescent ferns. The upper or ash colored portion of the bed, for about two or three inches in thickness, is filled with the impressions of an asteroid blossom, arranged in rows, upon a stem—sometimes six or eight in a line, the lower half of one resting on the upper half of another. They are of different sizes, but all equal on the same stem, and generally, each floret contains twenty four petals or rays. The marl in which they lie, contains a little mica, and is literally filled with them. The broad leaf of some arundinaceous plant is sometimes seen impressed amongst them. Figure No. 30, (page 9 of the wood cuts) gives a very correct view of their forms and size. Figure No. 31, (page 13 of the wood cuts,) is from a very slaty, micaceous sandstone, on the Little Muskingum, six miles east of this spot, and is a species of Neuropteris. No. 32, (page 9 of the wood cuts,) is from the same place, and is either a portion of a thick ribbed palm leaf, or of the impressed rays of the fin of a fish. It is most probably a palm leaf. No 31, is reduced to about one third, and No. 32, to about one fourth the natural size.—10 feet.

N. B. The boring for salt commenced in this stratum.

10. Dark, blue argillaceous sandstone, rather soft in its texture, but containing a considerable amount of sharp fine silex.—75 feet.

11. Red compact marl.—2 feet.

12. Hard blue rock, containing silex intermixed, scales of which scintillate with steel.—3 feet.

13. Blue, argillaceous slate, filled with iron pyrites of a bright brass color, leading the operator to think he had struck a rich gold mine.—19 feet.

14. Grey sand rock, with a large proportion of mica, coming up with the sludge in the pump, the size of a large fish scale two eighths of an inch across.—9 feet.

15. Blue, compact lime rock.—12 feet.

16. Grey sandstone, with a large proportion of mica.—3 feet.

17. Red sandstone.—3 feet.

18. Blue compact sandstone, with flint in fragments.—9 feet.

19. Red sandstone, with hard fragments of silex.—7 feet.

20. Black carbonaceous deposit, upper part containing some sand, and throwing off a large quantity of carburetted hydrogen gas, and considerable petroleum. The lower part of the deposit, five feet in thickness composed of black carbonaceous matter like the pulverized coal of pine wood and floating on the top of the water in the head of the well, quite dry when removed; probably the petroleum rendered it repulsive. I have some of it in my possession; it is quite inflammable and resembles mineral charcoal.—13 feet.

21. Blue, argillaceous conglomerate, with imbedded pebbles of white quartz, pieces the size of a pea coming up in the pump; when dried in the air, the fine mud became coated with a white salt, bitter and pungent, probably a muriate of lime. Here the boring ceased at 200 feet from the top of the well, and 359 below the surface of the hills.

Muriatiferous Rocks.

As we proceed up the Muskingum valley, the hills become more elevated, especially at the great salt deposits, about forty miles from the mouth of the river, where they rise to an elevation of nearly three hundred feet, above the bed of the river; at a point, twenty five miles from the mouth, to the falls at Zanesville, a distance of about thirty miles in a direct line, the strata dip south or south east, at the rate of about twenty feet to the mile, several of the strata cropping out between these two points; showing the same upward tendency of the saliferous rock strata here, that has been observed at the works on the Kiskiminitas and Kenawha, but whether this elevation was caused by the immense evolution of gases, much more abundant in early times at all the salines than at present, or from internal heat, remains as yet unknown. The temperature of the salt water as it rises from the deep wells, is found to be about 50° of Farenheit; while that of springs and wells of fresh water in the vicinity is about 52°. From this we may infer that the saliferous and secondary strata are of great thickness and that those seen, lie far above the primitive rocks, which are doubtless of igneous origin; and the existence of internal heat is countenanced by the fact that mines regularly increase in temperature as they descend deeper into the earth; the same fact is also observed in Artesian wells. Four miles above McConnelsville, a deposit of grey or horncolored flint rock, comes to the surface and rises upon the adjacent hills a short distance above; at this town in boring for salt water the flint stratum is reached at about one hundred feet, and it continues to dip at nearly the same rate for ten or fifteen miles below. This rock is a certain guide for the well diggers, as the main salt rock is very uniformly found at six hundred and fifty feet below it. At the lower wells on the Muskingum, twenty five miles from the mouth, the salt rock is reached at nine hundred feet from the surface. Some wells at these salines, are sunk more than three hundred feet below the present surface of the ocean, and the salt rocks, generally through the valley of the Ohio, lie below tide water. The rock strata below the surface, are similar to those passed at the other salines in the west, being a series of yellow and grey sandstones, slate clay, red argillaceous marls, bituminous coal, shells, flint, red or brown sandstone, calcareous rocks, and finally pure white saccharine sand rock, containing a small portion of silvery mica, in which the excavations terminate, and in which the only strong and lasting supply of brine is found, throughout the salt region. It is porous, and full of cavities, affording a free circulation to the water; the augur sometimes dropping several inches, at once into one of these cavities. At the Muskingum salines there are two strata of this rock which afford salt water—one at about two hundred feet below the siliceous rock, twenty four feet in thickness, affording good water but not in sufficient quantity. It is more compact than the lower rock but it is not of so pure a white. The second lies at about four hundred and fifty feet below this, and is from forty to fifty feet in thickness. The upper part of this rock is sometimes tinged with red. In all the salt wells on the Muskingum a stratum of rock is passed, known to the workmen by the name of the lower hard rock. At McConnelsville it is struck at six hundred and twenty feet below the surface, or about one hundred and eighty above the lower salt rock, lying between these two rocks. It is about forty feet in thickness and possesses some singular properties. From Mr. Stone, a very intelligent man who was for many years engaged in the salt business, I received the following description. Where he pierced this rock it is forty two feet thick and the boring occupied forty five days of labor. Through its whole depth, it is very dense and compact, and in particular veins, or beds, possesses great tenacity and hardness, so much so, that twelve hours operation, with an augur, weighing with the poles, more than half a ton, and making sixty strokes in a minute, penetrated only three inches; with these constant and repeated blows, the augur, or drill was not perceptibly diminished or worn away; proving from the effects, as well as by inspection of the detritus that the rock contains little if any siliceous ingredient. If not mixed with other matter thrown down from the rocks above, the sludge, or borings would be nearly as white as chalk; they are now almost white, and from chemical tests appear to be composed of carbonate of lime, a little salt and protoxide of iron. About six feet below the upper surface of this rock, the metallic pump, or sucker, used to bring up the sludge, was frequently arrested, both in its descent and ascent, as if forcibly held by some invisible power; and that so strongly, that the workmen were obliged to hook on the poles, in place of the rope commonly used for this service lest their efforts should break it. There was sufficient room for the pump without touching or rubbing much against the sides of the well, usually about four inches in diameter. The long continued and forcible blows of the steel augur no doubt excited great magnetic action, both in the hard ferruginous rock, found in the upper part of the stratum and in the iron connected with the rods. Mr. Disbrow in one of his experiments in boring to form Artesian wells, speaks of the drill being so highly charged with magnetic power as to sustain a heavy jacknife. I should ascribe the retention of the pump, rather to the magnetic power excited by the operation of boring, than to any inherent magnetism in the rock. The rock is entirely calcareous, and sometimes contains fine particles of salt, mixed with the borings. The most remarkable character of this rock is its singular density.

From the inclination of the strata, the lower salt wells produce a stronger brine than those higher up the Muskingum. Fifty gallons of water yield to the manufacturer fifty pounds of salt of a very fine quality. By an analysis of the water, made at Cincinnati, by a practical Chemist, four ounces of the water yielded the following results.

Muriate of soda, . . .	260 grains.
Muriate of magnesia, . . .	20 gr.
Muriate of lime. Say, . .	15 gr.

There was also a faint trace of Iodine and some carbonate of Iron. From this analysis it appears that the water contains about fifteen per cent of the muriate of soda, and is in strength and freedom from other ingredients rather superior to any other water yet brought into use in the valley.

Salt water is found in the vicinity of the Muskingum river, up to Coshocton, and probably further up, and, also on some of the larger creeks. Manufactures are in operation on Moxahala creek, where the bed of the stream is lime rock; also on Will's creek, where the whole country abounds in limestone. Coal and sandstone continue to accompany the muriatiferous deposits, and are found at very considerable depths below the surface. In excavating a shaft, on Salt creek, ten miles S. E. of Zanesville, a bed of fine coal, seven feet in thickness, was found lying under a thick deposit of slate, very compact and free from fissures. The rock perforated in this portion of the shaft, was one hundred and fifty feet in depth; it was dry and impervious to water, which caused great trouble in the sandstone strata above; the coal being found in the bottom of the shaft. The same fact was observed, in sinking a shaft near Portsmouth, Ohio, in slate, the whole distance, one hundred and fifty feet being very dry, and entirely free from water.

On all the eastern branches of the Muskingum, coal is found in extensive deposits, but becomes more scarce, and is found in thinner beds as we approach the table lands between Lake Erie and the river; this region being the northern and western verge of the great coal basin. Near the borders of the coal region, iron ore becomes much more abundant, and is found in extensive beds of recent argillaceous or bog ores, and also in kidney shaped masses, imbedded in clay, and often under coal deposits. Ores of this variety are extensively worked in Stark and several of the adjacent counties. The lime rocks here abound in fossil marine shells of the genera, Productus, Terebratula and Spirifera, with ammonites and chambered shells; indicating that some of the coal deposits have been deeply submerged under salt water since their formation; or that the vegetable materials, composing the coal had once floated in an ocean, and were precipitated by an accumulation of calcareous, argillaceous and sedimentary materials, collected on and about them while floating.

Marine fossils are found both above and below the coal, and sometimes deposits containing fresh water shells are intermixed, although they are not so common, as they are nearer to the Ohio river. Some of these fresh water fossils bear a striking resemblance to living species now found in our rivers. For a notice of No. 20, 21 and 22, (page 1 of the wood cuts,) see the appendix.

Through nearly all the coal region we find many proofs of the predominance both of fresh and of salt water. West of the coal deposits in Ohio, the fossil shells are altogether marine, at least so far as I have seen them, and many of them belong to the supercretaceous or tertiary genera, and are similar to those found in the same formations in the Southern States.

A section of the rock strata near Zanesville, will give a satisfactory view of the geological structure of this portion of the valley; and for this purpose, I have chosen a lofty hill on the west side of the river, called "Putnam hill." The scite of the town of Putnam, lying along its southern base was selected in the early settlement of the state, by General Rufus Putnam, and the town was named after him. The Muskingum river coming down from the N. E. here makes a bend, sweeping the base of the hill, and tumbling and foaming over the hard ferruginous limestone that forms its bed. This hill, at some remote period, was united in continuous strata with its congener of nearly the same elevation on the east side of the river. But the waters, which have made such changes on the surface of the earth, accumulating from the regions higher up the valley, here forced a passage, tearing away the sand rocks, slate clay, coal and shale, down to its present bed, leaving the face of the hill very abrupt; and with the assistance of a road excavated out of its side, affording a fine view of the thickness and order of stratification.

1. Argillaceous earth and clay, from the decomposed sandstone forming the stratum beneath.—10 feet.

2. Argillaceous sandstone. Slaty structure, tinged yellowish by the oxide of iron and containing imbedded nodules of argillaceous iron ore. The lower part of the bed dark colored.—10 feet.

3. Carbonaceous, slaty clay, with bituminous shale, containing thin seams of coal the thickness of paper, the coal still retaining the outlines of the vegetable foliage impressed on the shale. It is a thin bed of only one foot in thickness. Some of the impressions are similar to those found in Section No. 12.—1 foot.

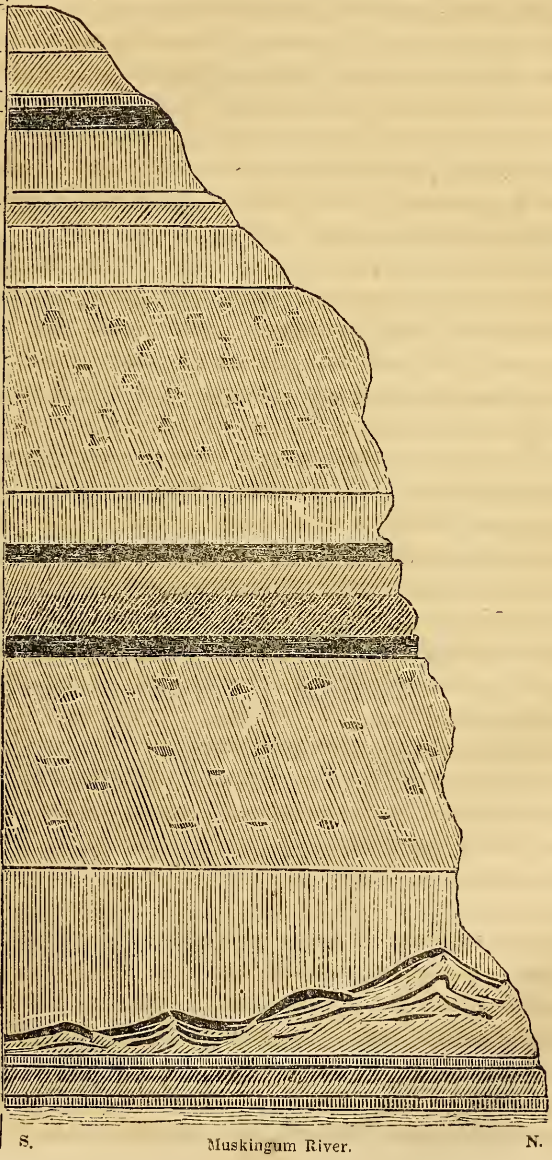
4. Bituminous coal. Structure foliated, splitting into thin layers. Color inclined to dark brown. Specific gravity 1.22, being rather less than the average for common coal. In deflagrating with the nitrate of potash, twenty grains of the coal consume one hun-

Section of "Putnam Hill."

Order, descending.—Strata, nearly horizontal.—Slight dip to S. E.

Fig. 4.

No.	Thickness.
1	10
2	10
3	1
4	3
5	15
6	1
7	$1\frac{1}{2}$
8	7
9	52
10	5
11	1
12	10
13	$1\frac{1}{2}$
14	60
15	40
16	1
17	3
18	1
	223 feet.



dred grains of the nitrate, which would give to the coal about sixty per cent of carbon; it requiring about thirteen grains of wood coal, to decompose that quantity of nitre. Forty grains of this coal heated to redness in a crucible, and kept at that point for a few minutes, left twenty one grains of coke, which contained but little earth, for fourteen grains of this coke, deflagrated, one hundred grains of nitre. While burning in a grate, it flames freely at first, but soon melts and runs together, obstructing the circulation of the air through the burning mass. This character is common to the coal from the upper deposit, not only at several remote points in Ohio, but also on the Kenawha river in Virginia. The bitumen it contains is very pure and free from sulphur.—3 feet.

5. Slaty, micaceous sandstone, in thin layers, from half an inch to two or three inches in thickness, very fissile—some of the lower layers are hard, and fine grained—when struck, emitting a metallic sound, as if they had been subjected to a strong heat. No vegetable remains have been seen in this stratum.—15 feet.

6. Fine plastic clay, nearly white; a few miles west of this locality, the same bed is found with a much purer clay, and is used in the manufacture of Pots for glass house furnaces. It supports a great degree of heat. This vicinity abounds in clays very suitable to the manufacture of earthen ware of various kinds.—1 foot.

7. Stratum of shelly ash colored limestone, with a tinge of yellow decomposing very readily into marl. It seems to be made up of decomposed and broken, and also of many whole shells, of the same genera, and generally of the same species with those found at "Flint ridge," a few miles west of this spot, in a calcareo-silicious deposit, abounding in cellular quartz, with veins of chalcedony, and furnishing a material for mill stones equal to the best imported Paris Burrh stones—a further description of this interesting deposit, which lies at an elevation somewhat greater than this, will be given hereafter. The figures of shells Nos. 1, 2, 3, 4, 5, 6, 7, 9, 10, (page 2 of the wood cuts, and fig. 8 on page 3,) are from this bed, a description of which may be given in the appendix. No. 11, (page 2,) is an impression very common in this bed of limestone. The stellated points are of a greenish hue and appear to be connected by a fine striated substance. It is probably a species of Gorgonia, but the fragments of stone are too small to give its original figure or outlines. The spines of a species of Plagiostoma, are very abundant in some parts of the bed. The perfect shell is found near Columbia in compact

limestone, two specimens from that place are in my collection.—1½ foot.

8. Very compact close grained, slaty sandstone in layers, from half an inch to an inch in thickness. It contains a portion of fine grained yellowish mica. The fracture is smooth, displaying dark colored lines, a sixteenth of an inch in thickness, passing through the stone in the line of stratification. The bed and surface-faces are remarkably even, like roofing slate, for which purpose it has been used, but is rather too heavy.—7 feet.

9. Pale blue, slaty clay—very fissile and loose in its texture. Considerable quantities of argillaceous iron ore are found in detached nodules scattered through the bed, in flattened reniform masses. On exposure, the surface becomes oxidized, and peels off in thin concentric layers. The clay contains fine particles of sand and mica. Near the bottom of this stratum, fossil shells, in good preservation, are found, imbedded in indurated masses of clay, indicating a removal from their original bed. Those in my possession, belong chiefly to the family of Pectens, with one Fusus. Figures are given in Nos. 12 and 13, (page 2 of the wood cuts,) with descriptions added below. This bed is very extensive, and without doubt is passed in boring for salt some distance down the river, as the whole series dips directly to the S. and S. E.—52 feet.

10. Dark blue limestone—compact and hard in the upper part of the stratum, lower part carbonaceous, loose and friable. It abounds in fossil shells of the genera Terebratula and Gryphea; it contains also Encrini, the latter in branches, three or four feet in length, are seen rising a little above the surface in the face of the stone, between the seams, and especially in weathered pieces. The animal structure is replaced by pure crystallized carbonate of lime. When the stone is fractured, these white cylinders appear in strong contrast with the dark mass of the rock in which they are imbedded. Some specimens are three fourths of an inch in diameter, others much smaller. Not having seen the base of these animals, I cannot determine the species, but from the figures in Parkinson, should call it the "Encrinus rectus."—The Terebratulæ are small, and many of them similar to No. 5, (page 2 of the wood cuts,) but so closely imbedded as not to be removed without defacing the specimen. The Gryphea, resembles "Gryphea arcuata."—5 feet.

11. Bituminous coal—a thin bed of less than a foot, but of a fine quality and brilliant fracture. Specific gravity about 1.30. There

is a thin bed of shale of two inches, above the coal, on which the limestone reposes. It has been remarked, that coal lying immediately under or over lime, is of a better quality than that which is associated with sandstone.—1 foot.

12. Slate clay, common and bituminous shale. The upper part of the deposit is of a light or ash color, four feet in thickness. The lower part is dark colored and bituminous, being made up of thin folia of shale and coal intermixed, frequently not thicker than paper. This portion of the bed is six feet thick, and strongly resembles a mass of tobacco leaves as they are pressed closely together in a hogshead, and still retain the brownish yellow color when first exposed to the air. This deposit is remarkable for the great variety and beauty of the vegetable impressions found between the lamina of coal. The most abundant variety belonged to a broad leaved, arundinaceous plant. Figures are given of ten species, from numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11, (on pages 3, 4 and 5 of the wood cuts,) and probably fifty or a hundred more might be found if diligent search were made, and the shale had a little more tenacity, but it is so fragile that only partial figures of the branches can be obtained. Nos. 1, 7 and 9, are portions of the cuticle, or bark covering the trunks or large branches of Fucoides. No. 9 exhibits a very peculiar structure, such as I have not observed in any other specimen. The surface is arranged in squares of about half an inch in diameter, separated by raised lines of a sixteenth of an inch, which break on each other, throwing the squares into alternate rows. In the center of each is a circular depression of two eighths of an inch, bearing a lustrous or glazed surface, as if a smooth, warty tubercle had been pressed forcibly into it. The intermediate surface is maculated, similar to the skin of the dog-fish. The whole impression is made in a thin layer of coal, glued to a brown ferruginous slate, and must have lain on the outer surface of the bed. The drawing is half the size of the original specimen. No. 1 is also impressed on a thin lamina of coal lying between layers of shale. The surface of No. 7 retains the vegetable coloring like that of the yellow leaf tobacco when dried. A portion of the shale an inch in thickness is impressed, from side to side, with these figures—other portions are marked by the smooth, broad leaves of arundinaceous plants. No. 2, is from the upper portion of the bed and resembles "Fucoides Wilsonianus." No. 4 is from the same bed and is also a Fucoides, but of an undescribed species, as I suppose many of

those which follow are also undescribed. Having had access only to the first six numbers of M. Brongniart's work on "Vegetaux Fossiles," I am unable to determine. The drawings are faithful delineations of the plants represented. Nos. 8 and 3, are beautiful species of arborescent ferns. The nervures on the foliage of No. 2, are very strongly impressed. The filaments of the leaves on No. 8, are united at the base, and considerably curved. No. 5, is a very singular fossil, and has several equivocal marks in its form and structure. The outlines of the fragment are similar to the hinder part of a fish; while its flattened body strengthens the illusion. The specimen is about four inches long, three inches wide and one in thickness, composed of ash colored, marly clay. The surface is covered with depressed spines of the eighth of an inch in diameter—none were over an inch in length when I received it, and those were all broken and shortened from their original extent. In the same bed a fragment was seen eighteen inches in length and much thicker than this one, but it broke into small pieces in removing it. It may be the remnant of a large Equisetum—the surface is bituminized. No. 6, is also a species of Fucoides, as near as I can determine; it is from the upper bed. No. 10, represents the seeds of some monocotyledonous plant, which are thickly scattered in patches, amidst the fossil leaves in the shale. The seeds are a little enlarged in the figure. No. 11, appears to be "Calamites remotus," and was taken from the upper part of the bed. The columns still retain the siliceous cuticle common to canes. The radius of the four columns, of which the specimen consists, being taken, the outlines of the whole circumference is given in the drawing. The oblong tubers on the face of the columns are finely preserved. The original whole, must have been a beautiful stem. The lower part of the shale bed is composed of the half bituminized leaves of grasses, arundinaceous plants, &c. the mass not being sufficiently vegetable to form perfect coal, although directly beneath, it passes into that state—several feet of the shale would afford nearly as good fuel as Bovey, or wood coal.—10 feet.

13. Bituminous coal, eighteen inches in thickness, of rather a poor quality, not sufficiently compact—structure slaty, displaying impressions of broad, delicate leaves between the seams, from which we may infer that wood did not enter into the composition of this bed. No. 34, (page 8 of the wood cuts,) is a piece of coal from the heads of Duck creek, but represents the appearance of the foliage, between the layers of coal as seen at this bed.—1½ feet.

14. Slaty clay—upper portion of the bed dark colored, middle and lower parts, light blue. This great deposit contains a few vegetable impressions in the upper part, with imbedded nodules of iron ore scattered through the whole. The lower part contains some sand, within a few feet of where it rests on the sand rock below.—60 feet.

15. Sand rock, composed mainly of siliceous sand, tolerably fine grained, with a little mica, general aspect yellowish. The structure of the upper part of the deposit is compact, or in very thick beds. The Zanesville canal is excavated in this rock, and as the work proceeded, it furnished many fine specimens of fossil trees, carbonized wood, and impressions, both in outline and figure, resembling the scales, and form of an immense fish, of some extinct species. A figure of a portion of one of these casts is given at No. 12, (page 6 of the wood cuts.) The centre of each scale is deeply sunk in this cast, but in the original, this part must have been raised, standing out boldly from the surface like the bosses on a buckler. The plates are arranged in rather curved lines, reposing on each other like tiles on a roof, and must have been a quarter of an inch in thickness, and from a half to three-fourths of an inch across the face. Towards the back of the specimen they are crowded and smaller, as if compressed forcibly together. It was, however, after all, most probably not a fish, but a portion of the trunk of a palm tree. Nos. 13 and 14, (page 6) have been in my possession, several years. They were received from Mr. Horace Nye, to whom I am indebted for many similar favors, he having furnished the most of the fossil specimens exhibited in the section of " Putnam Hill."

From the texture of the rock, I think they are from a more elevated bed, but are certainly from this vicinity. No. 13 appears to be impressed by the bark of a tree, similar to those now living. No. 14 is more lozenge shaped, and I should think lived at a period between those found in our coal deposits, and the growth of the earliest species of those now clothing the earth; there being a most marked and entire difference between those of the two periods. No. 15 (page 5) is a cast, apparently the termination of the trunk of some ancient palm tree. It is about eighteen inches in length, and three inches in diameter. The surface covered with lozenge shaped scales, arranged in spirally oblique lines. No. 16 (page 7 of the wood cuts) is about fifteen inches in length and six inches in diameter at the larger extremity. This is only half its original thickness, as it is split into two parts near the center and is considerably flattened. The surface is covered with double interrupted lines, or lines in pairs, about half an inch apart; the interruption or break in one line being opposed to the continued line in the adjacent row. These lines are raised less than the sixteenth of an inch, and follow the curve of the trunk. The space between the lines is filled with fine longitudinal striæ, resembling threads. The surface has a most beautiful and finished appearance, as if impressed by the hand of a master. The transverse furrow is evidently the cicatrix of the foot stalk of a broad leaf, half encircling the stem, like that of many arundinaceous plants. The rock in which these fossils are imbedded splits freely, and affords valuable materials for architectural purposes. It embraces the upper half of the deposit, which is forty-two feet in thickness. The lower half, although it is not equally divided, exhibits a very singular appearance ; the component parts are much coarser and apparently made up of a fragmentary sandstone, intermixed with slate, bituminous and carbonaceous materials in thin veins, pursuing an undulatory course, often rising in one spot and sinking in another, as if thrown up by the force of a current pressing against some obstruction, or as if otherwise disturbed after being deposited. Some of these veins of coal and slate are several inches in thickness, others only a line or two, or even less. They are frequently interrupted and broken, but are resumed again in a spot a few feet distant. The structure of this portion of the rock is slaty, easily splitting in the line of stratification. Between each of the contiguous layers is seen, a thin coating of bituminous argillaceous or carbonaceous matter, staining the surface of the seams, and often impressed with the figure of some leaf or stem of a plant ; amongst these varieties the calamites are rather more common than any other. This portion of the rock contains much more mica than the upper part of the bed. The shaded and curved lines in this stratum of the section will give a pretty correct idea of its appearance. The contorted portion of the bed rests on a deposit of fine argillaceous slaty sandstone, of one or two feet in thickness. It is very light colored and splits into laminæ of one or two inches, the surface of each piece being coated with a soft talcose material, which forms the line of separation.—40 feet.

16. Calcareous iron ore, deep brown color, resting on a thin bed of black hornstone or flint, of six or eight inches in thickness, con-

taining a great many broken and some whole shells of the genera spirifera and gryphea. The shells retain their calcareous material, effervescing freely with acids. The upper portion of the bed is intensely hard, but breaks into fragments, and is gathered up below the falls and used in the manufacture of iron. This deposit forms the bed of the rapids or falls at this place. The black flint contains numerous cells, as if it had consolidated suddenly after being deposited in a very hot state, as nothing less than a powerful heat can hold it in solution.—1 foot.

17. Fine compact ferruginous sandstone, filled with very perfect vegetable impressions, of several feet in length. Figures No. 17 and 18 (page 7, wood cuts) are from this deposit. No. 17 is a portion of a "calamites dubius," which is most beautifully and perfectly impressed, leaving a thin coat of bituminous matter in its place. No. 18 appears to be a fragment of the foliage of some palm, or arundinaceous plant. Portions of arborescent ferns, and the flowers of some vegetable resembling an aster, are very commonly impressed on the same fragment of rock. This deposit can be approached only at low stages of the water, as it lies in the bed of the river a little below the falls. The most distinct and perfect impressions of fossil plants in all this vicinity are found in this bed, as if nature jealous and careful of her choicest productions had placed them in a spot difficult of access, enveloped in numerous stony coverings, and protected by water from the prying curiosity of man.—3 feet.

18. Limestone—dark colored and carbonaceous—in beds of four and six inches in thickness—containing fossil encrini and broken shells.—1 foot.

I am informed that a few feet below this limestone there is a deposit of very fine coal, much thicker than any of the upper beds. A spot containing a more interesting series of fossils and rock strata, can hardly be found, than this in the vicinity of Zanesville. The sand rocks, on Monongahela creek, a few miles S. W. of this, are filled with the most perfect fossil casts of Palm trees, calamites, the roots of aquatic plants, &c. Figures No. 19 and 20, (page 7,) are from this place. No. 19 is a very fine sandstone. No. 20 is replaced by siliceous material. They are different species of the stems of arborescent ferns. No. 33, (page 9 of the wood cuts,) is from stratum No. 17, and is probably a monocotyledonous plant.

Cannel Coal.

The only places as yet known in this country where this interesting species of bituminous coal is found, are in the vicinity of Cambridge, Guernsey County, Ohio, on the waters of Will's creek; the first notice of which was given by the Hon. B. Tappan in Vol. XVIII, of the American Journal of Science. It will probably be found in some other places in that region, as I have picked up considerable masses of it on the shores of the Muskingum, brought down by the current from the streams above. It is found in a district abounding with limestone, which possibly may have had some influence in impressing its peculiar characters.

The composition of this coal, by analysis, does not materially differ from the common black slaty coal of the country. It contains rather more bituminous, and less carbonaceous matter. Its specific gravity is 1.41, while a large share of the common coal does not exceed 1.30. In deflagrating it with the nitrate of potash, thirty grains of this coal decomposes one hundred of the nitre, which will give about forty per cent. of charcoal. By carefully examining the appearance and structure of the coal, I am induced to suppose that it has been subjected to a degree of heat sufficient to melt and agglutinate it into a compact mass, after it was deposited in its present bed, and that it was originally a deposit of common slaty coal. The outer surface of many pieces, has marks and lines impressed on it, as if made by the superincumbent slate, while it was soft or fluid. Its fracture is vitreous and conchoidal like that of a mineral which has been in a fused state. The following description of the cannel coal deposit was kindly furnished by Judge Tappan, and taken by his son. "This bed of coal is situated about five hundred yards north of Grummon's tavern, five miles west of Cambridge; the country about it is rolling, the hills rising generally to the height of one hundred and fifty feet, with broad valleys between. The coal is found about sixty feet below the summit of one of these hills, near a small run. The bed of coal is twenty one inches thick, of a somewhat slaty structure in its lower part, and rests on and is covered by bituminous shale, which gradually passes into common shale above. Below it has been examined only to the depth of a few inches; the water of the run having prevented a more extensive search in that direction. I did not see any vegetable impressions in the coal, or in the shale, nor was any limestone visible, although I was informed that there is a bed of limestone six or eight feet thick at some distance above the coal. Sandstone, clay slate, and common bituminous coal are found in the neighborhood. The soil is a yellow clay. I was also informed that the same kind of coal had been found in digging a well, about one mile and a half S. W. of the place before mentioned, of about the same thickness, and at about the same level. I could not ascertain the order of superposition of the strata, no section of the hills having been cut for roads, or by the runs of water.

The limestone rock of this vicinity abounds in fine fossil shells, and other relics of a former age; many interesting remains being discovered in breaking the rocks to construct the national road. Amongst these, were some beautiful large ammonites and overgrown gryphea, or nautilites, with a shell which resembles a lymnea. Drawings of an ammonite and an ampullaria are given at figures 24 (page 1 of the wood cuts) and 14 (page 2) taken from the limestone in this vicinity, with descriptions below. Many of these fossils although imbedded in lime, are replaced by silex.

*White Lias Limestone.**

About twenty miles S. E. from Cambridge, on the head-waters of Will's creek, Little Muskingum, and Duck creek, in an elevated hilly country, is found a very interesting deposit of fine white limestone, of a quality similar to the lithographic variety. It lies in stratified beds of eight and ten feet in thickness, and leaves a space of eight or ten miles square, in the heads of these streams, lying chiefly on the southern side of the anticlinal line, between the waters of Will's creek and the other two streams. It is seen cropping out on the sides of hills, and in the beds of runs at various points through the neighborhood. It is the only deposit of this stone, of any extent, at present known in this part of Ohio. I visited that region last spring and took sections of the rock strata; two of which will be given, including two interesting deposits; and so far as I know both are peculiar to this district of country. One of them is white, the other a brecciated or fragmentary limestone, found a few miles north of the other. The hills at this spot are one hundred and eighty or two hundred feet in height, but in the dividing ridge, and on the waters of Duck creek a few miles west, rise to more than three hundred feet. This spot is distinctly marked on the map.

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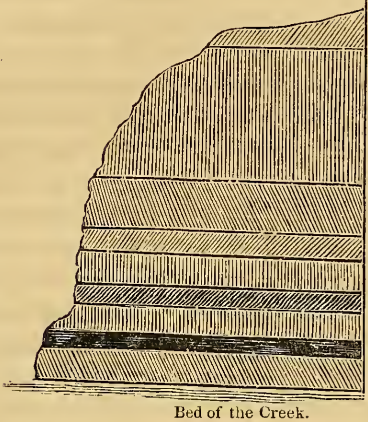
* We have not seen any specimens of this rock from Ohio.—*Ed.*

Section of White Lias Limestone Strata, on the "Clear Fork" of the Little Muskingum.

Order, ascending.—Dip S. E.

Fig. 5.



Thickness.	No. of stratum.
10	9
100	8
30	7
6	6
8	5
4	4
6	3
2	2
8	1
175 feet.	

Bed of the Creek.

1. Limestone; compact; dark; carbonaceous; in beds of six inches to two feet in thickness. It is destitute of fossil shells at this point, but on Papaw creek, a few miles south, contains orthoceratites of more than a foot in length, in sparry lime rock, resting on a bed of light blue clay, filled with beautiful crystals of the sulphuret of iron.—8 feet.

2. Bituminous coal; slaty structure. This bed is nearly all pure coal; fracture brilliant, and in spots, having the appearance of being melted, or made fluid by heat. It rests on the limestone below, and has a roof of the white variety, with a very thin bed of shell between. Its specific gravity is 1.38, being very near that of the cannel coal. It contains about fifty-six per cent of charcoal; twenty-two grains decomposing one hundred of nitre; forty grains burnt in a crucible, leaving twenty-two grains of coak.—3 feet.

3. Water lime, in thin beds, and not so firm and compact as the bed above, reposing on the coal.—6 feet.

4. A chloritic rock. This bed has all the outward characters of chlorite. Its fracture is rough and splintery, breaking into cuneiform fragments; saponaceous; not easily scratched with the nail, but may be cut with a knife. Its color is a deep, almost verdigris, green. The chemical constituents of chlorite, silex, alu-

mine, magnesia, oxide of iron and muriate of soda, are all found in our rocks, and these materials held in solution, at the time the lias beds were found, might have been deposited here. I have seen nothing in any other place that bears any resemblance to this bed. It lies between two distinct deposits of white limestone, and contains no fossil remains that I could discover. The bed is a very curious mineral earth, and might be called a secondary chlorite.—4 feet.

5. White lias limestone; structure compact; color yellowish white, where exposed to the air, but a greyish white in the bed, and when first broken. Its fracture is slightly conchoidal, with an earthy surface; adheres strongly to the tongue, and is composed of a nearly pure carbonate of lime, carbonic acid and a little carburet of iron. In its properties and appearance it approaches more nearly to *chalk* than any other mineral I have seen in the valley of the Ohio. It is cut easily with the knife, is perfectly smooth, and on wood, leaves a streak similar to chalk, but is too hard to be used for the same purposes. It stands the weather without exfoliating, and would make a most beautiful building stone; being easily wrought it could be worked into tomb stones, and various other useful articles. Its specific gravity is 2.08.—8 feet.

6. A variety of calcareous tufa, reposing on the compact limestone. It is porous, as if pierced in all directions by small worms. Color, greyish yellow, with many particles of spar intermixed, as if deposited in a portion of the cells, giving the surface a glimmering appearance. It is coarse grained, harder than the pure carbonate below, and mixed with other materials both argillaceous and arenaceous, not found in that, although it is evidently a kindred deposit. Streaks resembling yellow ochre are scattered through it. —6 feet.

7. Hard sparry lime rock; light dove color tinged with brown, in beds of about a foot in thickness; breaks into irregular masses, very compact and fine grained. The lower part of the bed resting on the tufa is coarse grained and tinged with yellow. No fossil remains were noticed, although it was examined very carefully for this purpose.—30 feet.

8. Sand rock; a very thick deposit; the lower half of the bed is stratified in thin layers of a few inches, with considerable mica. The upper half compact, rather coarse grained, composed of sharp sand, with a few scattering scales of white mica, and cemented by lime; color, light ash. It splits freely, and makes good stone for architec-

tural puposes. This portion of the deposit contains some fossil remains. Figure 21, (page 7 of the wood cuts) was taken from this bed, a little distance from this spot, and resembles the caudal half of a fish. The drawing is much reduced. The original, when taken from the rock, was three feet in length and about six inches in diameter, but has been broken and shortened. The figures on the surface differ in their arrangement in this respect, from any other in my possession, the greater diameter of the scaly impression is placed transversely, while in the others it is longitudinary.—100 feet.

9. Yellowish, argillaceous soil, rich and loamy; covered with a growth of yellow and white oak, poplar, hickory, &c. The soil on the hills being very loose and fertile.—10 feet.

This interesting deposit of white water lime, extends from the heads of Sunfish creek, across the heads of the Little Muskingum, over to the east fork of Duck creek, of an average width of six or eight miles, cropping out at various places, where the runs have cut away the superincumbent strata to a sufficient depth.

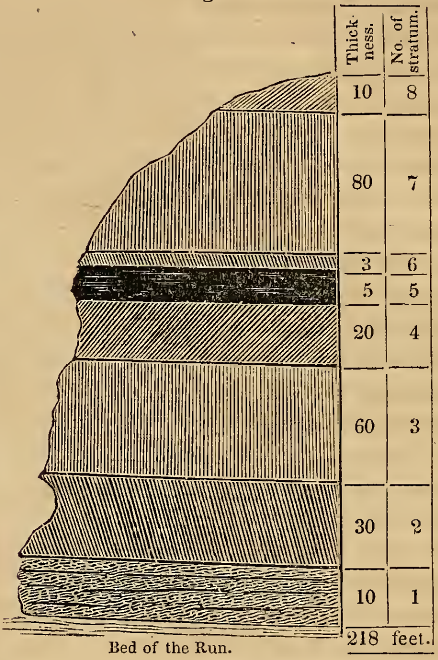
Calcareous Breccia or Fragmentary Lime rock.

About eight miles north west of the water lime beds, is found a very interesting deposit of fragmentary lime rock. This bed is on one of the southerly branches of Will's creek, two miles from Summersville, which is seated on the dividing ridge between the waters of the latter creek and those of Duck creek and Little Muskingum. A part of the same water which falls on this ridge, runs into the Muskingum river, above Zanesville, and apart into the Ohio, near Marietta. The waters of Will's creek, are deep and sluggish, while those on the south side of the ridge are rapid and shallow. The soil on the north side of the ridge is black and loose with a large proportion of sugar trees and yellow poplar amongst the growth of the forest. On the south side the soil is lighter colored, and the timber mostly oak, both indications of peculiar rock formations. The one is more calcareous, the other more argillaceous.

Section of Rock Strata on Will's creek.

Direction of strata, E. and W.—Position, nearly horizontal.—Order, ascending.

Fig. 6.



1. Coarse, calcareous, mill stone grit, or fine Breccia, in beds of about a foot in thickness. This rock is composed altogether of comminuted, and generally rounded grains of different colored limestone, from the side of a very large pea to that of fine sand. They are strongly cemented by carbonate of lime, with a little iron, which makes a very firm cement. The color of the grains is generally light ash, and a dirty blue. Where the component grains are fine, the sparry cement gives it the glimmering look of siliceous sandstone. From its great resemblance to the Laurel hill mill stones, which are siliceous, the neighboring inhabitants have manufactured it into stones for their mills, especially for the grinding of wheat—very good flour is made from these stones, but they need dressing often. When used a few days, the surface of the stone, between the furrows, takes a fine polish—shewing the imbedded grains of lime, similar to a Breccia. This deposit rests on a stratum of common grey limestone, which forms the channel of the run below. At the spot

where I examined it, there is a cascade or fall of six or eight feet, affording a fine view of the rock in place. At some remote period in the history of the earth, this deposit probably formed the shore of an ocean, or an extensive lake, which must have stretched far away north and west. This supposition is strengthened by the fact that calcareous pebbles coarse and large, form the substratum, at the distance of seventy or eighty miles west, a point which may be supposed distant from this shore; just as pebbles are now found in our present seas, with the sand and gravel, on, and near the shores, the lighter particles and fragments being driven higher up by the waves and tides, while the larger and heavier are left in deeper water. This fragmentary rock extends eastward to the heads of Sunfish creek, about fifteen miles, and is of a width at present unknown. No fossil shells were discovered, nor could I hear of any from persons manufacturing the stone.—10 feet.

2. Limestone, dark colored, and slaty structure.—30 feet.

3. Argillaceous, slaty, sandstone—easily decomposing.—60 feet.

4. Compact, sparry limestone, dove colored and fine grained.—20 feet.

5. Bituminous coal, resting on the limestone, of a good quality, burning freely—slaty structure. The same bed of coal makes its appearance on the south side of the ridge, in several places, under the coarse sand rock. The laminæ of coal when separated, display the impressions of some broad leaved plant between the contiguous layers; it is very peculiar in this respect, affording the most satisfactory and unequivocal proof of its vegetable origin, were any still disposed to doubt it. This bed, with the sand rock above, is degraded and washed away about fifteen miles north of Marietta, where the hills are much lower, and is seen no more in that direction. The impressions in this coal, when first displayed to the light, has the appearance of a dried, yellowish leaf—the vegetable matter, where not changed to coal, being replaced with yellow ochre.

The specific gravity of this coal is 1.42.—5 feet.

6. Bituminous shale, with impressions of broad, fine grained or delicately striated leaves of some arundinaceous plant.—3 feet.

7. Coarse sandstone, similar to that on the south side of the ridge, and above the Lias, crowning the tops of the hills.—80 feet.

8. Argillaceous earth—yellowish color—timber chiefly oak.

Topography of Hockhocking Valley.

From the sources of this stream to its mouth, the distance is about eighty miles. The average breadth for fifty miles above the mouth is about fifty yards. The region drained by its numerous tributary streams, and which may be called its valley, will average about twenty miles in width. The whole extent of the valley, except near its northern extremity, is hilly and broken; the hills rising from two hundred to three hundred feet above the beds of the neighboring streams. Its general direction is southeasterly. On one of the head branches, a few miles N. W. of Lancaster, there is a perpendicular fall of nearly forty feet; and about eighteen miles below Lancaster, the main stream has a fall of seven feet. At these spots several mills are erected, as well as at many other places along the course of the river. The alluvial lands are broad and rich, but are occasionally overflowed from the sudden floods that take place in this stream; the water being precipitated from the hills with such rapidity that the channel of the stream is insufficient to contain it. This difficulty is common to all the streams in the hilly parts of the Ohio valley, and will probably continue to increase as the country becomes more and more divested of its forests, which now act as a salutary check on the rapid descent of the rains on the hill sides, not only by their numerous roots and rotting foliage, which cover the surface, but by keeping the soil in a more loose and open condition than it is found to be in when in a state of cultivation. The hilly lands through this region are covered with a fertile soil, and clothed with a heavy growth of forest trees. At the southern extremity of the valley, the yellow pine is very abundant, and seems to have been once, and probably at no very remote period, the prevailing growth of this part of the country. Extensive districts in which a pine is not now found, are thickly scattered with pitch pine knots, lying on the surface, the relics of former forests, which some disease, or probably the depredations of insects, has destroyed. In these situations large quantities of pitch and tar, were formerly made. In numerous mounds, opened under my direction, the charcoal found about the human bones, which they almost universally contain, and which the aborigines first burned before casting up the mound of earth or stone, as a sacred monument for the dead, is most generally the charcoal of pine wood—leading also to the conclusion, that at the period of their erection, yellow pine was the prevailing tree of the forest, for it is not probable they would take the trouble of bringing it from any distance. While on the subject of mounds, I would remark, that I have not seen any in this part of the west which were thrown up by currents of water, as suggested by Prof. Hitchcock ; but they were all indisputably erected by human hands.

The rock strata in the hills are chiefly sandstone, with beds of limestone near the hill tops, and in the beds of the runs. The great siliceous deposit crosses this valley a little below the main falls, passing over on to the waters of Raccoon creek. Where it traverses this valley, the silex was precipitated in a fine white powder, in beds several feet in thickness. Portions of it are tinged of a deep yellow with oxide of iron, running in broad veins through the stone. It has been considerably worked into hones and stones for sharpening carpenters' and tanners' tools. Some portions of it are well adapted to these uses, and are considered nearly equal to the imported hones. In the central portion of the valley, bituminous coal is found in abundance. In the southern and northern extremities it is more rare. In the southern it is buried under the other rock strata, and in the northern, which approach the great tertiary deposits, coal has not been formed. It is found in three principal beds, pursuing the same order as in many other portions of the great basin. One is near the base of the hills, and in the beds of runs, which is usually the purest and best coal. Another is found about fifty feet above, and a third near the tops of the hills, which here, as has before been remarked in speaking of the great valley generally, have been formed by the degradation and wearing away of the surface by the action of water and other agents. A stratum found in one hill, is seen in another, at the distance of a quarter or half mile, across a valley or ravine, at the same elevation ; the intermediate rocks which once connected the hills, having been removed in the course of ages. In the vicinity of the salt deposits, or muriatiferous beds, on Sunday creek and the Hockhocking west of this creek, the deposits of coal are from five to ten feet in thickness, evincing apparent design in "Him who laid the foundations of the Earth," in the greater abundance of coal in those places where it would be most useful ; or otherwise the laws which governed the deposits of the muriatiferous rocks, and the coal, were most active and vigorous while these strata were forming. It may be that the soil over the saliferous rocks had some property congenial to the growth of such plants as formed the coal beds and not found in other soils, provided these bituminous deposits were formed of plants that grew on or near the spot, of which indeed there can be no reasonable doubt. There is a harmony in their mutual and uniform appearance, which the most careless observer cannot fail to notice. The same dip to the south east, so apparent in the coal and saliferous strata on the Muskingum, is also found to prevail on the Hockhocking. In sinking a salt well on Sunday creek, four miles above the mouth, a stratum of coal was passed, nine feet in thickness, at the depth of eighty feet. Near the mouth of the creek, at another well, it was passed at the depth of ninety four feet, and was six feet in thickness. At Athens, four miles below, on the Hockhocking, a bed of coal was passed at the depth of one hundred and eighty-five feet, six feet in thickness. At the mouth of Stroud's run, four and a half miles below Athens, a bed of coal is found at three hundred feet below the surface, which is eight feet in thickness, being twelve miles below the spot where this coal bed was first reached, on Sunday creek, making a dip of two hundred and twenty feet, or about 3°. At this angle the coal would come to the surface at a point five or six miles higher up the stream, which is without doubt the fact, as a thick stratum of coal is found in the bed of the Hockhocking a few miles north west of the upper salt well, and passes along under the base of the adjacent hills.

Main Muriatiferous Rock.

At the wells on Sunday creek, this rock is reached at the depth of about five hundred and fifty feet. It has that same clear, white, saccharine appearance which characterizes this remarkable deposit at nearly all the other salines. In approaching it, similar strata are passed, to those found at the Muskingum salt works, which lie about twenty five miles N. E. from this, and with them that notorious "Flint rock," so much dreaded by all salt-well borers. On Sunday creek it is found at about one hundred and forty five feet below the surface. At Athens, eight miles below the upper well, it lies at two hundred and fifty feet, and is so hard as to require on an average, eight or ten thousand strokes of an augur weighing several hundred pounds, to penetrate one inch. Four and a half miles below this, the salt rock is reached at eight hundred feet; and allowing the flint rock to proceed at the same angle, it would lie at three hundred and sixty five feet below the surface, or four hundred and thirty five above the salt rock; the two rocks lying a little nearer to each other than they do at the Muskingum salines. The brine procured on Sunday creek is very strong and pure, averaging at least fifteen per cent. of muriate of soda. That of the upper well is said to contain little or no muriate of lime, or "bitter water," and crystallises into a very white coarse salt. At the well, one mile above the mouth of Sunday creek, on the bank of the Hockhocking, the water is discharged with great force and freedom, rising in "the head," twenty feet above the surface of the river at common stages, and running in a constant stream, at the rate of twelve thousand gallons in twenty four hours. At this place, carburetted hydrogen is discharged, when the first veins of salt water are reached. Petroleum is not very abundant, but is found in some of the wells after passing the great coal deposit.

Fossil Remains.

The sandstone rocks contain many relics of fossil trees, of that ancient and curious family, bearing those rare devices and figures on their bark, so artificial in their appearance as to induce a common belief amongst the ignorant, of their being the work of man, in ages before the flood, and buried by that catastrophe in huge heaps of sand, since consolidated into rock. The excavations in sandstone rocks have been, as yet, so few and partial, that but a small number have been brought to light, although the strata through this valley are one vast cemetry of the plants of a former creation. I have seen some specimens found in quarrying stones for a cellar, or in grading a road, and have heard of many more, proving that there is an abundant supply laid up for future geologists, when the country becomes more cultivated, and extensive openings shall be made in the earth.

On the heads of Shade river, a few miles S. W. of Athens, there is a large deposit of Fossil trees, the wood being replaced by a dark ferruginous silex. The figure No. 22, (page 10 of the wood cuts,) was taken from a sandstone rock a few miles still further south, in company with several fresh water univalve shells, and casts resembling crayfish. The fossil from which this fragment is taken, was eight or nine feet in length, and from two to three inches in diameter, tapering gradually toward the extremity. It was probably several feet longer, as only a part of it was detached from the rock. So great is the resemblance of the markings on the surface to scales, that the discoverers called it a snake, only they could not find the head or the tail of the monster. It is a sandstone cast, not to be distinguished in texture from the rock in which it was imbedded.

In the limestone rocks, near the tops of the hills, north of Athens, are found many fossil shells. Figures of two of them are given in Nos. 13 and 14, (page 2 of the wood cuts,) both bivalves, although many univalves are also intermixed with them. Another of them will be given in the appendix. In sinking wells on the high grounds, remote from any large stream of water, wood, trunks of trees and leaves are often discovered at the depth of forty or fifty feet, generally lying in or under a bed of blue clay or mud, having the peculiar effluvia common to recent marsh mud. The same catastrophe which buried these vegetable remains, probably inhumed the mastodons, whose teeth and bones have been found in the diluvial, or ancient alluvial earth, near Athens, on the Hockhocking; and also on Federal creek, a large tributary of the former stream.

Coal Deposit, on Leading Creek and Carr's Run in Meigs' County, Ohio.

This deposit is found at an elevation of more than one hundred feet in the face of the river hills, three miles below the mouth of Leading creek, which is twelve or fourteen miles above the mouth of the Kenawha river. It continues along the face of the hills for eleven miles, gradually dipping to the S. E. until it disappears under the bed of the Ohio, two miles above Carr's run. Its extent N. and N. E. is unknown, but it is found for many miles in the country, the line of extension being in that direction, that is to the N. E. Coal, is also abundant on the Virginia, or left bank of the Ohio, opposite to this deposit, and is without doubt a continuation of the second bed found on the Kenawha, as the coal is very similar in appearance. At the upper and lower extremities of "the Carr's Run" coal bed, the deposit is thin, but gradually thickens in the middle to five or six feet. It is of this thickness at the mine owned by Mr. Pomeroy, near the center of the deposit. The bed has been followed at this place, and on Leading creek, two or three hundred yards into the hill, and in one place entirely through. The strata dip to the north, two or three feet in a hundred yards, requiring drains to free them from the water, when opened on the south side of the hill. Above the coal is a deposit of shale and ash colored marly clay, of eight or ten feet in thickness, which forms the roof of the mine—superincumbent on which, is a deposit of stratified sandstone rock, rather coarse grained, of nearly one hundred feet in thickness. The shale abounds in fine fossil plants, generally of the same species with those found at the Kenawha coal beds, to be described when speaking of that region. In mining the coal, gunpowder is extensively used; a small charge, throwing out large masses of the coal, which are readily broken into portable fragments, and taken to the mouth of the mine in a hand cart, where a rail road, conveys a loaded car to the river, dragging up an empty one at the same time. Large boats, lying at the shore, receive the coal from the cars, and convey it to the markets below. This coal, being of the black slaty structure, abounds in bituminous matter and burns very freely. Its specific gravity is 1.27. Twenty grains of the coarse powder, decompose one hundred grains of nitrate of potash, which will give to this coal, nearly sixty per cent of charcoal. It must therefore be valuable for the manufacture of coak, an article that must ultimately be brought into use in the numerous furnaces erected along the great iron deposit, a few miles south and west of this place. The accompanying *sketch* (see p. 31 of the wood cuts,) gives a correct view of "Pomeroy's coal beds," as seen from the road, a few rods above the works. The Ohio river, flows at the foot of the rail way, but is not seen in the drawing, being hid by the lofty sugar trees, which cluster along the bank. The country about the coal beds is very broken and hilly. I am indebted to Mr. Sala Bosworth, for this, and several other fine views of scenery, connected with the coal strata. It is a curious fact that the coal deposits, are very thin and rare, near the Ohio river, from the mouth of Pipe creek, fifteen miles below Wheeling to Carr's Run; at least none have been discovered. As the main coal dips under the Ohio, at both these places, the inference is, that the coal lies below the surface, and could be readily reached by a shaft, first ascertaining its distance from the surface, by the operation of boring.

Topography of the Valley of the Monongahela.

This valley occupies a space of about one hundred and eighty miles in length, by sixty or eighty in breadth, and lies between the Alleghany mountains and their collateral ranges on the east, and the Ohio river on the west. Its general direction is north and south, with a rapid declination from its southern borders to its northern extremity. The waters of the Monongahela pursue a course directly opposite to that of the Ohio, and some of its southern branches take their rise in the most elevated lands, west and north of the Appalachian range. The lofty peaks of the Cheat mountains rise to not less than twenty eight hundred feet above the level of the ocean, and more than two thousand above the waters of the Ohio, at the mouth of the Muskingum river. The head branches of the Monongahela, rise directly opposite to the outlet of the latter river, in a S. E. direction, at the distance of only about eighty geographical miles, and run a distance of not less than four hundred miles before reaching this spot; and although the descent in the beds of the streams is very great, yet it occupies about three days for the rains which fall on the head branches, and occasion rapid rises in its waters, to arrive in the Ohio, at Marietta; whereas, could they pursue a direct course like many of the streams below, they would reach this point in one third of that time. The sides of the valley are formed on the east by the Laurel and Cheat mountain ranges, and on the west by the high grounds, which lie between it and the Ohio river. Proceeding from the outlet of the valley southerly, the face of the country is composed of broad hills, of an elevation of four or five hundred feet, not placed in regular ranges, but scattered in disorder and apparently taking their direction from the water courses, as they fall into the main stream in the centre of the valley. The same formation of hills continues on the westerly side of the valley to the Ohio river, while on the easterly it soon reaches the spurs of the Laurel and Cheat mountains, and rises into lofty eminences with more regularity in their arrangement. The whole face of the country becomes elevated, and between the ranges of mountains we meet with long but narrow strips of level land, here called "Glades." They, in some respects, resemble the prairies of the west, being clothed with a scanty growth of forest trees, and shrubs, but are composed of a rich vegetable soil, well suited to the growth of grain, potatoes and grass, but are too much elevated and subject to late frosts for the successful cultivation of Indian corn. They were, without doubt, once the beds of lakes, and have uniformly a stream of water passing through their most depending portions. The table lands of Mexico, are here represented in miniature. The glades, were once portions of the original bed of the ocean, before the mountain ranges were lifted up, or "brought forth;" but at that period were elevated with the ranges, to their present height. Being surrounded by ridges, they, for a long time, remained covered with water, until by accumulations from the adjacent high lands, the water forced a passage through some less elevated spot, and draining off by degrees the accumulated flood, its bed was eventually laid bare, which bed now forms a modern glade. This broken, hilly, or mountainous country, is continued throughout the whole region, watered by the Monongahela and its tributary streams. Some tracts of level lands are found between the branches of the western fork of the river, as it approaches the waters of the Little and Great Kenawha. To a traveller, passing from the south eastern to the north western side of the Alleghany range, the change in the features and appearance of the country is very striking and interesting; and he would at once be led to conclude that they had been formed at different periods, and under different circumstances, or laws of deposition. On the eastern side, he sees well defined continuous ridges of mountains ranging parallel with each other, and composed of graywacke slate, magnesian limestone and other transition rocks, whose tops are sterile and barren, or clothed with naked rocks, from which, apparently the soil has ages since, been washed away, thus affording only a meagre support to the forest trees which cling to their sides. The streams of water are pure and limpid, and direct and rapid in their courses. Springs are abundant, copious and durable, affording a constant supply to the numerous rivulets which rise in the mountains and pour their tributary streams into the ocean. On the western side, the formations are altogether secondary, and abound in argillaceous and arenaceous materials. The streams are turbid and tortuous in their course, and as they descend into the valley, they become slow in their progress. The springs are few and small, and readily affected by the droughts of summer. The hills are irregular in their height, and in their arrangement, but they are generally very fertile, covered with a rich argillaceous soil to their very summits, and produce a luxuriant vegetation, such as is usually found only on rich alluvions; they are invariably clothed with forest trees of the most lofty height. This striking difference in the two opposite sides, is occasioned altogether by the different rock formations; so much does the character of a country depend upon the strata on which it is based. The different species of forest trees are arranged according to the elevation and quality of the soil. On the highest points of the Cheat mountains we find spruce, hemlock, white pine and birch, and also on the other ridges—as we descend, chesnut, chesnut oak, beech, poplar, dogwood, &c. appear; but the chesnut and chesnut oaks, are confined chiefly to the spurs and ridges that put out from the main ranges. In descending into the valleys, the various oaks, locusts, hickories, walnuts, sugar trees and buck eyes, clothe the sides of the hills. On the west fork of the Monongahela, the sycamore, papaw and spice wood, flourish at an elevation not common in other parts of the valley, which can arise only from the superior fertility of the soil.

Tygart's Valley.

One of the most interesting spots in the topography of this region, is Tygart's valley. It lies near the heads of "the Valley river," twenty miles S. E. from Clarksburgh; Beverly, the county seat of Randolph, lies in this valley. It is about seventy miles long, including that portion on Leading creek, and in breadth, it varies from one mile to three. Its boundaries are formed by ranges of the Cheat and Laurel mountains, rising to a great height, and affording many proofs that this valley has once been occupied by a lake. The accumulated waters, rising above the elevation of the Laurel range, have here forced a passage, and the Valley river, and Leading creek have formed for themselves channels in the bed of this ancient lake. This passage is about three miles in length, and from three to four hundred yards in breadth, cut down to the base of the mountains. The cliffs of rock on each side are of a stupendous height, not less than one thousand feet, affording a most grand and picturesque view, and may not inappropriately be called "the gates of the mountain." The fissure in the rocks, and strata on each side correspond; affording sufficient evidence of their former junction. The rock itself is of the coarsest conglomerate sandstone. Additional evidence of this valley having formerly been the bed of a lake, is also found in the fossils brought up in excavating the earth for wells. At the depth of twenty feet below the surface, pitch pine logs have been discovered, and what adds to the interest of the fact, is the circumstance that pines of this species, do not at present grow in this region. Petrifactions of shells are common in the rocks, and the lower portion of an os femoris, eight inches in diameter, was also found in the earth, detached, no other bones being discovered with it. Salt water is discovered in this valley, but not of sufficient strength to make the manufacture of salt profitable. The base of the valley rises very gradually as it advances towards its head in the Cheat mountains. The river meanders through its whole length with a calm and placid surface. Environed by ridges of lofty moun-

Topography of Tygart's Valley and the adjacent region.

Fig. 7.

South.

North.

Explanation.—a, North fork of S. B. of Potomac river.—*b*, Dry fork of Cheat.—*c*, Glady fork of Cheat.—*d*, Laurel fork of Cheat.—*e*, Cheat river.—*f*, Alleghany range.—*g*, Rich mountains.—*h*, Middle mountains.—*i*, Shaver's mountains.—*j*, Leading creek.—*k*, Roaring creek.—*l*, Middle fork of Valley river.—*m*, Buckanan creek.—*n*, *n*, Gate of the mountains.—*o*, Booth's ferry.—*p*, Mote's falls.—*q*, Vickwire's falls.—*r*, Heads of Gauly.—*s*, Heads of Elk.—*t*, Greenbrier river.

tains, and shut out from the strife and tumult of the surrounding world, this valley affords, at certain seasons of the year, all the natural and picturesque beauties of the fabled valley of Johnson. Here may be found nearly all the rare and curious shrubs, and flowering trees, indigenous to the western country. Enticed by the depth and warmth of the valley, protected from the cold winds by the lofty ridges which surround it, Flora here commences her earliest labors. Various species of honeysuckle entwine their branches around the trees in careless festoons; the broad petaled cornus florida, unfolds its white blossoms in strong contrast with those of the pink colored "Burning bush," or "Circis Ohioensis," that stands by its side; the rich fragrance of the crab apple, Chickasaw plum, and innumerable grape vines, all combine to shed over this spot the various beauties of the vale of Tempe, or of the favored recesses on the borders of Italy, to which the lofty peaks of the adjacent mountains bear no inapt resemblance. The slopes and sides of the mountains, bordering the valley, are clothed with the Liriodendron tulipifera, whose towering top and gigantic shaft, justly declare it the monarch of the hills, while its rich orange colored blossoms encircle its head with a flowery crown. The magnolia acuminata, with its graceful form and richly mottled branches, is often seen to rival the poplar in height and towering grandeur, while its more humble brothers, the tripelata and glauca, yet more beautiful in foliage and in flowers, stand modestly by its side. Still higher on the mountain sides are seen the hickory, the various species of oak, and many other trees too numerous to name with the prolific chesnut crowning the summits of the ridges. Numerous water falls and rapids, below "the gates of the mountain," give to this sequestered spot, by their noisy contrast, a still greater air of tranquility. In the distance of twenty five miles, the river has a descent of several hundred feet, as it passes down the broad plateaux of the mountains into the valleys below. Much of this descent is made up of rapids and ripples; but in other places it forms perpendicular cascades, and pitches over the sandstone rocks which generally form its bed. The first of any importance after the river leaves the valley, are called "Mote's falls." At one of these, the water has a fall of fourteen feet, at the other, of sixteen feet. The lower one is also, often called the "Well's falls," from the numerous cavities worn in the solid rock to the depth of eight or ten feet, and of the diameter of an ordinary well. These are formed by the unceasing whirl of hard pebbles, confined in a cavity and kept in perpetual motion by the current of falling waters. A few miles below, is a succession of rapids, called "Vickwire's falls," and at twenty five or thirty miles below "the valley," are seated the "Great falls," where the river has a perpendicular pitch of thirty feet, with several smaller cascades, making the whole falls, fifty one feet in the distance of a few rods. These numerous descents and rapids, afford an immense amount of water power, equal to any other in the United States, and which, at some future day, when this region shall be traversed with turnpikes, rail roads and canals, will be occupied with villages and manufactories, teeming with a dense population. The annexed sketch, (fig. 7 p. 55,) will assist the reader, to understand this interesting region, especially that of "Tygart's valley." It takes its name from one of its earliest settlers.

A branch of Cheat river, called Shaver's fork, runs for the distance of forty or fifty miles, in a narrow glade, on the top of one of the mountain ranges. On each side of this table land, are cliffs of a height, from one hundred to one hundred and fifty feet, composed of very coarse conglomerate. Near the river is a thin bed of coal, under the sand rock. The trees in this elevated spot, which is at least twenty eight hundred feet above the ocean, are spruce, hemlock, birch and laurel. All the head branches of Cheat, rise in these ranges; and taking a north easterly course, through a mountainous region of wilderness, covered with thickets of hemlock and dark evergreens, presents one of the most gloomy and desolate tracts to be found in all the ranges of the Alleghany. The water, from this elevated district has a descent of at least two thousand feet to the settlements of "Dankard's Bottom," a few miles above Kingwood, on the route from Clarksburgh to Cumberland. The waters of the Cheat river are noted for their dark, sombre color, supposed to arise from the hemlock roots and leaves over which the water passes. It takes it name from the numerous accidents that have happened to travellers in fording it. The current is, at all times rapid, even to near its junction with the Monongahela; added to which the round boulders and pebbles that fill its bed and are in constant motion, render it a very dangerous stream to horsemen, especially, when swollen with rains—many serious accidents have occurred on its waters. These pebbles are doubtless supplied from the decomposing conglomerate, that is found so abundantly in the mountains, and which not only fills its bed, but covers the sides of the mountains and the roads which traverse these ranges. A large proportion of the pebbles found lining the shores of the Ohio river, for hundreds of miles below, have been in ages past, brought by the currents from these mountains. No other rock, within my knowledge is constructed of materials that could possibly furnish these pebbles—many of them being of white and black quartz, greenstone, graywacke and sienite; the relics of former and older rocks, which were broken down and rolled by the waves of the ancient ocean, and in progress of time mingled with the sands on its shores and agglutinated into conglomerate. The Youghiogany river takes its rise in a mountainous region in the N. W. corner of Maryland, and passing through a broken and hilly country, unites its waters with the Monongahela, a few miles above Pittsburgh. The face of the country, does not differ materially from that on the latter river. In its course, it passes both the Chesnut and Laurel ridge of mountains. Some of the richest beds of bituminous coal are found on its head branches.

Geology of the Valley of the Monongahela.

The rock formations through the whole extent of this valley, are recent secondary, consisting generally of sandstone. In the composition of most of them, the argillaceous portion is very abundant, giving an argillaceous character to the soils which form the surface of the earth, and affording nourishment and support to the vast forests which every where clothe its hills. The prevailing color of the sandstone rocks is light grey, although often tinged with brown or yellow by the oxide of iron, which material is more or less abundant in nearly all the strata. The dark brown or red variety, known as the "old red sandstone," is seldom seen, except in some of the mountain ranges, and is strictly a transition rock. The structure is more close and fine grained, near the base of the hills, and coarser as it approaches their summits. In many places and in particular strata, silver colored mica, in small plates makes a conspicuous figure in its composition. In other strata, although rarely, the mica is yellow. It was originally deposited in horizontal beds, which are changed, more or less, from this position, by their proximity to ranges of high hills or mountains. The inclination of the strata, being evidently influenced by the rise of the country, as it approaches the Alleghany ranges, indicates that some force from below acting on the superincumbent strata, had raised the ranges of mountains to their present elevation, after the rocks which form them had been deposited in a horizontal and tranquil state. This general dip of all the strata to the north and west, or towards the Ohio river is probably one cause of a greater fertility of the soil, and a more luxuriant growth of trees and herbage on the north and west sides of hills than on the south and east, a greater quantity of moisture being directed to that side from the inclination of the strata.

From the tops to the bottoms of the hills, in many places, in often repeated series, the sandstone strata alternate with beds of coal, shale, recent clay slate, limestone, red, brown and white marl. For instance, two or three beds of coal are found in one hill, alternating with as many beds of sandstone, slate and shale. Where the earth has been penetrated to great depths, the same series is found to prevail below the surface, although the coal deposits are separated by a greater amount of intervening strata than those in the adjacent hills. On the western fork of the Monongahela, in the neighborhood of Clarksburgh, a singular arrangement is observed in the outlines of the hills. They have the appearance of being cut into broad terraces, often for several miles in extent, thus

Fig. 8.

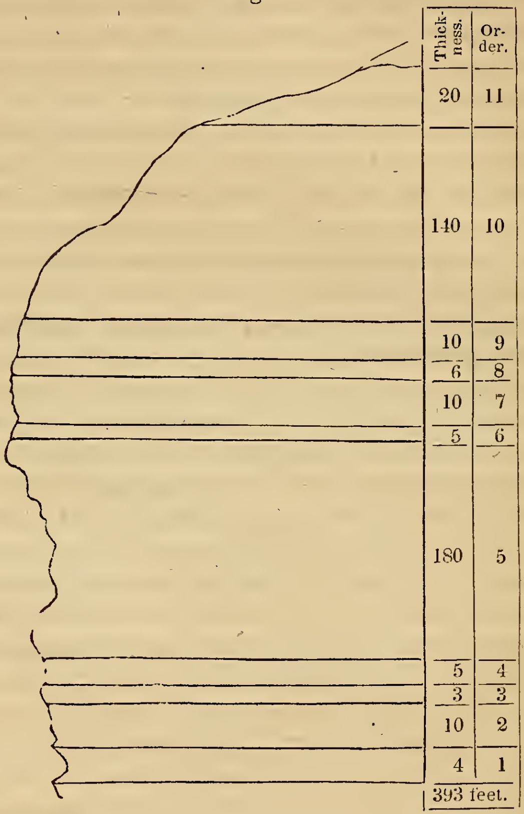
This appearance is produced by the immense beds of sandstone rock retaining their original position, while the softer deposits, have been decomposed and washed away. Slides or avalanches sometimes take place, in very wet seasons, which may also contribute to this remarkable appearance.

The following section of the rock strata, near Clarksburgh, was furnished by Judge Duncan, to whom I am indebted for much intesting and valuable matter, illustrating the topography and geology of the Monongahela region.

Section of Rock Strata, on the West Branch of the Monongahela River, near Clarksburgh.

Slight dip to N. W.—Order, ascending.

Fig. 9.



1. Limestone—full of cracks, and containing considerable iron. This stratum reposes on sandstone, in the bed of the creek.—4 feet.

2. Slate and slaty clay, dark colored and containing imbedded pebbles.—10 feet.

3. Bituminous coal, of a fine quality, rich in bitumen.—3 feet.

4. Bituminous shale, and slaty shale, with vegetable impressions.—5 feet.

5. Sandstone—fine grained—some part of the deposit lies in thin beds.—180 feet.

6. Slaty shale, dark colored and compact.—5 feet.

7. Bituminous coal—the main deposit—sometimes twelve feet in thickness. This coal is generally of the finest quality, and is found in exhaustless beds, near the Monongahela river, from this place to Pittsburgh. The specific gravity of this coal is 1.22; it contains a little over fifty per cent of charcoal. Twenty four grains, when heated in a crucible, decompose one hundred of nitrate of potash, and it leaves twenty two grains out of forty, in the state of coak.—10 feet.

8. Slate, bituminous shale, &c. containing in great numbers, small shells of the family of Pecten.—6 feet.

9. Limestone rock—breaking easily into fragments, and containing fossil shells of the genera Gryphea, Spirifer, Producta and Terebratula, similar to those found near Zanesville, and figured and described within the section of "Putnam hill" strata.—10 feet.

10. Sandstone—upper part coarse and compact—lower portion in thin beds.—140 feet.

11. Rich argillaceous soil, crowning the tops of the hills, and bearing a heavy growth of forest trees.—20 feet.

The thickness of the whole series of strata, is three hundred and ninety three feet, which is nearly the average height of the hills in this part of the valley; they continue of this elevation for the distance of many miles, to the vicinity of Brownsville.

As we ascend the Valley river, the deposits of sandstone rock become of much greater thickness, and the deposits of coal more thin, and of an inferior quality. At the head of this river we ascend the Cheat mountains, and passing over the Greenbrier range, descend into the valley of the Greenbrier river. The summits of these ridges, especially the peaks of the Cheat, are the most elevated lands of any west of the Alleghany range, as has been already observed when we were speaking of the numerous rivers that rise near this spot, and take many different directions, as may be seen by looking on the map of the coal region. The stratification of these mountains, is in the following order.

1. The summit stratum is a coarse conglomerate sandstone, composed of water worn silicious pebbles, of various colors, generally white, loosely cemented by an argillaceous, sandy material, of slight cohesive power, easily decomposing. Some of the lower beds are more compact, having a silicious cement, and of a quality suitable for millstones, to which use this species of rock has been largely applied and are known over the valley as the "Laurel hill stone."

It contains some fossil marine shells, chiefly Encrini, and other organic remains. This deposit is very extensive and is found on, or near the tops of the mountains, for nearly the whole length of the ranges.—300 feet.

2. A thin deposit of coal, with shale, about 3 feet.

3. Limestone, in a deposit of great extent, being found under the coarse conglomerate through the whole of this range of mountains. Its structure is not so compact as that of the limestone on the Shenandoah river, and generally of that S. E. of the mountains, but it is fragile, and broken into fragments of all sizes, as it lies in its bed. It contains fossil shells, and especially madrepores and corralines. Figure No. 25, (page 14 of the wood cuts,) is from this bed; No. 26, (Id.) is from the vicinity. In the County of Pocahontas, on the heads of Greenbrier and Gauly rivers, the limestone is very full of them, and as its cohesion is slight, it easily crumbles on exposure to the weather, and the madrepores are thus loosened, and falling out, remain on the surface in great numbers. They are generally replaced by silex. This bed is seventy five feet in thickness.

4. A deposit of slate or shale, containing impressions of ferns, and arundinaceous plants. It is only a few feet in thickness.

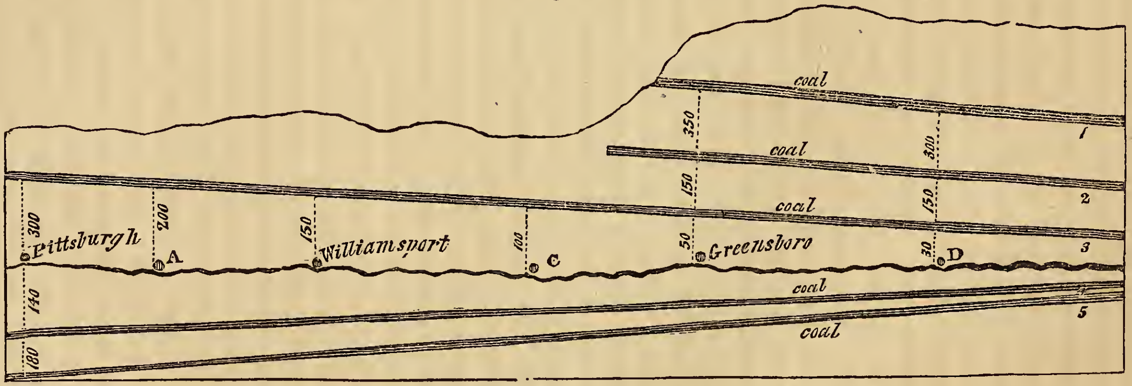
5. Sandstone, of various qualities, from coarse pebbly conglomerate to very fine argillaceous, in beds of various thickness, from a few feet to several hundred. Some beds contain mica. This formation continues to the Valley river at the foot of the mountains, fifteen hundred feet in thickness. In the heads of the valley, which is itself more than twelve hundred feet above tide water, we find limestone and coal. The coal is in thin beds, and of a poor quality. It may be received as a general law applicable to the coal in the valley of the Ohio, that the thicker the deposit, the better the quality of the coal. South of Clarksburgh, the coal diminishes rapidly, both in quantity and in excellence. In the vicinity of this town, and north of it, down the valley of the Monongahela, we find one of the richest and most abundant deposits of coal, in all the valley of the Ohio. The beds seem to have been deposited in a basin, the centre of which is now occupied by the bed of the river. I am led to this conclusion, from the fact of the thickest beds being found near the river, and from their becoming thinner as we travel east or west of this line. Two or three of the surface deposits, are from six to ten feet in thickness, and one near Clarksburgh, one hundred

feet below the surface, is eleven feet. These deposits continue to be very abundant at Pittsburgh, the outlet of the valley, and spread out laterally in a western direction, quite to the Ohio river, on whose banks they appear at Steubenville, Wellsburgh and Wheeling, and northerly, quite to the heads of the Susquehannah and Alleghany rivers.

Fifteen miles below Wheeling, the main surface deposit dips under the bed of the river, and is seen no more in any considerable quantity until it appears at Carr's run, nearly one hundred and fifty miles below. The same deposit extends into Ohio, and is found in great abundance about St. Clairsville, and the adjacent region. This deposit is at least two hundred miles in length and one hundred in breadth, affording one of the most extensive coal fields known in any part of the world. As we proceed northerly up the streams, which rise in the elevated lands on the southern borders of Lake Erie, the deposit of coal becomes thin and finally disappears on the surface, but may, without doubt, be found at considerable depths, as some of the deep beds discovered in boring for salt water, near Pittsburgh must extend a great distance northwestwardly. We are also strengthened in this opinion by the discharges of petroleum and carburetted hydrogen gas, which are known to issue from the earth in many places, not only near to, but immediately on the borders of the Lake. The following section and descriptions of the coal deposits in the valley of the Monongahela, and about Pittsburgh, furnished by the Rev. C. Elliot, who has traversed the coal measures, and examined them minutely, for several years, will more fully illustrate this interesting subject.

In the following illustration of the coal deposits, the curved line represents the river and the dark, right lines, the coal deposits, which are numbered in the order of their superposition. The figures above the curved lines denote the height of the several beds above the river at different places, while those below denote the depth of the two deposits underneath the river at Pittsburgh. The intervening spaces between the lines are occupied by the different rock strata of sandstone, limestone, slate shale, red and white marl, clays, &c., intermixed with nodules of iron ore: at Morgantown where the illustration commences, the hills near the river are from three hundred and fifty to four hundred and fifty feet in height. No less than four distinct deposits of coal are found from the tops of the hills to the bed of the river. No. 1. lies at an elevation of three hundred feet, *Sectional View of the Coal Deposits on the Monongahela River, between Morgantown and Pittsburgh.*

Fig. 10.



Explanation.—A, Elizabethtown.—C, Brownsville.—D, Morgantown.

N. B. The distance occupied in the above diagram, by the course of the river, is about one hundred miles, but in a direct line will not exceed sixty miles.

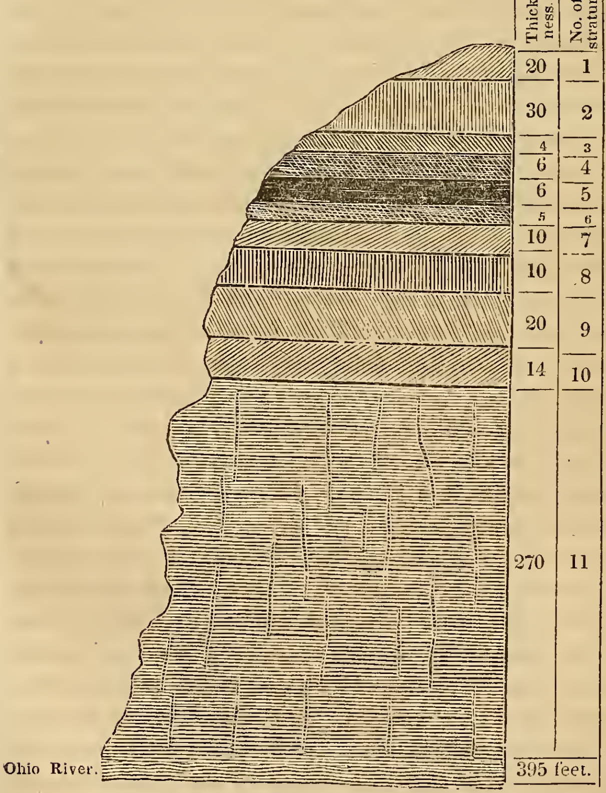
is six feet in thickness, and affords coal of a moderately good quality. No. 2. is one hundred and fifty feet above the river, is seven feet in thickness, and the coal of a very excellent quality. No. 3. lies near the base of the hills, and only thirty feet above the water in the river. The coal is of rather an inferior quality, and only three feet in thickness. No. 4. is a few feet beneath the surface at this spot, but four miles above, it appears in the bed of the river, and continues so to do for fifteen or twenty miles. It is six feet in thickness. This coal is of a very superior quality, highly bituminous and free from sulphur, or sulphuret of iron, and in repute for smith-work. There are in all the beds twenty two feet of coal. At the bottom of the best coal beds, is found a deposit of about eighteen or twenty inches of coal of great purity, and which for the manufacture of iron is fully equal to charcoal; burning without leaving any cinders, and very little ashes. The second place noted in the illustration is Greensboro', thirteen miles below Morgantown, and two miles from the Pennsylvania line. At this spot, there are three beds of coal above the surface of the river, and two below. No. 1. is at an elevation of about three hundred and fifty feet. No. 2. is seated at the height of one hundred and fifty feet, and is six feet in thickness. No. 3. is only about fifty feet above the base of the hills, and is eight feet in thickness. The coal in these beds is very compact, of a jet black when first taken from the bed, but after being exposed to the atmosphere, its surface becomes irised, with that beautiful play of colors which are exhibited by the peacock. This rich appearance of the surface is often noticed amongst our best coal, and is considered a mark of excellence. It burns with the greatest readiness and rapidity, exhibiting a bright brilliant flame. A cubic foot of it weighs from eighty to eighty five pounds. No. 4. is found at the depth of sixteen feet below the surface, and No. 5. at the depth of one hundred and forty seven feet: it was discovered in boring for salt water. This bed is stated to be thirty feet in thickness, but of a poor quality. The greater proportion of it is probably black bituminous shale, intermixed with thin layers of coal. The deposits at this place are not uniformly horizontal; some of them are undulating, and others interrupted by faults, or breaks. Below this spot, the beds No. 1. and 2. cannot be traced; but at some distance N. E. of Pittsburgh, they make their appearance in the hills of Connemaugh. It is probable, that, at a very remote period, before the rock strata possessed their present density, several of the upper deposits were removed by debacles and the gradual washing away of the surface, before the rivers were settled into their present channels. This is evidently the fact in many other places; beds of very considerable thickness, which now are found in place at the heads of streams, are washed away and gone before they reach the lower portion of the valley at their mouths. No. 3. does not pursue a level line, as is represented for convenience in the illustration, but is undulating, in its course; the estimates of its height above the river being only approximations below Greensboro'; but above that spot they are actual measurements. Below Brownsville, the deposit No. 3. dips nearly into the bed of the river, but rises again, regularly, as we travel down stream, until at Pittsburgh it is at an elevation of three hundred feet. Mr. Elliot says, "in tracing out No. 3, and following it up the Monongahela, as well as the Youghiogeny, I can be in no doubt, as to the correctness of the statements, as I have many times, while travelling over the country, traced it from hill to hill, up both these rivers. A person sailing up the river can easily perceive as he ascends, that the coal banks are becoming nearer the water's edge at every hill he passes, until at Greensboro' and Morgantown, they are within a short distance of the water: as you retire from the river and follow out the creeks, you find this stratum on their shelving banks, and sometimes forming the beds of the runs; and when you reach their heads it has sunk beneath the surface too far to be reached at all, except by shafts. Thus about Washington, Pennsylvania, there is but little coal to be found in the face of the hills. This stratum shows itself again west of Pittsburgh on the Steubenville road. It also appears north of the Alleghany river opposite to Pittsburgh, at an elevation fully equal to, if not greater than its height in "Coal hill." But the stratum north of Pittsburgh is not to be found on that side of the river any farther west, than about two miles north of Alleghany town, where the coal is somewhat inferior in quality, being stained with streaks of iron rust and it is rather brittle; yet it burns well, leaving few cinders, but it is not so durable as that found either north, east, or south. I doubt whether this stratum is the same with that which appears about Wheeling, Wellsburgh and Steubenville, as it probably runs out a few miles west of Pittsburgh, and farther down the river No. 4. makes its appearance. But of this I am uncertain, for I have not examined the country with sufficient accuracy. No. 3. can also be traced along the Pennsylvania canal, dipping nearer to the water as you ascend, until you find it at Blairsville only thirty feet above the surface. Beyond this point I cannot trace it. At Johnstown, a few miles above Blairsville, the stratum of coal is at an elevation of two or three hundred feet. Besides, the coal at Johnstown is only about four feet thick, and of a quality greatly inferior to that of Blairsville or Pittsburgh. Stratum No. 2. is certainly that which appears at Johnstown and Armagh on the Connemaugh. In these places the coal is brittle, and does not contain the same amount of bitumen which No. 3. does. No. 2, I think, makes its appearance at Smithfield, about twenty two miles east of Uniontown, Pa., where the coal is better than at Johnstown, but not equal to the coal at Brownsville, Uniontown or Pittsburgh. Deposit No. 2, there is every reason to believe makes its appearance in Cumberland, Maryland, as the coal is very similar, as nearly as I could judge from rather a hasty examination while travelling through that place. Deposit No. 1. I have been unable to find in any other place except near Morgantown and Somerset, Pa. There is no bed west of the mountains corresponding to this; for it is No. 3. alone that makes its appearance at so many points on the Monongahela and Youghiogeny rivers, and small streams, except near Morgantown and Greensboro'. But it must be recollected that the hills in these neighborhoods are prolongations, or spurs of the mountain ranges, which may account for its appearance in these places only. The stratum at Somerset, Pa., appears to be a continuation of No. 1. It is much more elevated than the bed of No. 2. at Smithfield or Johnstown. The coal also is peculiar. It is quite brittle and fissile; has but a small quantity of bitumen; is hard to ignite; produces a dull, feeble flame; will not burn at all in a grate, but only in a stove. As to the deposits No. 4 and 5, they are below the surface, but we have evident proofs of their existence, as they have been reached in boring for salt water at Pittsburgh, Greensboro', Connemaugh, and at various other places. "Their depth at Pittsburgh, as ascertained from a well just below that place, is as follows: No. 4. at one hundred and forty feet, and No. 5. at one hundred and eighty feet below the surface. A short distance from Clarksburgh, on Elk creek, No. 4. was reached at one hundred feet, and at that point is said to be eleven feet in thickness. As to the coal deposits on the Alleghany river above the Kiskiminitas, but few facts have been collected. At Franklin, and south of that place, coal is abundant. In Mercer and Butler counties, the beds are few, and the coal of a poor quality. It would be interesting to know whether stratum No. 3. is the same bed which appears at Beaver, Steubenville and Wheeling. It is more than probable it is so, as the general dip is towards the S. and S. W., and the coal very similar, yet I conjecture it is a lower stratum, perhaps No. 4."

The specific gravity of the coal from bed No. 3. at Morgantown and Brownsville, is 1.30. It contains nearly sixty per cent. of charcoal, twenty grains of the coarse powder decomposing 100 grains of nitre, showing it to be a superior coal for coaking.

Section of "Coal Hill" at Pittsburgh, (Pa.) at the mouth of the Monongahela River.

Order descending.—Slight dip to the S. or S. E.

No. 11.



1. Reddish brown argillaceous earth, intermixed with fragments of limestone; affording a strong soil for cultivation.—20 feet.

2. Sandstone; fine grained; ash colored; the upper portion of the deposit very argillaceous, like marl or ochre; becoming more arenaceous and solid as it descends; structure, slaty.—30 feet.

3. Dark brown, carbonaceous shale; slaty structure, with impressions of leaves of Arundinaceous, Neuropterous, and various other species of plants, detached and scattered through and between the layers. It decomposes into a brown clayey earth, when exposed to the influence of the atmosphere.—4 feet.

4. Dark colored, carbonaceous clay; plastic and not stratified in laminæ; very heavy and compact; reposing on the coal, and common to this deposit through all this region, being No. 3. of the "Illustration."—6 feet.

5. Bituminous coal; of a fine quality; burning with great freedom. This bed has been worked through the hill at this spot, the distance of half a mile, and has a moderate dip to the S. E. sufficient to drain the mine. It is found in all the adjacent hills at nearly the same elevation, and is the main deposit for supplying the city of Pittsburgh with all its numerous manufactures. Its specific gravity is 1.28. In deflagration with nitre, twenty four grains will decompose one hundred of nitrate of potash, which will give it about 50 per cent of charcoal; there being some variation in different parts of the bed.—6 feet.

6. Dark, slaty clay; splitting into thin laminæ near the top of the deposit and becoming thicker and more compact below. This bed contains fewer fossil plants than the one above the coal.—5 feet.

7. Sandstone; ash colored; in thin beds of from four to twelve inches in thickness.—10 feet.

8. Dark colored limestone, in beds of three or four feet in thickness; no fossil shells observed.—10 feet.

9. Sandstone; light colored and argillaceous, deposited in beds of from three to five feet in thickness. These sandstone deposits, all contain in greater or smaller numbers, casts and impressions of plants. A drawing of one, "calamites cannœformis," is given on figure No. 35 page 23 of the wood cuts, and on No. 65 p. 29, probably an Equisetum, furnished by R. Peter, M. D. to whom I am indebted for many valuable facts. In other places, broad flat leaves, in great profusion, are replaced by or changed into carbon. A fossil, fluviatile unio, was taken from the sandstone rock, about twenty miles up the Monongahela, where many impressions of coal plants are found in the slaty shale. In excavating the canal tunnel through "Grant's

hill," on the north side of the river, fossil Melania and Lymnea, both fresh water shells, were found in a bed of dark carbonaceous clay, under sandstone rock, at a level many feet below the coal bed. A fossil terrestrial Helix was found in the shale over the coal, changed to sulphuret of iron. Terebratulæ, and a small thin shell, probably a Pecten, both marine shells, are also found in the sandstone rock, affording incontestable proofs of the wonderful changes that have taken place in this valley, since the period of the first, or lowest coal deposits.—20 feet.

10. Limestone; light colored, hard and compact; very few fossil shells are found in the limestone rocks at this place, but at Waynesburgh and other places farther south they are more abundant.–14 feet.

11. Great sandstone deposit; fine grained and compact; contains but little mica; color light brown, changing to yellowish; argillaceous. It has many vertical seams from the eighth of an inch to several inches in thickness, filled with carbonate of lime, infiltrated from the limestone rocks above. Where blocks are obtained, solid and free from fissures, it makes a good building stone. This deposit extends to the bed of the river, and is two hundred and seventy feet in thickness. A little below, at the mouth of a small rivulet, several wells have been bored for salt water. At the depth of one hundred and thirty feet, after passing through alternations of blue and grey sandstone rock, white, red and blue marl slate, a bed of soft, red marly rock was struck, five feet in thickness, under which was found petroleum, and strong salt water. The bed of red marl reposes on a deposit of coal six feet in thickness. Forty feet below, or at one hundred and eighty feet from the surface, still passing through alternations of sandstone rocks and beds of marly slate, or shale, is a deposit of coal ten feet in thickness, being the two beds noticed in the "sectional view" or "illustration" of the Monongahela river coal deposits. At two hundred and fifteen feet from the surface there is found a tolerable supply of salt water. From all the wells large quantities of carburetted hydrogen gas were discharged, when first sunk, and although several years have since passed away, gas is yet freely afforded. The boring in some of the wells, has been pushed to the depth of more than six hundred feet, and coal found at four hundred and forty, four hundred and eighty, five hundred and eighty and six hundred and sixty two feet, the last only four inches in thickness, a proof of the vast depth of the coal measures in the Monongahela valley. Coal is abundant in Mercer county, sixty miles north

of Pittsburgh, but is of an inferior quality to the coal of this vicinity. Small traces of coal are also found near to Meadville, within a short distance of Lake Erie; it extends eastward to the Alleghany mountains, quite to the waters of the Susquehannah river, rocks apparently of the transition class, being its boundary in that direction. At the mouth of the Beaver, or Walhouding, the main coal deposit is found at fifty feet above the bed of the river, and two miles above Steubenville, it dips into the bed of the Ohio, where it is more than six feet in thickness and of a very superior quality. At Wheeling, the main coal bed is found at ninety feet above the river, from which point it dips S. W. until it disappears beneath the water at fifteen miles below, and is seen no more in *considerable* quantities until we reach Carr's run one hundred and fifty miles below in Meigs county, Ohio.

Topography of the Kiskiminitas and Connemaugh region.

The Kiskiminitas is a tributary stream of the Alleghany river; taking its rise in the ridges and valley of the Laurel and Chesnut ridges of mountains, and uniting with the Alleghany, at a point thirty miles above Pittsburgh. The Connemaugh is the continuation of the Kiskiminitas, above the month of the Loyalhanna, a large branch putting in from the south side, below the Chesnut ridge. In the valley, between the Alleghany and Laurel mountains, the Connemaugh divides into two large branches. The country through which these streams pass is hilly and broken, affording much fine farming lands in the vallies between. The hills are from two hundred to five hundred feet in height. The rock strata here departing from their usual, nearly horizontal position, are influenced in their direction by the outlines of the country and rise or dip in conformity with the ridges of mountains and hills, in some instances at an angle of nearly twenty degrees. This is the fact more especially at the salines on the Kiskiminitas, eighteen miles from the foot of Chesnut ridge; at this spot, the ridge is two miles broad and five hundred feet high, through which the river has cut a passage to the base of the hills—the river here pursues a N. W. course. Near the upper well at the foot of the ridge, a stratum of coal makes its appearance on the margin of the river, and one mile and a half below, the same bed is seen at an elevation of two hundred feet in the face of the cliffs; a few miles further down, it dips again into the bed of the river, the superincumbent and inferior rock strata pursuing a conformable direction. At the salines on the Kenawha river, there is a similar elevation of the rock strata but at a much smaller angle—the base line being about ten miles and the elevation three hundred feet—apparently designed by the creator to bring this precious deposit near to the surface, for the benefit and the use of man. The same rich deposits of coal are also found to accompany the saliferous rocks in both places, to supply fuel for the manufacture of salt. At the salines on the river Muskingum, the same arrangement is found to take place. Rock deposits at the depth of several hundred feet at one point on the river, are found on the surface at another place a number of miles above. But all the strata being of secondary origin and composed of arenaceous, argillaceous, or calcareous materials, the change produced on the surface is not apparent to common observers, and is detected only by close inspection, and the observation of those engaged in penetrating the earth in quest of salt water, who, operating at different points on the river, take notice in their downward passage, of some rock, remarkable either for its composition or extraordinary hardness, and noting its distance from the main salt rock, can trace its progress to the surface with great accuracy and certainty. The main muriatiferous deposit on the Kiskiminitas and Connemaugh, lies at the depth of from five hundred to seven hundred feet, according to the rise or the dip in the rock, corresponding in this respect to the strata on and near to the surface; although salt water is found in strata much nearer the surface, it is but slightly impregnated; the deeper wells have much stronger water. The strength varies at different wells, some requiring two hundred gallons to make fifty pounds of salt, while at others seventy five gallons afford this quantity, evidently depending on the abundance of the saline particles contained in the muriatiferous strata below, and the facility with which the water can reach those particles; and this depending on the compact, or porous quality of the rocks, through which the water percolates. The quantity made at both these places now amounts to about five hundred thousand bushels annually. The Pennsylvania canal, passing along up these streams, affords every facility for its transportation to market.

At the Connemaugh works, a few miles above, the hills are only about two hundred feet high, but they observe the same order in their stratification with those at Kiskiminitas, the strata corresponding to the curve assumed by the hills, and they evidently owe their elevation, to the same upward force from below, that raised the Alleghany, Laurel and Chesnut ridges of mountains to their present height. At the Connemaugh salines, only one bed of coal is found above the surface of the river, the other two seen at the works below, are yet probably beneath, owing to the lesser elevation of the hills at this spot. At Johnstown, four miles from the foot of the Alleghany mountain, the canal ceases, and its place is supplied by a rail road across this mountain range, over to the waters of the Juniata on the south side of the ridge. A narrow, but lofty spur of the mountain opposes the further progress of the road at this spot, to overcome which a passage has been made by *tunneling* through its rocky sides. The length of this tunnel is eight hundred and seventy seven feet. It is twenty four feet in width and twenty feet in height. The rocks, penetrated by the tunnel are all of the secondary class, composed of sandstone of various qualities; some containing a large proportion of mica, and others very compact, hard, and sparry, approaching the transition class, which is the prevailing rock in the Juniata hills on the south side. There are slate rocks of different textures, from loose slaty clay to compact; brown shale or clayey marl, quite hard when first removed from its bed, but decomposing and crumbling into earth after exposure to the air and rains. On the north side, is a thin stratum of coal from six to eight inches in thickness, extending south for two hundred feet. It lies on the floor of the tunnel, and rises five feet in that distance, when it runs out or is exhausted. "In the slate, are found numerous impressions of leaves; the trunks of large trees, and the scales of very large fishes, as broad as the thumb nail." This statement I have from Mr. Appleton, one of the contractors for excavating the tunnel. It is possible that the supposed fish impressions are made by the scaly bark of the palm tree. The trunks and branches of various species of this family, being found in all the western coal strata. The impression being in slate, is in favor of their being Ichthyolites. The greater part of the fossils found in this region are in bituminous slate or in deposits connected with the coal series. A fine collection of these interesting fossils was made by Mr. Appleton, for his friend, the Rev. C. Elliot, and carefully packed in a cask and forwarded for him; but by the carelessness and wanton neglect of the agent of a warehouse on the route, they were all destroyed and lost, so that when Mr. Elliot called for them in the spring, nothing could be found but the staves of the cask. He had kindly promised to share the collection with me; and from these ancient, rare, and authentic records of the revolutions of nature, I had anticipated the discovery of many interesting and valuable facts, that would have been useful in elucidating the geology of the valley: opportunities for examining the interior strata of our mountains, or of the rocks generally, in this country are so rare, that it will probably be a long time before so favorable a chance again occurs. The roof of the tunnel is two hundred feet below the top of the mountain, or spur, as it is called. The time occupied in performing this work was eighteen months; and eleven thousand pounds of gunpowder were expended in blasting the rocks.

Geology of the Kiskiminitas.

The rock strata of this region, like that of the Monongahela, consist of alternate beds of sandstone, limestone, slaty marl of different colors, and coal and shale, extending to the depth of many hundred feet. At the salines, twelve hundred feet of these deposits have been explored, seven hundred below the bed of the river, and five hundred above. The upper surface stratum of soil, where it is in a situation to admit of cultivation, produces good crops. The only ores found are those of iron, which is of the argillaceous species, and it is generally found in slaty marl or clay. The deposits of iron in the Laurel and Chesnut ridges, are usually at a greater elevation than the coal; in one place, at the foot of the ridge, a thick bed of coal reposes immediately on the iron ore deposit.

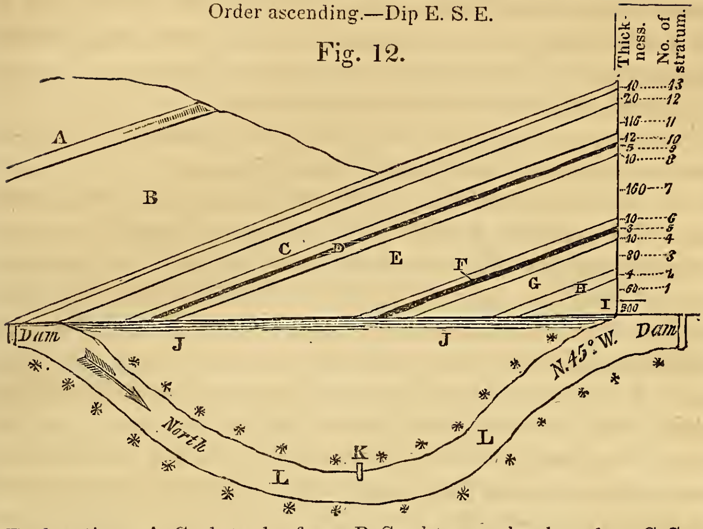
The salt wells at Kiskiminitas and Connemaugh, are singular in one respect; they afford no petroleum, but an abundant supply of carburetted hydrogen. When a well is first opened, the gas rushes up with such violence as to force the water, in a column or jet, thirty feet above the mouth of the well, returning at intervals, and continuing an hour or more at each period. The absence of petroleum seems to indicate some peculiar state of the coal beds in consequence of which they afford the gaseous and not the fluid products of vegetable decomposition, the difference consisting chiefly in the different proportions of the carbon and the hydrogen.

The following section of the rock strata at the salt works on the Kiskiminitas, five miles below Saltsburgh, will give a correct view of the geological structure. It was furnished by A. Boggs, Esq., who resided several years at this place and superintended the boring of several salt wells, and to whom I am indebted for much valuable information.

Section of Rock Strata at Kiskiminitas.

Order ascending.—Dip E. S. E.

Fig. 12.



Explanation.—A, Coal, twelve feet.—B, Sandstone rocks, slate, &c.—C. Sandstone rock.—D, Coal.—E. Sandstone rock.—F, Coal.—G, Sandstone rock.—H, Lime.—I, Sandstone rock.—J, J, Bed of the river. High cliffs near the water.—* Salt wells.—K, Large well.—L, L, Course of the river at the salines, north of west.

1. Hard argillaceous sandstone rock. This rock forms the bed of the river at this spot. A short distance above, in sinking a bed for a well, this rock was found at the depth of sixty feet below the surface, dipping to the E. S. E. or up the stream.—60 feet.

2. Carboniferous limestone rock, containing many fossil remains of marine shells and joints of the Encrini. In sinking the well noted above, this rock was found at fifty feet below the surface. A half mile below, this stratum is seen at an elevation of one hundred feet in the face of the river cliffs.—4 feet.

3. Sandstone rock, argillaceous and fine grained. The upper portion of the deposit more carbonaceous and grey—the lower part tinged with pale yellow and not so hard as the upper, both affording good materials for architectural purposes, and containing impressions and casts of fossil plants.—80 feet.

4. Dark carbonaceous slaty clay, under the coal.—10 feet.

5. Bituminous coal, black and compact—structure slaty, burning freely, and is used for fuel in the manufacture of salt. This deposit is a little over 3 feet.

6. Black bituminous shale, containing a vast many impressions of plants, and it is also said of Ichthyolites.—10 feet.

7. Sandstone in beds of various thickness and qualities; some coarse conglomerate, with imbedded pebbles, others grey or yellowish and fine grained, containing fossil trees and casts, with the bituminized leaves of various species of plants.—160 feet.

8. Dark carbonaceous slaty clay.—10 feet.

9. Coal deposit; black, hard and vitreous fracture—worked extensively for the manufacture of salt.—5 feet.

10. Dark bituminous slaty shale, resting on the coal and forming the roof of the bed. It is filled with the impressions of Neuroptera and Sphenoptera. These ancient families of plants, are very abundant in nearly all our coal deposits. Animal remains have been found in this deposit, a fossil Turtle, and several shells having been taken from it by Mr. Boggs.—12 feet.

11. Yellowish grey argillaceous sandstone rock, in thick beds containing fossil vegetable impressions.—116 feet.

12. Slaty sandstone rock, friable and loose texture.—20 feet.

13. Yellowish argillaceous soil, top of the hill intermixed with slaty fragments.—10 feet.

14. Bituminous coal. This bed of coal first makes its appearance at the margin of the river, one mile and a half above the location of this section, and crops out on the surface of a hill a short distance above. The angle of elevation is such, that were it continued, it would be at the height of two hundred feet above stratum No. 9 of the series. It is nearly twelve feet in thickness. This bed, with the superincumbent strata, must have been washed away and destroyed down to its present outcrop, at the period when the Kiskiminitas forced a passage through this opposing ridge. At the Connemaugh works, a few miles above, but one deposit of coal makes its appearance, and it is without doubt the second bed seen at the Kiskiminitas. Here it is only four feet in thickness and at an elevation of about sixty feet in some places, at others, near the margin, or under the bed of the river, rising or dipping with the surface of the hills—at this place, the hills are only about two hundred feet in height, which accounts for the lower bed not being seen here.

Salt was first manufactured at Connemaugh in the year 1814; at Kiskiminitas in 1821.

The following extracts from a very full and luminous report of a committee of the Senate of Pennsylvania, made by I. J. Packer, chairman, March 4, 1834, discloses many new and interesting facts, as to the extent and value of the bituminous coal measures, within that state.

"*The Bituminous Coal Fields of Pennsylvania.*"

"Nature, in the disposition of her bounties, seems to have bestowed upon Pennsylvania, more than a due proportion of the treasures of the mineral kingdom. Great and valuable as are her anthracite deposits, and rich and abundant as are her mines of iron ore and other minerals, her bituminous coal region is still more extensive and inexhaustible. The great secondary deposit, extending as is generally believed, from the Hudson to the Mississippi, and to the Rocky mountains, is in Pennsylvania limited by the Alleghany mountains, which appear to form the barrier, or dividing line between the anthracite and bituminous coal beds, or between the transition and secondary formations. The union or junction of these formations is plainly and distinctly marked in the end of the mountain, where the west branch of the Susquehanna breaks through it, above Bald Eagle, the latter resting against the former, and forming the basin in which the bituminous coal, in regular and successive strata, is deposited. This coal field is therefore confined to the west side of the Alleghany, and is supposed to extend to the centre of the mountain. In the S. E. corner of Somerset county, and in the western parts of Bedford and Huntingdon counties, it would appear to extend to the S. E. of what is there called the Alleghany, and occurs in great abundance on Wills' creek, Jennings' creek, &c. emptying into the Potomac. The chain of mountains called the Alleghany above Bedford, is very wide; and large mountains diverge from it, and although the mountain ranging through Somerset and dividing the waters of Youghiogany and Connemaugh, from those of the Potomac, may be the largest, it seems most probable that Wells or Evetts, or possibly Sideling mountain, there forms the boundary of these deposits, and upon examination will be found to exhibit a continuation of the same characteristic features between the secondary and transition formation."

The bituminous coal beds, vary from one foot to twelve feet in thickness, but rarely exceed six feet. They lie in nearly horizontal strata, with about sufficient dip to free the mines from water—some hills contain *three and four* beds, with alternate layers of earth and slate, and rest between a firm and smooth slate roof and floor. *Faults* or *troubles* are seldom met with, and in this they differ from the anthracite, and go far to confirm the opinion, that all this vast extent of secondary rocks, was once the bottom of the great lake or sea, and that it suffered little if any interruption from the gradual discharge of its waters, through its distant and widely extended boundary. It has evidently been drained by the Mississippi, the St. Lawrence, the Susquehanna and the Hudson; and it is a curious and interesting fact, that near the northern termination of this coal field, in Potter county, the head waters of the Alleghany, the Susquehanna, and the Genessee rivers, flowing into the gulf of Mexico, the Chesapeake and the St. Lawrence, take their rise in an area or space of about five miles.

With the exception of the Susquehanna and its tributaries, and Wills' creek, emptying into the Potomac, all the streams rising in the coal field, west of the mountains, flow into the lakes, or into the Ohio river, and consequently the ground falls off or recedes in the same direction, and becomes too low, as is generally supposed, to contain the coal measures. Its northern termination or boundary may be traced from the head waters of the Towanda creek, in Bradford county, thence across the high lands or dividing waters of Tioga, Potter, McKean, Warren, Venango, &c. to the Ohio state line. The Tioga river and its tributaries penetrate the coal field in the vicinity of Blossburgh and Wellsborough in Tioga county. A recent and interesting mineralogical report, upon this region, has been made by R. C. Taylor, a practical engineer and geologist, for the Blossburgh rail road company, in which it is satisfactorily shown that the coal runs out as the streams decline to the north. "There would need," says the report, "a total height of mountains of five thousand, one hundred and twenty feet, at the state line between New York and Pennsylvania, to contain the coal measures, whereas the hills, there, are probably below six hundred feet in altitude. This calculation is entered into with a view of showing the futility of the expectation, not uncommonly expressed, of tracing these coal fields in a northerly direction beyond the limits at which they are at present discoverable."—"This field being bounded on the south by the Alleghany mountain, extending into the state of Virginia, and westward; coal may be said to be present, to a greater or lesser extent, in all the western counties, with the exception of Erie, in which it has not been discovered. The counties of Bradford, Lycoming, Tioga, Potter, McKean, Warren, Crawford, Bedford, Huntingdon and Centre, lie partly in and partly out of the coal field. The counties of Alleghany, Armstrong, Beaver, Butler, Cambria, Clearfield, Fayette, Greene, Indiana, Jefferson, Mercer, Somerset, Venango, Washington and Westmoreland, are wholly within its range, and embrace together an area of *twenty one thousand* square miles, or *thirteen millions four hundred and forty thousand acres.*" Coal has been used for fuel and manufacturing purposes, west of the mountains, from the earliest settlement of the country. It is mined, to a greater or less extent, in all the above counties, at the rate of one cent and two cents per bushel, and is thus brought within the means of all, and literally to every man's door—abounding throughout all this vast extent of territory, and fitted and used for almost every purpose requiring heat, it is impossible to form any thing like a correct estimate of the quantity consumed yearly, and sent to market. That its great abundance and cheapness have given birth to the vast and widely extended manufacturing establishments of the west, there can be no doubt. Without coal they could not exist. It constitutes the life spring of western Pennsylvania, and the pedestal of our great manufacturing emporium. Pittsburgh and its environs contain ninety steam engines for the various manufactures of iron, steel, glass, cotton, salt, brass, white lead, flour, oil, leather, &c. &c. These engines consume two millions sixty five thousand three hundred and six bushels a year. The city of Pittsburgh and its suburbs, Alleghany town, Birmingham, &c. contain a population of thirty thousand souls. "The coal consumed for every purpose, in and about Pittsburgh, is estimated at seven millions six hundred and sixty five thousand bushels, or two hundred and fifty five thousand and five hundred tons—at four cents per bushel, the price now paid in Pittsburgh, it would amount to three hundred and six thousand five hundred and twelve dollars."—"The coal consumed in the manufacture of salt, in the western counties is very great. There are on the Alleghany, Kiskiminitas, Connemaugh, Crooked creek, Mahoning, Saw mill run, Brush creek, Sewickly, Youghiogany and Monongahela, about ninety salt manufacturing establishments and many others about going into operation. These establishments produce yearly about one million bushels of salt and consume five millions of bushels of coal."—"The coaking process is now understood, and our bituminous coal is quite as susceptible of this operation, and produces as good coak, as that of Great Britain. It is now used to a considerable extent by our iron manufacturers in Centre county and elsewhere."

These facts, elucidating the immense mineral wealth of the "valley of the Ohio," open to the imagination a long vista of power and greatness, which the utmost stretch of the imagination is hardly able to equal.

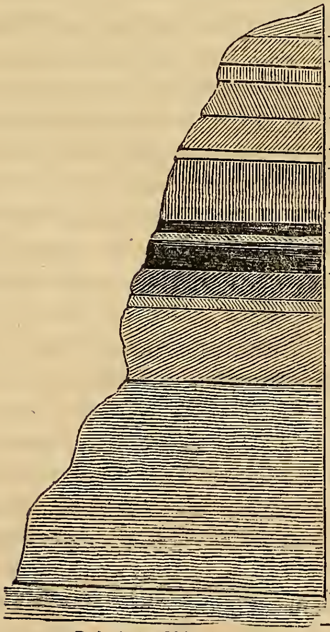
Coal deposit at Wheeling, Virginia.

The hills in this vicinity are about two hundred and fifty feet in height, varying from that, down to one hundred and fifty. The topography of this contiguous portion of Virginia, is much like that of the Monongahela valley. The hills abound in coal, very similar in its character to that of Pittsburgh. In some of the beds it is beautifully iridescent, vying in splendor with some of the richest anthracites. Vast quantities are annually sent from this neighborhood to the towns below the coal deposits on the Ohio river.

Section of the Wheeling Coal Strata.

Order, descending.—Dip 1° S. W.

Fig. 13.



No. of stratum.	Thickness.
1	10
2	12
3	6
4	14
5	12
6	2
7	24
8	2
9	1
10	7
11	8
12	1 1-2
13	25
14	60
	182 feet.

Bed of the Ohio river.

1. Yellowish clay loam on the top of the hill; growth of oak, beech and hickory; soil rather poor and thin, formed chiefly of the decomposed argillaceous sandstone rock beneath.—10 feet.

2. Argillaceous, slaty, sandstone rock; easily decomposing.—12 feet.

3. Greenish colored, siliceous rock, breaking into parallelograms or cubes, from one to four inches in thickness. Its composition is much like the common honestone and answers for the same purposes.—6 feet.

4. Yellowish, argillaceous deposit, interspersed with nodules of limestone.—14.

5. Fine grained, argillaceous sandstone, in thin strata, with fine plates of mica, in horizontal seams; color, dark brown or grey. It makes good grindstones: lower part of the bed carbonaceous, resting on coal.—12 feet.

6. Coal deposit; slaty and poor; bed not worked.—2 feet.

7. Limestone rock; thick deposit of nearly twenty four feet, in distinct beds, deposited at different periods and with different chemical affinities. The upper part of the bed five feet in thickness, is a dark carbonaceous rock, lying under the coal. The succeeding bed is of a light dove color, fine grained, and contains much argillaceous matter combined with the calcareous. Thin, fine, ash colored veins pass through it in all directions, but generally horizontally; on exposure to frosts and rain it decomposes into a fine rich marl. This stratum is six feet in thickness. The next five feet is ash colored; more compact; and when burnt makes a strong lime mortar; it contains some faint indications of fossil shells. The bottom stratum is eight feet in thickness—a dark, compact, carbonaceous rock. It is considerably charged with iron—the surface being covered with rust or brown oxide, when exposed to the air; reposing on the coal bed below.—24 feet.

8. Bituminous coal; slaty structure; fracture glistening; does not burn freely. In mining, or digging out the coal from the deposit below, this bed is left for a roof to the mine.—2 feet.

9. Dark, carbonaceous, slate clay, filled with the impressions of various species of calamites, and the thick leaves of some aquatic plant, like the Nelumbium luteum. In the operation of mining, this bed is removed with the coal, being too fragile and tender, falling upon the workmen.—1 foot.

10. Main coal deposit; varying from six to seven feet in thickness; structure compact and highly bituminous; between the laminæ the remains of the vegetable structure, usually called fossil or mineral charcoal, are seen in considerable abundance; it is simply the fibre of the vegetable skeleton, and may be seen in many, probably in most varieties of coal, provided they are split fortunately or

skilfully in the direction of the natural layers. This bed furnishes coal for the town of Wheeling and its numerous manufactures; and stretching along the face of the river hill for fourteen or fifteen miles below, it gradually dips under the bed of the river. It is dug in vast quantities, passed immediately down rail ways or slides from the mouth of the mine, into large flat bottomed boats, carrying from three to five thousand bushels, and sold at various places on the river below. The price, when delivered in the boats, is only three cents per bushel. The hills have been pierced in many places, for several hundred yards. The roof is usually supported by pillars of coal, four or five feet square, at intervals of six or eight feet, according to the strength of the roof. If the roof is very fragile, planks and puncheons are used for support, especially about the mouth of the mine, where the weather has access to the rock. In some parts of the deposit, considerable quantities of the brown sulphuret of iron, or "copperas stone," are found: large quantities of copperas are made at Wheeling from the products of this bed. Fossil wood is found in this deposit; a fragment of a branch, or root, nearly three inches in diameter and eighteen inches in length, is now in my collection. It contains a large share of iron and some silicious matter. The surface is striated longitudinally. To what species of tree it belonged it is difficult to determine. From the quality of the coal and the thickness of the deposit, there is every reason to conclude it is a continuation of bed No. 3, found at Morgantown and Pittsburgh. Four miles west of Wheeling, in Ohio, the same stratum of coal appears by the side of the "national road," as it leaves Indian Wheeling creek, to ascend the hills. The coal was brought to light in grading the road, while digging away the earth that had slipped down from the sides of the hill and covered the deposit. It is more than six feet in thickness, at an elevation somewhat greater than that on the east side of the river. The coal is remarkably fine, and extensively worked for transportation down the river. When the water is high, boats ascend to the beds and load there; at other times, they load in the mouth of the creek. It has been worked for several hundred feet under the hill, and is one of the most valuable in this vicinity. The rock strata, here, have a dip of about one degree S. W., and this bed sinks beneath the river, near "Pipe creek," fourteen miles below. Coal is abundant in the hills of Belmont and Jefferson counties, but whether from the same deposit has not been ascertained.

The specific gravity of a specimen of the Wheeling coal in my possession is 1.23. Twenty grains of this coal decomposed one hundred grains of nitrate of potash, which will give it about sixty per cent of charcoal, and make it a valuable coal for coaking.—6 feet.

11. Dark blue, carbonaceous, slaty clay, of nearly the same quality as the bed above the main coal. It contains many fossil plants, impressed between the laminæ.—8 feet.

12. Limestone rock; sparry and compact; dark colored; free from organic remains; makes a strong cement for mortar.—15 inches.

13. Sandstone rock; silicious; rather coarse grained, and contains many fine plates of silvery mica in its composition. The cement appears to be lime. This deposit contains casts of fossil plants; a very perfect portion of the extremity of a calamites cannœformis, was found in this rock, a drawing of which is given in figure No. 36, page 8 of the wood cuts.—25 feet.

14. A thick deposit of slaty clay, in alternating beds of different colors, of red shale and ash colored marl, containing, no doubt, many vegetable impressions, as the rock reposing on this deposit is very similar to that described at the "*Grotto of plants,*" below Marietta. This bed extends to the surface of the water in the Ohio river where it is at low stages.—60 feet.

In boring for salt water a short distance above, at the depth of three hundred feet, a bed of coal was passed, eight feet in thickness; the usual group of carboniferous rocks being passed in reaching it. The section of the Wheeling coal strata was taken with great accuracy and care, by a very intelligent friend residing at that place; specimens from all the different rocks being forwarded at the same time.

Topography of the Valley of the Little Kenawha.

This stream is about one hundred miles in length, and takes its rise near the most elevated portion of the mountain ranges; its head branches drinking in the same showers that supply the Gauly, Elk, Cheat and Greenbrier rivers. Towards the heads of the stream, there are tracts of table or flat lands, affording scites for extensive settlements, well suited to the growth of grass and small grains. About eighty miles from the mouth, are falls or cascades of considerable elevation, where the river descends from the more elevated table lands, or mountain districts, into the region at their feet; affording many fine seats for mills. The whole course of the stream is rapid and pretty direct; in time of flood rushing with great violence into the Ohio river, across which stream it often throws its waters with such force as to cast drift wood on the opposite shore; and when laden with ice it has been fatal to boats, as was the fact a few winters since, when it crushed and destroyed a steam boat, which lay moored on the shore of the river. There is a marked difference in the rapidity of the current, in the streams putting in on the north and south sides of the Ohio: on the south the streams are more sudden in their rise, and rapid in their course, keeping their mouths free from sand bars, and affording deep water for a considerable distance up; on the north side, the streams rise less rapidly, and rush with less violence to their outlet. Their mouths are often obstructed by sand bars; the current, not being sufficiently powerful to overcome the resistance of the Ohio, and to force the sand and debris which collect at their outlets into that majestic and noble stream. Directly at the foot of the mountains, below the principal falls in the Little Kenawha, salt springs are found, denoting that the saliferous deposit is approaching the surface from under the mountain ranges. This is an interesting fact; and the course of the salt rocks can be traced along the base of the Alleghany range, from the Salines on the Big Kenawha to those of the Connemaugh, east of Pittsburgh, a distance of not less than three hundred miles, and probably still further on to its eastern limit, at the Onondaga works in New York. The vale of the Little Kenawha is hilly and broken, containing however much rich land in the valleys, and along the water courses. The hills are clothed with a most luxuriant growth of large trees; among which are seen large forests of yellow pine, and chesnut. White pine is found on the north sides of moist rich hills and wet valleys, a considerable distance from the mouth, but not of that towering height which is found on the Alleghany river, being rather small, as if recently colonized amongst the hills. On the waters of Hews's river, a large eastern branch of the Little Kenawha, the magnolia acuminata seems to have found a congenial soil and climate. It here vies in magnitude with the most lofty tenants of the hills, rising to more than a hundred feet in height. A single tree has been known to afford six cuts, three feet in diameter, and sixteen feet in length, without encroaching on the branches. It is so abundant and so large, as to be often cut down, with other forest trees, especially the towering poplar, and taken to the saw-mills for the manufacture of boards. The magnolia tripetala, or "Jesuit's tree," as it is here called, is found in the sheltered hollows, but is much smaller, seldom exceeding forty or fifty feet in height and a foot in diameter. On the southern and western head branches, the holly is very abundant, cheering the lonely winter with its ever green leaves and bright scarlet berries. Many of the hills and ridges, as they approach the mountains, are covered with extensive forests of chesnut, having in early days, afforded a grateful repast to the wild tenants of the wood. The bear, the deer and the wild turkey, associated in countless numbers at the season of their ripening, and fattened on the nuts which covered the ground. In more recent days, the inhabitants drove their hogs from considerable distances to feed upon the "mast" in these mountain districts; and at this time, in favorable seasons, a man, with a rake, can gather a number of bushels in a day. Thirty years since, about the period of my becoming an inhabitant in the valley of the Ohio, the wild turkey was found in astonishing abundance; many hundreds being, on favorite feeding grounds, often seen in one flock. They were so little alarmed at the sight of their natural enemy, man, that they often entered his fields close to the door of his cabin, and partook of the corn he had thrown out to his hogs. They also regaled themselves from that standing in the fields. At this period, a "backwoodsman" had established himself on or near to, the eastern branches of Hews's river, between Marietta and Clarksburgh, Va. He had erected a cabin and opened a small "clearing." In the autumn, he enclosed a lot near his door, in which to feed and fatten his hogs. A flock of about thirty turkies, attracted by the corn, came regularly, morning and evening, to partake with the hogs, which, being themselves in those early days, well fed, when every kind of food was abundant, made no opposition to their visits. The owner of the cabin, standing in the door, however, every day shot one or two of the unsuspecting birds: seeing no person near, they were but little alarmed by the report of the rifle, nor were they frightened away by the sight of their dead companions. In this manner, without leaving the door of his hut, the owner, at the time of my information, had killed *twenty seven* out of the thirty turkies. The same man had also, at that time, in his possession a tame female deer, which he had taken when very young and brought up with the children. They soon become remarkably docile, and much attached to their home. This deer, in the summer and autumn, made daily visits to the surrounding forests for food. At her return, she often brought with her, as a companion, one or more of the wild deer of the wood, which at that day, were far more numerous than the domestic cattle of the present period. On approaching the cabin, the wild animal generally made a halt, to examine the strange appearances around him. Taking advantage of this stop, the hunter, who had notice of their approach from some of his children, discharged his rifle, and seldom failed in securing his new visiter. Without leaving his cabin, he had killed fourteen deer in one summer and autumn, by the innocent aid of his little pet.

Geology of the Valley of the Little Kenawha.

In that portion of this region, below the spurs of the mountains, much of the surface soil is red or brown, being formed from the decomposing beds of clayey marl, or shale, which are here found of great thickness and extent. Sandstone is the prevailing rock. Limestone is rarely found, except in the beds of some of the streams. Huge, mural cliffs are common on some of the branches. Coal is found in many places, but in much thinner beds than in the valley of the Monongahela, about Clarksburgh. Lead ore is said to have been found in detached masses on Hews's river, but no regular veins have as yet been discovered.

Petroleum.

About six miles from the mouth of Hews's river, there is an extensive spring of petroleum. It is found along the margin of the stream in a bed of gravel, for the distance of four or five miles. At low stages of the water, it is seen floating on the surface of the stream. The manner of collecting it is by digging trenches along the margin of the creek, down to this bed of gravel, a few feet below the surface. By opening and loosening with a spade or sharpened stick, the gravel and sand, which is only about a foot thick, the oil rises to the surface of the water, with which the trench is partially filled. It is then skimmed off with a tin cup or some other suitable vessel, and put up in barrels for sale, or domestic uses. In this way from fifty to a hundred barrels are collected in a season; and much more could be gathered if the demand required. In the adjacent hills is a thin bed of coal; and coal is found in abundance near this place; but the source whence this petroleum flows must be deep in the earth, and the material which furnishes it, vast in dimensions.

The process is one of nature's hidden mysteries, carried on in her secret laboratory, far beyond the reach, and inaccessible to the prying curiosity of man. On the ridge of land which divides the waters of the western branches of the Monongahela from those of Hews's river, is found a bed of the foliated sulphate of lime or selenite, splitting into broad transparent plates, of several inches in breadth and length. I have a specimen in my cabinet, but no accurate description of the deposit or of the accompanying rocks. Salt is manufactured below the falls; but the water is much weaker than that of the salines in the Big Kenawha. Carburetted hydrogen is discharged in great abundance near these salt wells, and may be considered a sure indication of the presence of salt water below.

Topography of the Valley of the Kenawha River.

The Kenawha is, on many accounts, one of the most interesting tributaries of the Ohio. In its course from the Iron mountains of North Carolina, where the headmost branches extend, to its mouth, its waters pass over a *primitive, a transition and a secondary* region; which cannot be said of any other river, running north and west from the mountains. It crosses three degrees of latitude, and traverses, in its windings, a distance of not less than three hundred miles, passing across numerous mountain-ranges, and rushing through all the rocky barriers that oppose its progress. Its numerous tributaries rise in the most mountainous portions of western Virginia. Its floods are sudden and rapid, and when at full banks, it pours out a volume of water that vies in strength and grandeur with the Ohio itself; throwing its current across the latter stream, and often stranding heavy laden boats on the opposite shore. For seventy miles above its mouth, the average width is, about three hundred yards; and with the improvements made in its channel, it admits of steam boat navigation to that distance; after the junction of the Gauly, one hundred miles from the mouth, it takes the name of the "New River," which was given to it by some of its first discoverers from North Carolina. From the mouth of the Green river, to the mouth of Gauly, a distance of about seventy miles, it has a descent of more than seven hundred feet. This portion of its course is called "the cliffs of New river." From thence to its head, there is a continual succession of falls and rapids, with but few interruptions. Its primitive tributaries, are Coal river, Pocatalico, Elk, Gauly and Greenbrier; the three latter, large and powerful streams, but too full of rapids to admit of good navigation; yet affording an almost unlimited number of fine scites for mills. From the mouth of the Kenawha to the mouth of Elk, the face of the country is broken into hills and ridges, of an elevation of one hundred and fifty to two hundred and fifty feet. From that point to the upper extremity of "the salines" a distance of fifteen miles, they rise to five hundred feet above the bed of the river, and a few miles back in the dividing ridges, they are from one hundred to one hundred and fifty feet higher. From the latter position to "the falls" a distance of twenty five miles, the hills have attained an altitude of from six hundred to seven hundred and fifty feet, and above the junction of Gauly, one hundred miles from the mouth they rise into mountainous ranges, pursuing a N. E. and S. W. direction, at an elevation of twelve hundred feet. The bottom lands on Kenawha, are from a quarter to half a mile in width on each side of the river; varying in this respect, in accordance with the bends in the stream. The valley cut by the current of the Kenawha in the rock strata through which it passes, will average a mile in breadth, and from two to seven hundred feet in depth; the corresponding rocks and beds of coal in the hills, on each side of the valley, affording incontestible proof that they were once united, and at some remote period anterior to the existence of the present river, formed continuous beds; at seventy miles above the mouth, this valley becomes much narrower, with a proportionate diminution in the width of the alluvial deposits. The bottom lands are very fertile, producing abundant crops of grain and grass; where the native growth has been undisturbed, the alluvions are covered with the heaviest forest trees, common to the wood lands of the west. Below the mouth of the Elk, the hills are composed of sandstone, with extensive deposits of *red marly clay*, which has given an argillaceous character to the soil of this region not seen in the hills above; embracing a tract from the mouth of the Guyandott, to the mouth of the Cole river, and thence to the waters of the Little Kenawha, and over to the northern and western side of the valley of the Monongahela. Through all this region, the soil is, in many places, deeply tinged with brown or red, probably from the oxide of iron contained in the clay-marl, or red shale. The hill tops and ridges are clothed with yellow pine, which seems to delight in a soil of this composition; and the sides of the hills with the various species of oak, poplar, hickory, walnut, gum and sassafras; while the richer hill sides and narrow bottoms afford a soil congenial to the beech and the sugar tree. A considerable portion of this tract will admit of cultivation and already embraces many fine settlements, especially that portion lying on the west side of the Kenawha, between the mouth of Guyandott and Cole creek, where are some extensive tracts of flat lands. From the mouth of Elk to the mouth of Gauly, the country on both sides of the river, with the exception of the narrow alluvions on the water courses, is too mountainous and broken to admit of tillage, but will ultimately afford grazing farms. The streams of water rising in these lofty sandstone hills, are limpid and pure; free from the turbidness of the waters rising in the clayey hills below the mouth of Elk. It is soft and free from carbonate of lime, so common to most of the streams nearer the Ohio river, where limestone is more abundant.

Climate of the Valley.

As we proceed up the valley of the Kenawha, in the spring season, after the unfolding of the buds has commenced, we percieve a striking and marked difference in the progress of vegetation; although the course of the river is southerly, the change is much more rapid than that of latitude could produce. The foliage of the forest trees at Charleston, is at least a week more forward, than that on the Ohio river near the outlet, although the distance in a direct line, is little more than forty miles north. This great difference cannot be altogether accounted for from latitude; the peculiar situation of the valley, environed by lofty ranges of hills, excluding the cool breeze of the north and admitting the warm rays of the sun, reflected from the sides of the hills, heating and rarefying the air, which is confined to the valley by the walls of hills, no doubt assists the progress of vegetation, fully as much as the additional southern latitude. I visited the valley between the ninteenth and the twenty fifth of April. The change, at every turn in the river, bringing some new and beautiful varieties of foliage into view, was like that of magic; at Charleston, the quince and coral honeysuckle were in bloom, and peas in the open ground not only in blossom, but with pods two inches in length; on the garden gooseberry was fruit as large as a pea. I had left Marietta, at the mouth of the Muskingum, only twenty four hours before, where the foliage was just beginning to unfold; while here, it was fully expanded on nearly all the forest trees in the valley, and on many of those on the hills; as we travelled up the stream in the vicinity of "Great falls" the change was still more striking. The twenty second of April at the foot of the falls, the Fringe tree, or Chionanthus, had not only expanded, but had commenced shedding its numerous delicate, bell shaped flowers. This tasteful and rare shrub, or rather small tree, is found only in the vicinity of "the falls" and near the mouth of Gauly river, for the distance of six or eight miles. This wild and romantic spot, environed by hills of seven or eight hundred feet in height; warmed by the radiated heat of the surrounding rocks protected by them from the cold air and wintry winds; and kept humid by the rising spray of the falls and rapids that fill this portion of the river, affords a shelter and a soil, congenial not only to the Fringe tree, but to many other rare and beautiful plants. The holly, is scattered over all the adjacent hills, from Charleston to the mouth of Gauly; at which spot, I noticed a Holly tree of nearly forty feet in height, with a trunk eighteen inches in diameter; an evergreen woodbine, and a new species of climbing fumitory, with bell shaped blossoms, are found in this favored spot; on the Gauly, six miles from its mouth, the magnolia tripetala was ready to expand its flowers. The *acuminata and mychrophylla* are also found, within a few rods of each other. Rhodendron maximum and *Kalmia* latifolia cover the tops of the cliffs and rocky hill sides. The dark hemlock is seen along the borders of the water courses, while the cone shaped cedar, and lively green yellow pine, are hanging carelessly amongst the towering rocks that threaten ruin to the valley beneath. In the narrow ravines at the foot of the cliffs on "New river," ten miles above the falls, the vegetation is still more rare and curious. This spot, inaccessible to the haunts of domestic animals, and almost so to the foot of the deer, Flora seems to have chosen as one of her favorite retreats. It abounds in flowers and shrubs found in no other place in this region; among numerous other rare plants, are seen the cane and gama grass. The warmth of this narrow ravine, seated at the base of cliffs, several hundred feet in height, and kept humid by the spray of the flowing water, has given a richness and vividness to the deep green of the foliage, not seen at any other spot.

The botanist could not ask a more productive field from which to fill his herbarium with rare and precious specimens. The place itself is one of intense interest. The mountains here are at least twelve hundred feet high, and the naked perpendicular cliffs of sandstone rock that confine the river to its narrow and rocky bed, are more than eight hundred feet in height. At the foot of one of the most elevated, called "Marshall's pillar," in honor of the venerable judge Marshall, who visited the spot and measured its altitude, the river suddenly becomes calm; while all above and below is a sheet of foam, as it struggles and roars amongst the huge fragments of rocks that obstruct its course. The river, at this place, is more than one hundred feet in depth, a line of that length not reaching its bottom. An immense fall, of many hundred feet, was once seen at this spot, whose ceaseless torrent continued, for ages, to excavate this profound abyss. The river is confined to less than one hundred yards, and by cutting and wearing away the rock strata, from the mouth of Gauly in a manner similar to the Niagara river, it has worn itself a passage, more than one thousand feet in depth, and fifty or sixty miles in length, through the solid sandstone rocks. At the period of its first efforts to work itself a channel through the mountain ranges, the rocks were, without doubt, much more soft than at present, and easily gave way to the vast collection of waters, whose volume and rapidity nothing could resist. At the foot of the cliffs on New river, a grey, argillaceous, marly deposit, forms a substratum of many feet in thickness, on which the sandstone rock reposes. The feeble resistance of this stratum would hasten the fall of the superincumbent beds, in a manner similar to that of the clay slate, under the lime rocks of Niagara. For a view of this interesting spot, taken from the cliff above Marshall's pillar, see page 32 of the wood cuts. The face of the country in the vicinity of the cliffs of New river rises into broad, lofty ranges of mountains, whose tops afford good farming lands, and are cultivated in many places. The state turnpike passes along, for many miles, near the river, and at occasional turns, we see the foam of the cataracts and hear the roar of the noisy waters. The traveller, in his progress towards Lewisburgh, in the valley of the Greenbrier river, passes numerous parallel ranges of mountains, trending from the S. W. to the N. E. They bear the names of the "Big and Little Sewell," and the "Meadow mountains." From the tops of the Big Sewell, he has a view of the valley of the Greenbrier, stretched at his feet, dotted with cultivated spots, and broken into masses of low hills; while beyond, the towering Alleghany lifts its rocky ranges marking the southern boundary of the secondary deposits. The elevated peaks of the Sewell and Meadow mountains are three thousand feet high, and are said to be visible from "the peaks of Otter," across the Alleghany range, a proof of their great altitude. They are composed of different varieties of slate, slaty clay, and fine and coarse grained sandstone rocks. On the top of this range, is found a fine grained saccharine, white sandstone, in some parts of the bed nearly crystalline. The general structure, color, and form of the grain, are similar to that of the *great white sandstone rock*, underlying all the valley of the Ohio, varying in depth from four hundred and fifty to nine hundred feet; and in which the principal reservoirs of salt water are uniformly found. At Massillon, on the northern verge of the valley, in Stark county, Ohio, in the table lands on the head of the Muskingum, a similar rock comes to the surface. It is very white, free from mica, and almost crystalline, similar to this on the Sewell mountains, and there are strong reasons for concluding it to be the northern termination of the white sandstone rock deposit; a few miles below Zanesville, the deep seated rock strata rise rapidly to the surface, although not so abruptly as in the mountain ranges. A few miles above Zanesville, the muriatiferous rocks are reached at one hundred and fifty feet, and a white sandstone rock comes to the surface similar in quality to the upper white sandstone rock, found in boring salt wells near McConnelsville, which affords an additional fact in support of this opinion. This rock is not found on the surface at any intermediate spot across the whole width of the valley, but lies at a great depth beneath the superincumbent strata, which occupy the space between these two points. The white sandstone rock reposes upon a thick deposit of " red sandstone," and this is the only place west of the Alleghany range, where it has made its appearance on the surface, at least, no similar fact has come to my knowledge. It may be called a fine conglomerate, made up of irregularly shaped grains, from the size of a mustard seed to that of a pea, cemented by quartz; color, dark brown or chocolate, and is very similar to specimens in my collection from the valley of the Connecticut.* In the salt wells on the Muskingum, a rock of the same character is found at great depths, intermixing with the white sandstone rock. Its geological position is far below all our other surface rocks; but here we find it on the top of a mountain pushed up from beneath the superincumbent strata,

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* Most if not all the red sandstone in the valley of the Connecticut, is now admitted to be the new and not the old, although it was at first supposed to be the old.—*Ed.*

while the other rocks are found in order as you ascend or descend the sides of the mountain ridges, which, in these ranges, are very abrupt and narrow. In descending the Sewell mountain into the valley, we pass different colored clay slate, grey, yellowish and ash colored sandstone rocks to the base. Coal is also found in its proper place amidst the other strata in the sides of the mountain, which dip in proportion to the rapidity of the rise of the range. About ten miles south of the foot of the Sewell mountains, a very striking change is observed in the character of the surface strata. The sandstone rocks disappear and a dark *calcareous* deposit takes its place. The line of demarcation is so well defined that large fragments are sometimes seen, one part of which is limestone and the other part sandstone. The valley of the Greenbrier is from thirty to forty miles wide at its S. W. extremity, where it rests on the New river, narrowing gradually to a point, as the ranges of the Alleghany and the Greenbrier mountains approach each other at the heads of the Greenbrier river, a distance of one hundred miles. A thick deposit of calcareous rock covers the whole of this valley, reposing on sandstone, which appears at many places on the sides and tops of hills, into which the valley is broken, in abrupt cliffs, evidently showing the more recent formation of the limestone stratum, over and amongst the sandstone deposits. The whole valley abounds in extensive caverns, cut out of the limestone, from the dissolution and wearing away of the rock, by the agency of water, all the caves having streams running in some part of them, or bearing evident marks of the course of former currents. Some of these caverns abound in saltpetre earth, and contain fossil bones. The bones of the megalonyx, described by Mr. Jefferson, were found in a saltpetre cave in this valley. "Sink holes" are numerous, into which the surface water discharges itself and finds its way under ground to the river, or rises again in some other place below: as the whole valley has a rapid descent to the S. W. which is proved by the numerous falls and rapids in the bed of the Greenbrier river. This stream is about one hundred yards wide at its mouth, and has a descent of more than six hundred feet, from its head at the base of the Cheat and Greenbrier mountains, to its junction with the New river; that point, being thirteen hundred and twenty five feet above the ocean, and its heads more than two thousand. The calcareous soil of the valley, combined with decomposed vegetable matter, is well suited to cultivation, and many fine wheat and grazing farms are scattered over its surface. The whole face of the valley is broken into hills, with here and there tolerably smooth intervals, denominated "levels," sufficiently large for considerable settlements. It is not uncommon for pretty large streams to sink and pass under ground for several miles and then rise again to the surface. Sinking creek, a branch of the Greenbrier, passes under a large hill, near the State turnpike. Before its descent, the water is pellucid; when it emerges, the current is turbid and muddy, changing its name to Muddy creek. In this manner, it is probable, many of the large caverns were formed. The situations of some of the most celebrated and interesting are marked on the map. They are very extensive, some not less than three or four miles in length. The limestone rocks in the upper end of the valley, are filled with madrepores and corallines; lower down, the imbedded remains of many species of small Pectens and radiated Encrini are most common. Coal is found on some of the branches of the river, but rarely in the center of the valley. A bed has been opened on Howard's creek on the south side of the river, near the foot of the Alleghany range, and also on the sides and spurs of the Sewell mountain; but ceases where the limestone rock prevails, or is buried deep beneath it in the sandstone, on which the calcareous deposit reposes. In this valley, are many celebrated mineral springs, deriving a large share of their sanitary qualities from the magnesian limestone, through which they pass; the compounds of this mineral being found, in greater or less quantities, in nearly all the medicinal waters of this region. The most celebrated of these are the white sulphur, the red sulphur, the blue sulphur and the salt sulphur; the places of each being marked on the map. The sweet and warm springs, lying south of the Alleghany mountain, are without the limit of my remarks. A number of these springs are but just rising into deserved celebrity.

White Sulphur Spring.

This spring is on Howard's creek, near the western base of the Alleghany mountains. It is the most celebrated of the springs, and at present has a larger number of visitors than any other. It takes its name from the white sediment, deposited along its margin, after parting with the sulphuretted hydrogen which held it in solution. This sediment, when subjected to heat, burns and emits the strong smell of sulphur. These waters are said to be more purgative than any other in Virginia. They are ueful in bilious obstructions, and in a variety of cutaneous diseases. The smell of sulphur is communicated to those who bathe in, and drink freely of the water; the effluvia changing the color of silver watches in their pockets. I procured a bottle of the water last August, carefully corked at the spring; but exposure to light and the agitation of the water, while on the road, expelled all the sulphuretted hydrogen. The quantity was too small to make any other than a *qualitative* analysis. The following is the result for which I am indebted to R. Peter, M. D., assistant Professor of Chemistry in the Transylvania Medical College, Lexington, Ky.

" Experiments 1 and 2. Added litmus and turmeric infusions; no change; consequently, there was no sensible quantity of free acid, or free alkali, present in the water.

" 3. Add solution of acetate of lead; copious white precipitate, acquiring, by standing, a slight buff tinge. If any quantity of sulphuretted hydrogen had been present, it would have been indicated by a *black* precipitate; the slight buff tinge was owing to a trace of it. The white precipitate may have been produced by sulphuric, muriatic, or carbonic acid.

" 4. Added solution of nitrate of silver; copious curdy white precipitate, which was not dissolved by nitric acid, indicating the presence of *muriates.*

" 5. Solution of muriate of barytes, produced copious white precipitate not dissolved by nitric acid; indicating the presence of *sulphates.*

" 6. Lime water; slight turbidness; very little carbonic acid present.

" 7. Oxalate of ammonia produced copious white precipitate, indicating the presence of some salt of lime.

" 8. Carbonate of ammonia, do. do. Same inference.

" 9. To the filtered liquid of the last experiment, I added phosphate of soda, which produced a copious white precipitate, indicating the presence of *magnesia*—the carbonate of ammonia having previously precipitated all the lime.

" 10. Added nitric acid and starch to the water; no change of color; no sensible quantity of iodine present.

" 11, 12. Added succinate of ammonia.

" 13, 14. Infusion of galls—prussiate of potash, sulpho-cyanate of potassium—severally, } no change; no sensible quantity of oxide of iron present.

"15. Added chloride of platinum; no precipitate; presence of potash not indicated.

"The result of the examination is, that the water contains a *notable* quantity of *muriates* and *sulphates* of *soda, lime* and *magnesia;* in what proportion, for reasons already given, I am unable to say. It contains very little carbonic acid, still less sulphuretted hydrogen, and no perceptible amount of iodine or iron. If it is desired to know the proportion and the amounts of the ingredients, ten or twelve pounds of the water should be boiled down in a clean smooth vessel, and the saline residuum carefully saved for *qualitative* analysis."

Red Sulphur Spring.—This spring is situated on Indian creek, in the western extremity of the valley, on the south side of the river. It receives its name from the color of the sediment deposited by its waters, which is a deep red. It is probably an oxide of iron. The taste of the water indicates sulphur, but not so decidedly as the white sulphur waters. The *Salt Sulphur* spring, is in the same neighborbood, and takes it name from muriate of soda, being strongly tasted in its water. The *Sweet Sulphur* is close by, and is considered valuable in pulmonary complaints, having a sensible effect on the pulse, reducing the frequency by several beats in a minute. The *Blue Sulphur,* is seated on Muddy creek, on the north side of the Greenbrier river, and near the western extremity of the valley, not far from the foot of the Sewell mountain. It is rising fast into notice. The water contains iron and magnesia, in considerable quantities, and is a valuable tonic and deobstruent; curing many female complaints and diseases from debility, and want of tone generally. It is owned by a company in Charleston, Va. who are making many improvements for the comfort of the invalid, and that of visitors generally. I do not know that its waters have been accurately analyzed unless it was done in the course of the last season.

A search has been made for salt water, on the Greenbrier river, twelve miles above Lewisburgh, and a well bored to the depth of four hundred feet. An immense discharge of sulphuretted gas issued from the opening, and continued for a number of days. Very little salt water was obtained, and that of a weak quality; indicating that the main muriatiferous deposits, lie north and west of the Sewell and Gauly mountains, near the base of the ranges. Another attempt for salt water, was made on Lick creek, near the New river, and about fifteen miles west of the Blue Sulphur springs. At the depth of two hundred feet, a strong sulphur water was struck, which rose copiously to the surface, and is in taste and sanative qualities, similar to the waters of the white sulphur spring; showing an extensive range of the materials used in the elaboration of the water of the numerous mineral fountains, found in this region. The water of all these springs is cold; that of white sulphur, being 63° of Farenheit. With occasional interruptions near the New river, the limestone deposit continues on to the heads of the Holstein and Clinch rivers, and down these streams into Tennessee. Salt water is found in abundance on the Holstein.

On the south east side of the Alleghany range, in a transition formation, are seated the celebrated thermal springs. A few miles west, the same range is called the Peter mountain. Where the road crosses this mountain from Montgomery court house to Pack's ferry on the New river, the top of the mountain exhibits many marks of the action of heat on its rocks. The surface stratum is a chocolate colored, quartzose rock, tinged with iron, in irregular broken masses; beneath this, lies a bed of coarse sandstone, the surface in many places vitrified, as if subjected to fire. The same internal heat, which vitrified these rocks, and raised these mountain ranges to their present height, may also still supply caloric for the warm and hot springs of Jackson river. After the extreme southerly branches of the New river leave the Iron mountains and the primitive rocks of North Carolina, the river pursues a S. Easterly direction, amidst the transition ranges, crossing and breaking through several high ridges in its course, and it is filled with numerous rapids and water falls, until it receives the assistance of the Greenbrier river from the east. Aided by these additional waters, it finally forces a passage across the Sewell and the Gauly ranges, leaving "the perpetual cliffs of New river," as lasting memorials of the strength and power of these accumulated waters, in their primeval days. The Greenbrier valley was evidently once the scite of a lake, and might have discharged a part of its waters through the gap, at present occupied by Second and Dunlap's creek, until a deeper channel was cut in the track now pursued by the New river.

On the top of the Peter mountain, about sixteen miles south of the Red Sulphur spring, is a lake of fresh water, half a mile wide and three miles long. It is of unknown depth and discharges its superfluous water down the almost perpendicular side of the mountain, in a never failing stream, of sufficient volume to work the machinery of any kind of mill. It abounds with fish, and being placed on the top of one of the highest mountains of the Alleghany, at least eighteen hundred feet above the bed of the river, it is difficult to account for its formation, and for its abundant and continual supply of water.

Topography of the Country on Gauly River.

This stream is about one hundred miles in length, and at its mouth more than one hundred yards in breadth. It takes its rise in the spurs and sides of the Laurel, Greenbrier and Gauly ranges of mountains. The country through which it passes is mountainous and broken into lofty precipitous hills of sandstone rock. "The cliffs of Gauly," are second only in height and grandeur, to those of the "New river," extending for many miles, on each side of the stream, at an elevation of five or six hundred feet. The river itself is precipitated over falls and rapids, for a considerable part of the course, and its bed is so filled with huge blocks of sandstone rock, as to prevent any navigation on its waters. In these secluded spots, nearly inaccessible to the foot of man, a few remnants of the Beaver tribe still find a safe retreat; and in the adjacent mountains, here and there, a solitary Elk sustains a precarious existence; the last remnant of a numerous race, that a few years since animated the forests with their numbers. Towards the heads, the mountain ranges spread out into table lands, here known by the name of "glades." They lie in long narrow patches, at an elevation of seven or eight hundred feet above the water courses, with an elevated ridge, or border, along their sides, through which, at intervals, are found gaps for the water to pass off, down immense precipices to the streams below. They are destitute of heavy timber. The more elevated and drier portions, produce fine crops of barley, oats and potatoes, while the more wet afford good meadows, and the swampy places, produce cranberries in abundance. The soil is black, based on yellow clay; indicating that these glades were, at some remote period, the beds of lakes or ponds. Near the head waters of the South easterly branches, extensive deposits of limestone rock, take the place of the sandstone; and continue over to the headwaters of the Greenbrier. Lead ore has been found in several places on the borders of this calcareous rock. Coal is very abundant, for sixty or seventy miles above its mouth, and is found at great elevations in the mountains.

Geology of the Gauly River.

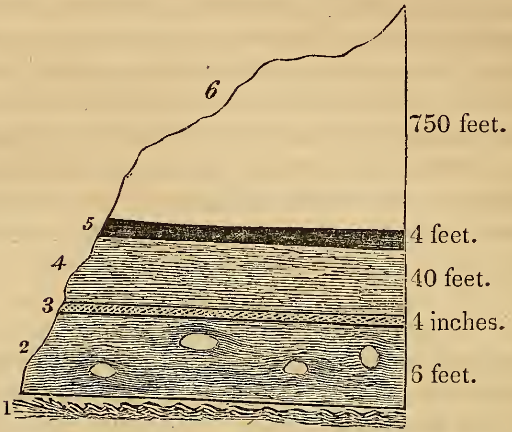
Sandstone is the prevailing rock in all the region of the Gauly hills and mountains, until we approach the heads of some of the southerly branches. Limestone in any considerable quantity, is not seen from the mouth of the Elk, below Charleston, until it appears in the valley of the Greenbrier river, and continues over to the heads of the Gauly. The lime used for building in all this space of one hundred miles in length, by thirty or forty in breadth, is either transported in wagons from the Greenbrier river, or in boats upon the Kenawha from the mouth of Elk river.

Fossil Columnar Madrepore.

Six miles above the mouth of the Gauly, on a branch called Bell creek, I found a very interesting locality of huge masses of fossil madrepore, in a bed of bituminous shale. They are found in detached blocks, generally circular, and flattened on the sides, resembling millstones in form. They are from one foot to three feet in diameter, across the disc of the mass, and a foot in thickness. The shale or slate bed in which they lie, is about six feet thick; and composed of thin layers, which bend and accommodate themselves to the shape of the block. Reposing on the slate, is a thin bed of limestone conglomerate, composed of small irregular fragments, about four inches thick; above the conglomerate lies a deposit of thin sandstone slate, of a dark carbonaceous color, and forty feet in thickness. A bed of bituminous coal, four feet in thickness, reposes on the slaty sandstone. Above this, slate and sandstone rock, for eight hundred feet, compose the side of the mountain. The whole deposit, from the slate to the bed of the river, is highly charged with petroleum, and of a dark, nearly black color. It is quite extensive being found under the base of the adjoining hills, and runs more than a mile distant. The surface of the bowlders is waterworn, and has all the marks of attrition. They are composed of cone shaped pieces, from one inch to three inches in length, and from half an inch to an inch in diameter; terminating in a point. The surface is striated circularly, and the striæ pass one into the other, like a nest of thimbles. Figure No. 27, (p. 14 of the wood cuts,) will give a correct impression of the form of this fossil.

Section of the Madrepore deposit, on Gauly River.

Fig. 14.



1. Bed of the run; composed of slate, very dark colored.
2. Slaty shale; containing the rolled blocks of madrepore.—6 feet.
3. Limestone conglomerate, very dark colored.—4 inches.
4. Slaty sandstone, in thin layers, dark colored and fragile.–40 feet.
5. Bituminous coal.—4 feet.
6. Sandstone rocks and slate, with other coal beds from the side of the mountain, to an elevation of eight hundred feet.

No other fossil was discovered, associated with the madrepores. Small quantities of the red oxide of iron, are found in the bed of the run; some of which contain impressions of encrini. Fragments of lydian stone, or silicious slate, are found detached from that vast deposit, mentioned in another place. From the simplicity of the structure, so much resembling a crystallization, and the great depth of the superincumbent strata, under which they lie buried, these fossils must have been among the first created animal productions of that ancient ocean, which once rolled its tides over tracts now occupied by ranges of lofty mountains.

Geology of the Falls of the Kenawha, below the mouth of Gauly River.

The rocks at these celebrated falls, are composed of a compact, sandstone conglomerate, containing imbedded fragments of water-worn white quartz, from the size of a pea to that of a nutmeg. They are not very uniformly diffused, but appear in groups with scattered grains in the intervals. The whole stone contains considerable silicious cement, which has given it durability, to resist the unceasing action of the water for so many centuries. It is stratified in beds of from one foot to three or four feet in thickness, and forms the channel of the river for a number of miles up both the New and the Gauly rivers, filling the former stream with falls and cascades, some of which are nearly equal to the "great falls" in elevation. The rock which forms the great falls, takes an oblique course across the river, and, not many ages since, formed a continuous cataract of twenty two feet fall, from shore to shore. At this period and since the first settlements on the river, the waters have cut a channel on the left bank, which is gradually enlarging and extending up stream. Through this channel, at low stages, the whole waters find a passage and leave the rocks composing the falls naked; resembling, and in fact constituting an island; but in floods, the whole falls present a sheet of falling water. The river at the foot of the falls is four hundred yards wide, and when swollen by floods, the whole body of water, rushes over the rocks with tremendous force. The situation is very favorable for the purposes of manufactures, and several saw mills and a grist mill are erected along the course of the falls. The building of flat bottomed boats, for the transportation of salt, is carried on here very extensively. The annexed view, (see p. 33 of the wood cuts,) will assist the reader in understanding the situation of the falls, and the adjacent scenery.

The surface of the rock is full of inequalities and holes worn by the attrition of pebbles, kept in a continual whirl by the water. Near the margin of the falls, where the rock projects over the water below, holes have been cut entirely through it, and a number of small trees and shrubs have taken root in the crevices, and give still more the appearance of an island. At low water, the surface of the rock is exposed, for two or three hundred feet in breadth. The face of the perpendicular sandstone, over which the water pitches, is not smooth and uniform, but is broken into numerous deep recesses, giving it a zigzag appearance, and showing the structure of the rock to be rhombic, breaking up into square blocks, having a vertical as well as a horizontal line of cleavage. This, I have observed, is the general character of many of the compact sandstone rocks throughout the coal measures. It is one of the most noted spots for fish on the western waters. The river here abounds with the choicest species, while calm water, at the foot of the rocks, affords them a resting place, after passing the rapids below, and the fisherman seated on the projecting cliffs exerises his skill, and is soon rewarded with a most abundant supply of Perch, Pike, a species of Salmon, &c., of a magnitude unknown to the eastern rivers. It was a favorite haunt of the aborigines, numerous relics of their utensils being found at this spot. In moving the loose stones, at the head of the great rapids, to lay the foundation of a "wing dam" five or six Indians axes were found lodged in the crevices of the rocks. They are of French manufacture, long and narrow, with light poles, weighing from two to three pounds, and are in good preservation. Near the top of the rock, in the falls, I observed a bed of three feet in thickness of a peculiar stratification. It is composed of thin layers of sandstone, containing considerable mica, lying at an angle of 15°, while the strata above and below are horizontal—thus.

Fig. 15.

The bed crosses the river, and is seen at the base of the hills by the road side. I also observed the same singular deposit several miles up the Gauly river, at two or three places, gradually rising as it advanced up stream, but preserving the same inclination. The hills, at the falls, are about seven hundred and fifty feet in height, and are composed of sandstone rock of different textures, slaty clay, and deposits of coal. Their tops are crowned with a coarse grained sandstone, with feeble cohesive power, which, as it crumbles away, assumes various fantastic shapes. The relics of one near the falls, have assumed the form of a chimney, by which name it is called. Forest trees clothe the hills to their summits, and at various points on the river, afford many most beautiful and romantic views.

Geology of the Valley of the Kenawha below the Falls.

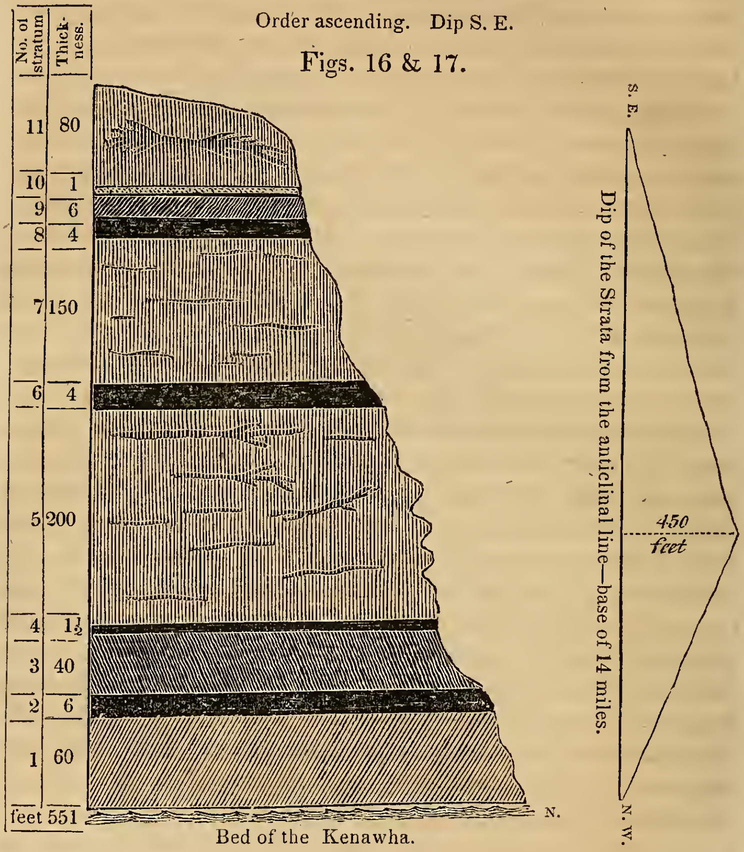
This beautiful valley presents many attractions, not only to the practical geologist, but also to the mere amateur of fine scenery. The hills assume so many different shapes in their outlines and manner of grouping as to form endless varieties of scenery for the painter or the poet. The mural cliffs and bold faces of the hill sides, afford every facility for the study of their formation, and the order of stratification in the upper, or surface strata; while the numerous borings for salt wells, disclose the hidden order of the strata below; and, although from these, we learn nothing of their fossil contents, we ascertain their composition, whether argillaceous, calcareous, or silicious.

From the mouth of the Elk river, upwards to the falls of Kenawha, a distance of forty miles, the rock strata, above the bed of the river, are composed altogether of silicious and argillaceous materials. Below the mouth of Elk, limestone is occasionally seen in the beds of creeks quite to the Ohio river. The rocks in the bed of the Kenawha, excavated a few years since, in improving the navigation, are sandstone, containing a proportion of mica and numerous impressions of fossil plants. This is especially the fact at the "Red house shoals." Coal deposits are less abundant in this tract of country—there being only one or two of any considerable thickness—the general dip of the rock strata, towards the N. W., as they approach the Ohio, sinking those found in the lower parts of the hills, above Elk, beneath the bed of the river. From the mouth of Elk, up the Kenawha, to the center of the salt wells, a distance of nine miles by the river, the rock strata rise at the rate of nearly fifty feet to the mile. Above this point to the upper extremity of the salines, the strata dip to the S. E. at an angle somewhat less, or about thirty three feet to the mile, for the distance of six or eight miles; above which point they gradually rise again to the Gauly mountains—the anticlinal line of the strata at the great salt deposit being near to the center of the works; the general bearing of the strata being E. and W. and the dip from the line, N. W. and S. E. at an angle of three or four degrees. This arrangement of the strata is of incalculable benefit to the manufacture of salt, as it brings the mineral riches of the muriatiferous deposits nearer to the surface and at the same time raises one or two additional beds of coal, without which the expense of manufacturing would be greatly enhanced.

The following section will assist in understanding the order of stratification at the Kenawha salines.—Order ascending.

N. B. Beneath all the coal beds there is a stratum of Black bituminous slate, or slaty clay, from two to four feet thick, although not included in this section.

Section of the Coal Strata at the Salines, on Kenawha River.



1. Sandstone rock, compact and hard, grey colored, with considerable mica in its composition. This stratum extends to the bed of the river.—60 feet.

2. Coal, six feet in thickness, being not only the deepest bed, but also affording the best coal of any in the series. It is extensively worked, for several hundred feet under the hills. A few miles below, this bed dips under the bottom of the river, and also a few miles above, it disappears in the same manner, but again appears in the base of the hills between that spot and "the falls." The specific gravity of the coal from this bed is 1.25. It contains more bitumen and less carbon, than the beds above it, twenty grains of it decomposing one hundred of nitrate of potash, which will give it about six-

ty per cent of charcoal. Forty grains burned in a crucible and being kept at a red heat for a few minutes, left twenty three grains of coak, which contains but little earth, as fourteen grains of it decompose one hundred of nitre.—6 feet.

3. Bituminous shale, and slaty shale, with a little sand, forty feet. The lower part of this deposit, resting on the coal and forming the roof of the mine, contains a thin stratum of clay iron ore, in flat kidney shaped masses, formed of concentric layers, and having a nucleus imitating a large leguminous seed. They are of various sizes from that of a bean to that of a quart basin, and all lie with the flattened side next to the coal. The whole of this slate and shale is filled with the impressions of extinct species of plants. Every layer of not more than an eighth or the fourth of an inch in thickness when separated, displays fresh impressions of a variety of species, delineated on the face of the slate with the most exquisite beauty and perfection. The minute markings of the ribs and nervures are faithfully preserved. The vegetable matter is replaced by a thin coating of coal, and when this is removed, the perfect impression is left on the slate. The pealing up or separating of the folia of shale, seemed to me like opening the leaves of a sealed book, here deposited by the Creator, from the earliest ages; containing a faithful and true record of the history of vegetation, in its primitive days. Before me was collected a vast library of natural history, containing the stereotype copies of an almost endless variety of trees and plants, whose families and species, as we have every reason to believe, lived and died, before the creation of man. Four or five species of the Palm tree, as many of Calamites, several Sphenoptera, Neuroptera and Equiseta, &c. were unfolded, in the few hours which I spent in studying this most interesting collection. How beautiful and how valuable are the means which the all wise Creator has provided for the comfort and the happiness of man. Vast magazines of iron, salt and coal (the latter indispensable to the population of many parts of the globe) were laid up in store for his use, before he was "yet formed from the dust of the earth."

Drawings of a number of the fossil plants from this deposit are given in figures Nos. 37 38, and 39, (page 8 of the wood cuts;) Nos. 40, 41 and 42, (page 16;) Nos. 43 and 44, (page 17;) No. 45, (page 18;) No. 46, (page 19;) No. 47, (page 18,) and No. 48, (page 20). The impression of figure No. 37, appears to be similar to that of "Equisetum columnare," and is given of the natural size, near the joints, but embraces only a part of the original, which, when first separated from the slate, was nearly a foot in length; it may be called a cast, as it parted in a thin layer and came out from the rest of the stone. No. 38, "Calamites Steinhaueri." No. 39, "Calamites ramosus." Nos. 41 and 42, are different varieties of the same and ought to receive distinct names. But my knowledge of fossil botany is too limited to permit me to venture on conferring many names until the fossil plants are more thoroughly examined. No. 40, is without doubt, a new species of Calamites, much resembling "Calamites arenaceus." The figure is only one sixth the size of the original, which is beautifully impressed in slate, with the large oval cicatrix finely developed in relief. No. 43 and 44, are probably different species of Equisetum, although the scaly cuticle resembles some species of the palm tree. No. 43, represents a number of branches, broken from the main stem, and so great is the likeness to the scales of a snake, that the workmen call them the remains of petrified snake skins. The scales are replaced by coal, the whole thickness of the remains not being over the sixteenth of an inch, but very perfectly figured. No. 44, is a differently formed scale, and much larger. No. 45, represents two varieties of "Sphenopteris crenulata." No. 46, resembles, in some respects, "Neuropteris Dufresnoyi," but is doubtless a new species; the leaves are too ovate for that species, and single leaves of the same are scattered through the mass. No. 47, I have called Neuropteris acutifolia. The two figures at the bottom may be the terminal leaves of other branches. No. 48, much resembles "Sphenopteris obtusiloba." It is broken into several pieces, the large stem at the the bottom being a part of the same branch.—40 feet.

4. A thin bed of coal, twenty inches in thickness, resting on the great bed of shale and slate clay; it is not worked.

5. Argillaceous sandstone rock, composed of fine round grains, of sand, and but little mica, color light iron rust or light buff. The upper portion of this great deposit is stratified in thin beds. The lower part, in beds of fifteen or twenty feet in thickness. It splits easily into fine building stone, and is extensively used in the structure of salt furnaces. This bed is nearly two hundred feet in thickness and is a vast magazine of fossil palm trees, Calamites and other fossil remains. Figures No. 49, (page 21 of the wood cuts;) Nos. 50 and 51, (p. 19;) No. 52, (p. 21;) Nos. 55, 56 and 58, (p. 22,) are from this rock. No. 49, is a fragment of a large trunk of a "Calamites

arenaceus;" at least it resembles this. This fragment is eight feet in length, and eighteen inches by nine inches, in diameter; being considerably flattened, the whole must have been twenty five or thirty feet long; cicatrices, five inches long by three and a half wide, raised in the center and of an oval shape, are placed obliquely across the stone. There were two of them on this fragment, near one extremity; the succeeding ones were probably on the next piece, left in the rocks; this had tumbled out and lay on the side of the hill near the foot. The surface is striated with five lines, running longitudinally, in interrupted series. The cast is sandstone, similar to the rock in which it was imbedded, with some portion of it still adhering; a little coal is seen about the raised cicatrices. Numerous fragments of branches, and parts of other fossil plants, are lying across and along side of this trunk. No. 55, is a "Calamites dubius," from the same spot. No. 56, may be a fragment of Calamites remotus, all composed of sandstone beautifully preserved. No. 58, is from the same place and is a portion of some testaceous animal. The lobes are too much lengthened for a trilobite and the stone is too recent. It may be a part of some flying insect, with the annular portion of the abdomen; lying on it in the stone, is something which might pass for elytra, or wing covers. No. 57, is the impression of a delicate, arundinaceous leaf, in slate. No. 50, is a portion of an impression, or cast, in the same rock, but higher up the stream, near Kelly's Creek, and it is now in my collection. The figures are one half the natural size. The trunk of the palm tree, or arborescent fern, (which it is I am unable to say,) was between thirty and forty feet in length, and nearly three feet in diameter, in the longer axis, and eighteen inches in the shorter, being flattened or oval, with a large indentation, as represented in fig. 51, which is an imaginary section of the trunk as described to me by the man who assisted in removing it from the quarry. The cast of the trunk was replaced by an ash colored marly rock, that was decomposed on exposure to the weather. No. 52, is from the same deposit, in sandstone rock. The figures on the surface are raised, and separated by lines an eighth of an inch deep; the figures are one half the natural size. This was probably impressed by the scales of a large palm tree.

This deposit abounds in rare and curious fossils, and when it shall be more extensively opened will afford a rich treat to the geologist. A fragment of this sandstone rock five feet long and two feet wide, was dressed out and used a number of years for a hearth stone. It was known through all that region by the name of the "calico rock." The impression on it was that given at No. 50, a thin coating of coal surrounding and covering the raised figures, gave it much the appearance of a paint or stain, and the regularity of the impressions fully equalled any work of art. I saw this rock, on my return from the falls, at Mr. Stockton's, sixteen miles below; a portion of it is in my collection. The section gives a very striking likeness of the trunk flattened and compressed by the sand before it was consolidated into rock.—200 feet.

6. *Bituminous Coal.*—This bed is four feet in thickness, and is generally worked by the manufacturers of salt, being found in all the hills adjacent to the salines. When brought to the mouth of the mine, it is discharged down the side of the hill in a "Slide," constructed of planks, and is received on a platform below; whence it is taken in a wagon, drawn by a mule or horse, on a railroad constructed of wood; the wagon running on cast iron wheels, with flanges, is confined to the track. On these roads, one mule draws from eighty to a hundred bushels, being as much as was formerly drawn by four horses. It is but a few years since coal came into use at the furnaces; wood was formerly the only fuel and continued to be in use until the adjacent hills were entirely stripped of their clothing, which gives them their present naked appearance, as seen in the annexed "view of the salines." See p. 34 of the wood cuts.

Beneath the coal is a deposit of dark carbonaceous slate, filled with casts and impressions of fossil plants. Drawings of a number are given taken from this bed at figures Nos. 53 and 54, (p. 22 of the wood cuts;) No. 59 and 60, (p. 24, of the wood cuts;) No. 53, resembles "Equisetum dubium." No. 54, bears a greater likeness to "Calamites cruciatus," than any other figure in Mr. Brongniart's collection of drawings, but still differs in many points. It is most probably a new species. The drawing is taken from a cast of a trunk, eight or nine feet long, six inches wide, and one inch thick, compressed and flattened, and probably also wasted away. The surface is coated with coal, the main body is slate or indurated clay. It is coated with circular depressions, one third of an inch in diameter, and two eighths deep in the center placed in transverse lines. The original stem must have been twenty feet or more in length; casts like this are very numerous in this bed. I observed no similar ones in the bed below. No. 59, appears to be a small species of "Neuropteris heterophylla." No. 60, appears to be a new species of

Neuropteris—some of the leaves are replaced by ochre and others by bituminous matter. The two latter figures were drawn by Mrs. Brigham of Charleston, Va.

The specific gravity of the coal from this bed is 1.29. It contains rather more carbonaceous matter than the lower bed, seventeen and a half grains of it decomposing one hunded grains of the nitrate of potash, which will give it about sixty five per cent of charcoal. Forty grains burned in a crucible and kept for a few minutes, at a red heat, left twenty four grains of coak.—Coal.—4 feet.

7. Coarse, sharp grained, silicious, sandstone. This deposit reposes immediately on the coal without any intervening slate, or shale, and forms a very safe and durable roof to the mine. It contains some fossil casts, but not so many as the rock described below. —150 feet.

8. *Bituminous Coal.*—Third and last bed; this coal is not so compact and glistening in its fracture as the two lower deposits. Its structure is more slaty; in burning, it melts and runs together, obstructing the current of air necessary to combustion, a fact noticed as common to nearly all the upper and last coal deposits. In some of the coal mines the beds are undulating or broken, forming small "*faults*," but never so large as to cause much inconvenience to the miner. The water which collects, is generally drained off easily by shallow trenches, as the dip is but small. The slate or shale, on which the coal rests, contains many impressions of plants, but more arundinaceous and culmiferous species than the lower beds, indicating a considerable change in the families of plants during the long period of time required to form these immense deposits that are found between the different beds. The impressions on figure No. 61, (page 15 of the wood cuts,) are all from this bed with the exception of (*e.*) which is from a piece in Pomeroy's bed, on the Ohio at Carr's run. (*a.*) resembles the "Odontopteris Brordii" in fruit, most beautifully impressed on an ochre colored ground; (*b.*) appears to be some species of grass; (*c.*) an asteroid flower which in one place seems attached to the grass, but it is probably only a chance position; (*d.*) and (*e.*) may be single leaves of some large species of Neuropteris; (*f.*) is a "Sphenopteris myriophyllum;" (*g.*) resembles "Odontopteris obtusa." In the thin bed of shale, between the coal, and silicious slate, over it, was found the flattened cast of a large trunk, two feet across, with impressions similar to No. 44, only much larger, showing that this plant, if an Equisetum, attained a very large

size; a portion of these casts is in my collection. The specific gravity of the coal in this bed is 1.25. It contains over sixty per cent of charcoal, as eighteen grains of it decompose one hundred grains of nitrate of potash, when burned in a crucible; and forty grains leave twenty six of coak, which probably contains considerable earth, as a large portion of cinders is left when burned in a grate.—4 feet.

9. Very dark colored, nearly black, silicious slate, or lydian stone, in thin beds, of from two to six or eight inches in thickness. This deposit forms the roof of the coal, a thin stratum of shale being interposed. It is five feet thick at this spot, at others it is six and eight feet. I consider it one of the most remarkable deposits of the whole series. It is extremely hard, not being impressed by the best tempered steel. The aborigines manufactured it into arrow heads, knives, &c. which are often found in the ploughed fields, throughout the valley. I have traced this deposit from the mouth of Elk river, into the Gauly mountains, a distance of more than forty miles; while its extent, east and west, has been traced from the head waters of Elk, over to the Guyandotte, a still greater distance, covering an area of at least two thousand square miles. While coals and sandstone rocks from different beds so much resemble each other, this has a character of its own not to be mistaken. As we approach the falls of Kenawha, this deposit still maintains its elevation above the other strata, and is seen crowning the tops of the hills six or seven hundred feet in height, where the superincumbent sandstone rock had been wasted away. As we approach the dividing ridges between the Gauly, and the small streams putting into the Kenawha, it is seen towards their sources forming falls and cascades in their beds; its superior density compared with other rock strata preventing its abrasion or disintegration. As we travel still nearer the dividing ridges, it disappears under the superincumbent sandstone rock, and again crops out on the opposite side of the ridge on coal river; this deposit is seen in similar situations on the heads of Elk, and is found high in the hills near their tops. Whence could have been derived the materials for such an extensive deposit of silicious matter, in a secondary region? The fact excites our wonder—but doubtless the process, by which it was accomplished, was very easy. Water, at its usual temperature in this climate, will hold in solution but a small amount of silex; but when at the boiling point or at an elevation much greater, as it is often found in volcanos, under great pressure, it is capable of holding suspended large quantities of silicious matter

as well as other materials.* A discharge of hot water from the bowels of the earth may have taken place, at that period of time when the Sewell mountains and the accompanying ranges were raised to their present elevation, which as it slowly cooled, deposited its mineral contents in this present bed of silicious, and other materials. For it contains several other substances, both argillaceous and ferruginous, combined with the silicious portion. In all our coal beds, there are evident indications that the coal has been subjected to a strong heat, as well as pressure, either at the period of, or after its formation. Portions of it present every appearance of having once been in a melted or semifluid state, and this is still more apparent in cannel coal, a variety of the bituminous. Its fracture is almost invariably vitreous, a still stronger evidence of its having once been in a melted condition. A similar, dark, carbonaceous, silicious deposit is found in many parts of the coal region, especially at considerable depths in the earth, when they are boring for salt water, but no where in such vast abundance as here. It is seen, with a similar character, in the bed of the Muskingum at Zanesville, but only about a foot in thickness. That deposit contains fossil shells; but I have not yet learned that any fossil remains have been discovered in this deposit, although it is probable it contains them, for they are found in the strata both above and below it. The specific gravity of the *silicious slate*, is 2.43. It does not melt before the common blow pipe, but requires the heat of the compound pipe fed by oxygen and hydrogen gases.—6 feet.

10. Resting on the silicious slate, is a thin deposit of argillaceous iron ore, in nodules of from three to six inches in diameter, imbedded in argillaceous, yellowish marl. This deposit does not exceed eight inches in thickness.

11. Coarse grained, yellowish sandstone in thick beds; composition chiefly silicious sand, with feeble cohesive power; in the dividing ridges, this deposit is one hundred and fifty feet in thickness; but near the Kenawha, on many hills, it has wasted away by frosts, rain, &c. to a very thin bed; at this spot it is eighty feet thick. The hills near the river are crowned with the remains of this deposit, worn and wasted away into many curious and fantastic shapes. In some instances they imitate pillars and columns, in others, chimnies tables &c. cavities being worn quite through large masses of fifty or eighty feet in height, leaving them standing on several bases like

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* Especially if aided by alkali.

a table or an old fashioned case of drawers; other fragments are worn into inverted pyramids. This deposit is very interesting in another point of view; it contains a vast many fossil trees entombed in its bosom, of a family much more recent, than those found in the strata below. They are composed of silicious matter, tinged with iron, which has given them durability to resist decomposition, after the sandstone, has crumbled away and left them. Whole trees with their roots and branches attached have been found on the hills a few miles from Charleston, at an elevation of six hundred feet. The crevices in the original wood, have been filled with fine drusy crystals of limpid quartz, which gives to many fragments a beautiful appearance. The trees appear to be generally of the coniferous family and much resemble the Yellow Pine in the form of the knots and arrangement of the ligneous fibres. The bark is always bituminized. That these immense fossils are numerous is inferred from the great number of fragments, of broken branches and roots, strewed over the beds of streams. Some trees have been found, fifty or sixty feet in length and three feet in diameter. They seem to have been torn with violence from their native beds, as the greater number have their roots attached. Whatever may have been the catastrophe which overwhelmed them, it appears to have been very extensive, as trees of the same character are found imbedded in a similar rock, at Gallipolis, below the mouth of the Kenawha, and on Shade river a few miles south of Athens; at the latter place they are very numerous. The same are also found on the hills in Scioto county, and without doubt on the Sandy river, as its sandstone rocks are similar. I have specimens from several of these places. This stratum, seems to have been among the last of the sedimentary rocks, and completed the series deposited from the waters which once covered this region. It was formed long after the coal beds, as I have seen fragments of bituminous coal, taken from the rock, disclosed by the quarry men in preparing the stone for building. A *living toad* was also found in the same deposit, it being, where not wasted away by natural causes, the upper one on our hills.

Very few fossil shells, or animal remains of any species, are found in the valley of the Kenawha, in the surface strata, although it is probable, from the composition of the lower strata, that they contain numerous relics of the ancient world. They cannot, however, be reached without the aid of shafts, which, it is thought will not be attempted very soon, in search of the rock salt, supposed to be deposited in some of the lower strata; the richness and abundance of the salt water at present forbidding any such attempt.

Muriatiferous Rocks of the Kenawha Valley.

It has been observed that the principal salt deposits, throughout the globe, are generally situated near the base of extensive mountain ranges, on the borders of vallies or plains. This, however, is not universally the fact, for salt is sometimes found in very elevated situations, on or near the tops of mountains. From its being often found at the feet of high mountain ranges, it has led some to suppose that these ranges were once the barriers or shores of inland seas of salt water, which having become dry by evaporation, left these deposits of salt deep down, to be subsequently covered with other deposits of earth and sand from fresh inundations. Whatever may have been the origin of the salt now found in the earth, it seems to have been placed there under a uniform law, governing the process in all parts of the earth: wherever found, it is associated with particular species of earths and rocks, the prevailing ones of which, are *red marl* and *sandstone*. We find this law holding good through all the valley of the Ohio, in the vicinity of the muriatiferous deposits. In some districts the *red marl* is very abundant, coloring the soil by its decomposition, and existing in thick beds on the sides and at the foot of hills. When boring for salt water it is found at considerable depths, constituting a tolerably hard rock, alternating with sandstone, slate clay and limestone and coal. A single deposit, has recently been pierced for one hundred and fifty feet, in boring a well on March run, near Marietta. Limestone is seldom found at the Kenawha salines, but is abundant at all the other principal salt works, not only on the surface but deep in the earth. It is without doubt to be found here, at great depths, for the muriate of lime is a prominent constituent in the composition of the brine, running freely from the fresh made salt in the "Bitter water." Gypsum, or sulphate of lime, is constantly with *rock salt* as an accompanying mineral, wherever found in other parts of the world. Through the valley of the Ohio, it has not yet been found to accompany the rock strata near the surface of the earth, although indications of it are discovered at great depths below, especially at the works on the Muskingum river. Gypsum is deposited in extensive beds on the *borders* of the valley, in the secondary and transition rock at the surface, and may be deposited beneath the series of sandstone and coal, deep in the earth throughout the whole valley. It is seen in great abundance along the southern shore of lake Erie, near Sandusky, and in various other intermediate places, quite to the borders of New York and in the interior of that state, being found at intervals from the shore of the lake, to the mountain ranges. At the salt works, on the heads of the Holstein, it is discovered in great abundance, appearing partly to encircle the salt region with a cordon of deposits. From the fact, that no *muriate of lime*, or *magnesia*, enters into the composition of *native rock salt*, it being a pure muriate of soda, wherever discovered in other parts of the earth, I am led to conclude that the brine springs in the valley of the Ohio, are not supplied from a deposit of *rock salt*, but from salt in small grains and particles, pretty equally diffused through the lower strata of rocks and marls, wherever the salt springs abound. The notorious fact, that the brine becomes weaker in a well worked very constantly, and the necessity of boring deeper to renew the strength of the water, goes to confirm this opinion, especially on the Kenawha; whereas, if the water was supplied from a deposit of pure solid salt, the well would remain of uniform strength. Another proof is found in the fact, that the *deeper* wells are supplied with a *stronger* water, showing that the further the saline strata are penetrated the more certain they are to supply a strong brine. The nearer saturated, the more heavy the water becomes, and it settles to the deeper cavities. The water which holds the salt in solution, being supplied by the river above, percolates gradually through the crevices and openings in the different rocks, dissolving the saline particles as it descends, in the same manner that water dissolves the particles of potash in wood ashes: the lixivium at the bottom of the leaching tub, being much stronger than that near the top, or half way down. The principal salt works in "the valley," are uniformly found on large water courses; wells sunk on small creeks, always affording a weak brine, or a very scanty supply of water. The vicinity of some large stream is therefore necessary to bring the salt water to the surface of the earth; the water in the wells uniformly rising, as the water rises or falls in the river, showing an intimate connexion between the waters below, and those in the stream above. The strongest water and most abundant supply, are furnished by a stratum of fine grained, white sandstone, at nearly all the works of any celebrity; and although naturally of a compact structure, cavities of several inches are found in all parts of it, through which the water finds a free and easy circulation. It lies at various depths in different parts of "the valley," being deeper near its center or most depending portion, and rising nearer the surface on its borders. At the lower wells on the Muskingum it lies at eight hundred feet; on the Kenawha at four hundred. It is not uniformly white, but in some places is highly tinged with red. It is an interesting fact, that this rock on the Muskingum, lies at a depth far below the present surface of the ocean, it having been pierced at nine hundred feet, which is three hundred below tide water at the mouth of the Mississippi. The mouth of the Muskingum is only five hundred and seventy feet above, and the works on the Kenawha are about the same. The main salt strata on the Kenawha occupy an extent of twelve or fourteen miles on the river; above and below these extremes, the brine is found at a greater depth and of a poorer quality. The lower rock strata at the salines, as before noticed, approach much nearer the surface, describing, in some measure, the arc of a large circle. At the center, good brine is found at three hundred feet; at the upper end, or six miles above the center, at four hundred and fifty feet, and at the lower end at five hundred feet. The surface strata have also, a conformable curve, or dip each way from the anticlinal line, near the center of the works.

It is believed by many persons that the salt springs are supplied from a large deposit of solid rock salt. The following are the views of a very intelligent gentleman, who has lived many years at the works and been extensively engaged in the manufacture of salt.

"Suppose a conical bed of rock salt, whose original apex was nearly on a level with the water in the river—this bed is gradually dissolved by the water passing downward through the perpendicular fissures in the rock forming the bed of the river, and laterally in the cavities below, until it reached the salt rock, where it receives its impregnation, and thence is drawn off in openings made by boring. These cavities run in inclined and irregular courses from the region of the salt rock in rather parallel directions—a cavity communicating with the upper surface of the rock is first reached with the augur; the saline matter is speedily exhausted and fresh water rises in its stead. The next cavity is thus perforated and a more strongly impregnated water is found, it having a more extensive surface to act upon. It is more permanent, but will not rise quite as high, having greater specific gravity and yielding not quite so large a quantity of water in the same time, the cavities being smaller, and so on, with fresh cavities, as you penetrate deeper in the rock. It has been suggested that this opinion is not in accordance with geological theories, and does not correspond with the regular stratification exhibited in our mountains. That the stratification below is not of the same uniformity as above is well established from numerous facts, collected from those engaged in boring for salt." "In penetrating our mountains for coal, considerable collections of water are found near the mouth of the mine, conducted there by perpendicular fissures; but these fissures diminish as we proced, and having gained an entrance to the interior, we shall have passed all moisture. The layers of rock have become impervious to the water from above; hence we have no perennial springs, and hence if there be a *rock salt* deposit, it cannot be dissolved by springs. There must be perpendicular fissures in the lower rock strata, else whence the numerous constant streams of inflammable gas, rising in bubbles from the surface of the river and the adjacent earth at the "Burning springs?" Cannot the water pass down where the gas rises? There must be rock salt either in mass or lying imbedded with the sandstone and slaty deposits of this region. If the latter, it would be difficult to account for the uniformity of saline impregnation for so long a period—no traces of rock salt are found in the borings—why should not the first openings have possessed equal strength? and why should not the volume of water increase as the saline matter is carried from the cells to enlarge their openings? If the mass of rock salt exists as suggested, and the stratification is similar to that of our coal deposits, the dip will be each way from the center of the works, the salt rock lying adjacent to the center, the brine will be found at the least depth here and at greater depths towards the extremities, but not of quite equal impregnation, receiving in its passage from the salt rock an intermixture of fresh water, but having the same head, it will rise to the same height in the salt wells." "On Campbell's creek, two miles from its mouth, a well was bored to the depth of five hundred feet; salt water of a very slight impregnation was found. This well is a little north east of the old Buffalo lick, where salt was first made. From this spot there is a slight dip towards the river. On Elk river, two miles from its mouth, a well was bored many years since. Salt water was procured of an inferior quality, and actually passed through into fresh water; this well is north from the Buffalo lick."—"Wells have been sunk fifteen miles above, and forty five miles below us, and salt water obtained, but too weak, to come in competition with the water of the salines."

If the solid rock salt should ever be procured by sinking shafts, it would be no better than the present salt water, as it would need to be dissolved and recrystalized before it could be applied to domestic purposes.

For the early history of the salt business on the Kenawha, I am indebted to Col. David Ruffner, who was among the first of the manufacturers.

Early history of the Salt Manufacture.

At the first settling of the Kenawha river, a large Buffalo lick was discovered on the N. E. side of the river, about six miles above the mouth of Elk river, and a short distance above the mouth of Campbell's creek, near the margin of the river at low water. Nearly opposite to the lick is a low gap in the ridge, through which the buffalo and deer passed on their way to the lick, in such numbers, that their paths up and down the creek were worn so deep, as to be visible at this day. For a considerable distance round the lick, not only the herbage but the foliage of the trees, as high as the animals could reach, was all eaten up by the buffaloes, after they had drank of the salt water. If not disturbed by the hunters, they generally remained here two or three days. At this spot, several hollow logs, or "gums" were found, sunk into the gravel at the margin of the river, and probably placed there by the Indians, as they had every mark of great antiquity. In the same manner, the early settlers sunk gums into the bed of the river, six or eight feet deep, in which was collected a very weak water, and from it they made a little salt for their own use. In the year 1794, Joseph Ruffner, of Shenandoah County, Va., bought a tract of five hundred and two acres, including the Buffalo lick; and in 1795, he moved his family on to the Kenawha. But little was done towards making salt, until the year 1807, when David and Joseph Ruffner, sons of Joseph, bought a tract of land a little above the Buffalo lick, and commenced their operations about one hundred yards above the lick, where there was no appearance of salt water. Having selected a "gum" or hollow sycamore trunk, about eighteen feet long and three feet across the cavity, they, with great labor and difficulty, sunk it in the gravel and sand at the margin of the river, to the depth of fourteen feet, down to the smooth sandstone rock which forms the bed of the river, and is very uniformly found at this depth, up and down the river, as far as any gums have been sunk. The depth of the river, for ten miles above Elk, is uniformly about sixteen feet, and two hundred and fifty yards wide at low water mark; by which it appears that little if any deposit is made in its bed by the floods from year to year. The lower part of the gravel through which the gum was sunk, for four or five feet, is very hard and tenacious, approaching that state, when gravel beds change into rock. When the gum was fairly settled on the rock, their next attempt was to sink a well or shaft into the rock, of sufficient depth to afford a supply of water, but in this they were foiled, as they could devise no means by which to keep out the water from the river so as to go on with their work. At length, by putting a tight bottom of planks into the gum, and through a hole in the bottom inserting a tube three inches in diameter, into the rock below, no water could enter but what passed through the tube. Here the process of boring was commenced, by an augur or chisel, passed through the tube which bored a hole two and a half inches in diameter, the augur and rod, or pole, being fastened by a rope to a "sweep pole." When they commenced, they little expected to obtain a supply of water by merely boring a hole in the rock, having never heard of such an attempt before; but in this they were agreeably disappointed. In order to ascertain the quality of the water, they had frequently to stop and clear the hole not only of the water but of the borings. At seventeen feet they struck a vein of salt water, the first indication of which was a bubbling or hissing of the gas in the hole. This water, though requiring three hundred gallons to make a bushel of salt, was then thought to be very good. The well was sunk to the depth of twenty six feet, when they left off boring the first of October, 1807, and proceeded to the erection of a furnace, of about forty kettles, which went into operation the 11th of Feb. 1808, and made about twenty five bushels of salt a day, which was then worth $2,00 per bushel. A small vein of fresh water that came in a few feet below the top of the well, they contrived to exclude by means of a wooden tube pushed down into the well, after reaming it out. From this example, has arisen the practice of pushing down tin or copper tubes, by the modern well borers, to any desirable depth. Not long after this, William Whitaker obtained salt water, and erected a furnace on the opposite side of the river; and about the same time a well was bored and a furnace erected at the old lick, and several improvements made both above and below this spot. The salt water in the gums, at this early day, usually rose about a foot above the surface of the river at low stages—at high stages, the water rose with that of the river, but not quite so high as it was in the river. The salt water was also increased in strength as well as in quantity by a rise in the river. When the wells were only twenty six feet deep, they afforded water only for two furnaces; but when, in the second year, they were deepened to sixty and ninety feet, the water was sufficient to supply four furnaces of sixty kettles, holding thirty or forty gallons each, making from fifty to sixty bushels of salt every twenty four hours. To prevent the river, when high, from flowing into the gum, an additional one of eight or ten feet was set upon its top, and the water drawn out of it with a bucket and sweep by the hand. Soon after, pumps were used worked by horses, one set of pumps raising sufficient to supply two furnaces, which was the usual number attached to each well. The furnaces were about fifty or sixty feet in length, with the same number of kettles set in two rows. The fuel then used was wood. Successive improvements continued to be made, both in the form of the furnaces and in the size and shape of the kettles, until the latter reached the capacity of one hundred and fifty or two hundred gallons each, weighing from seventeen to nineteen hundred pounds, and requiring only five or six for a furnace. These large kettles were used only for boilers, the smaller ones still being continued for "graining" or crystallizing the salt. After coal came into use for fuel, which was not until the adjacent hills were striped of their wood, in the year 1819, broad pans of sheet iron were used for boilers. Col. David Ruffner first introduced the use of coal, and his example was soon followed by the other manufacturers, who, at that time, had become numerous. He suffered considerable loss, and many disappointments before he could adapt the form of the furnace and the pans to this new fuel. The pans were twelve or fourteen feet long, and three feet eight inches wide, and were placed in the front part of the furnace over the fire, for boilers. These being soon corroded and worn out, cast iron pans were substituted, made of separate pieces and fastened together with screws, the joints being tightened with a cement of cast iron borings. With care, these pans last a long time. The pans used at the present period are about twenty five feet long and six and a half feet wide, and the length of the furnace from eighty to one hundred feet. The quantity of salt made at the time when they began to use the stone coal furnaces was from two hundred and fifty to three hundred bushels per week. As the furnaces were enlarged, and improved in their structure and management, the quantity increased, until, at the present time, they make in some instances, nine hundred or a thousand bushels per week. The salt water, as it comes from the wells, is very clear, and of the temperature of the coldest spring water. When it becomes even moderately warm, it begins to turn red, and when saturated by boiling, it is nearly of the color of blood. In this state, it is drawn off into a large trough, called "the brine trough," placed near the furnace, for the purpose of settling or clarifying. When cool, it becomes perfectly clear and is then returned into the grainers, where it is boiled down into salt, and lifted out upon a platform, for the purpose of draining off the "bitter water," or muriate of lime, a very abundant and troublesome component in all the western salines. In the course of eight or ten days, a red sediment, two or three inches in thickness, resembling red paint, forms in the bottom of the "brine trough." It is composed principally of a carbonate of iron, held in solution by the carbonic acid gas of the water, and set free on the application of heat. At this period, a large portion of the furnaces have a small steam engine attached for the purpose of raising the water, which contains more salt the nearer they approach to the bottoms of the wells. The average quantity required to make a bushel of salt, is about seventy gallons. The total amount made in the year 1834, is estimated by the inspector at one million and a half of bushels—a very great advance from the year 1807.

Within a few years, the manufacture of coarse salt* has been commenced, and large quantities are produced, equal in quality to the best Turks Island salt. After the water is evaporated to the state of strong brine and purified, it is drawn off into a long shallow vat, or cistern, and kept at a moderate temperature by the aid of steam, furnished by the boilers, and conducted the whole length of the cistern in a metallic or a wooden pipe. The salt is deposited slowly on the bottom of the vat, in beautiful, four sided, pyramidal crystals, of great purity. It is removed once in eight days, and is then usually about a foot deep, all over the floor of the vat; some vats are several hundred feet in length, and ten or twelve feet in width.

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* Strangely called alum salt.

The Kenawha salines present a most interesting and lively scene of activity and business. At intervals of every quarter of a mile, both shores of the river are lined with furnaces, sending forth dense curling volumes of coal smoke. The busy hum of voices, and the rattling of the "train wagons," along the rail ways, with the bustle of the salt boats, and steam boats, to which the depth of the river affords a safe and pleasant navigation to the upper furnaces, give to this spot all the life and activity of a large city. The annexed "*view of the salines*," (see page 34 of the wood cuts,) with the outlines of the hills, will assist the reader in understanding both the geology and the situation of this interesting spot.*

Petroleum.

This mineral oil rises in nearly all the wells. It is, however, less abundant than formerly, when the avenues through which it ascends to the surface were far less numerous. The source of its origin must be below the present bottoms of the salt wells, as no large beds of coal are passed in boring for water. It has been remarked, that as the wells become numerous, the salt water does not rise in them so high, by several feet, as it did in the first wells. This is probably owing to the partial exhaustion of the immense magazines of carburetted hydrogen, that formerly assisted the ascent of the water. Writers are generally agreed, that petroleum is a product of the vegetable decomposition, which produces bituminous coal. The manner of the production of petroleum down deep in the earth, being out of view, is of course, to a degree, a mystery. The art of the chemist, and of the manufacturer, have, however, been able to imitate it to a good degree, by the distillation of bituminous coal, and by the ignition of wood, as happens in preparing charcoal in iron cylinders for the manufacture of gunpowder; and also in the manufacture of pyroligneous acid, during the distillation of which, something like petroleum is produced; and from that source a fluid resembling naptha has been obtained by a subsequent distillation. The inflammable gases evolved in the salines, with or without the petroleum; those that flow from the strata of coal mines, and those obtained by the destructive distillation or slow spontaneous decomposition of vegetables, being identical, leave no

* I am indebted to Doct. Patrick J. C. McFarland, Col. Donally, Mr. L. Ruffner, and Mr. Whitaker, for many valuable facts in the history of the "Kenawha valley."

doubt that the source of these things is one and the same. Immense quantities of this gas are continually rising from the various wells, but not in such violent discharges as formerly, when the whole volume of water in a well was sometimes thrown a hundred feet high, with tremendous force and noise. This was remarkably the fact in a well dug at the lower part of the salines, when the discharge was kept up for a number of days. In some places it is discharged periodically, at intervals of eight or ten days, bringing up with it large quantities of petroleum, to the amount of several barrels. For the collection of such vast quantities of gas there must be corresponding cavities in which it may be treasured up until they become so full, as to overcome the resistance of the superincumbent water, and force a passage to the surface. Collections of the same nature sometimes take place in the hills, at a distance from the rivers, or saline springs. Several places are known where the earth and rocks have been blown out to a considerable distance, leaving a cavity of several yards in diameter and in depth. As to the origin of the gas—although it is so commonly associated with the salt water—there is nothing in the history of the latter which should lead us to suppose that it is any farther concerned in the production of the gas, than as affording moisture and perhaps to a degree, modifying vegetable decomposition, so that it may proceed more tardily and equally, and therefore endure longer and consequently afford gas for a greater length of time.

Probably the true reason why saline fountains are commonly attended by inflammable gas is, that the coal formation and salt deposits are, geologically, close neighbors; the salt being usually above in Europe and other countries, but not invariably so in the valley of the Ohio, and in the valleys of its confluent streams. It appears from the facts detailed in this memoir, that the salt is often below the coal and probably alternates occasionally with it. If the gas comes from the coal, there must be extensive beds below the salt deposits not yet discovered in boring, for those which have been penetrated are not sufficient to furnish such immense and constant supplies as are daily and hourly discharged at the salines. The most rational conclusion is, that, in the manner indicated above, they both assist in furnishing the materials. This compound gas is the same with that which collects in such quantities in the coal mines of England, and by its explosion proves so destructive to the lives of the miners, but which the immortal Davy has rendered harmless by the use of his safety lamp.

One of the most interesting of these gaseous springs, is that known by the name of "the Burning spring," near the center of the salines. The gas rises in a cavity about a foot in depth and five or six feet in diameter, through the alluvial soil, eight or ten rods from the river. This cavity, except in dry seasons, is partially filled with water, through which the inflammable air constantly rises with considerable commotion. On applying a lighted candle, or brand of fire, it becomes ignited and throws up a light lambent flame to the height of two or three feet, and continues to burn until extinguished by a sudden dash of water or by a violent agitation of the air. It rises near the center of an open square of about an acre, given to the public by the liberality of Washington, who owned large tracts of land on the Kenawha; he viewed it as an interesting natural phenomenon, which no parsimonious individual ought ever to appropriate to his own benefit. In the low grounds, between this spring and the hill, gas is discharged at several places as well as at various points along the margin of the river. There appears to be no diminution in the amount of gas, from its first discovery to the present time; the same Almighty and liberal hand, which furnished the perennial fountains with water, having also provided this gaseous spring with the means of an exhaustless supply.

Coal Deposits.

The immense beds of bituminous coal found in the valley of the Ohio, fill the mind with wonder and surprise, as it reflects on the vast forests of arborescent plants required in their formation. Age after age, successive growths of plants, springing up in the same region, were entombed beneath thick strata of shale and sandstone, until the whole series had accumulated to a depth of more than a thousand feet; while beneath the whole, lay the bed of an ancient ocean floored with fossil salt. Indications of coal are found at intervals, across the great valley, from the Alleghany to the Rocky mountains. It is found near the surface in Kentucky, Ohio, Indiana, Illinois and Missouri, and without doubt, may be found beneath the extensive tertiary deposits, which form the substratum of the great prairies in the central and northern parts of the western states. As low down as New Madrid on the Mississippi, coal was thrown up from beneath the bed of the river, by the great earthquakes of 1812—a sufficient proof of its continuation in the most depressed part of the great valley.

That coal is of vegetable origin, no one who has read much on the subject, or personally examined the coal beds, will now deny. Time was, when it was considered a peculiar mineral product, formed in the earth in the same manner and at the same time with the rocks that surround it. The product of its chemical analysis, being altogether vegetable, and the artificial formation of coal from wood by Sir James Hall, have silenced all doubts on the subject. The only mystery now is, how such vast quantities of vegetable matter could be accumulated and grow on the spot where they were buried. That they grew in general, on the surface now occupied by the coal, appears certain from the perfect state in which the most delicate leaves and stems are preserved. Had they been transported by currents of water, and especially from any distance, it is hardly possible that they should not have received more damage. The climate, at that period, must have been both more warm and more humid than at present, as many of the plants are of those families which now grow only in tropical climates; and as the laws of nature never change, this may be deemed a correct inference. A similar climate seems to have prevailed in the latitudes north of 30°, both in Europe and in America, many of the same plants being common to the coal strata of both countries, as will be evident by comparing the drawings of several of the species found in the valley of the Ohio, with those exhibited by M. Brongniart, in his work on "Des vegetaux Fossiles," of the European coal beds. South of lat. 30°, but few coal deposits are found, the climate requiring but little fuel for the comfort of the inhabitants; but north of that parallel, many districts could be but very thinly inhabited, or perhaps not at all, were it not for the wonderful provision of coal laid up in the bowels of the earth for the use of its inhabitants, after the forests were destroyed to make room for cultivation.

The coal deposits of Britain, by nourishing her manufactures, which have raised her to her present proud attitude among the nations, are the principal source of her present greatness.

In the valley of the Ohio, some of the coal beds, were covered with marine deposits; in others the deposit was made in fresh water, as is demonstrated from the character of the fossil shells found in the rocks, both over and under the coal. In what manner these changes were brought about, remains for future geologists to determine, after the science has become mature.

Where not removed by degradation, or buried under other strata, there seem to have been three distinct deposits of coal throughout the main coal region, embraced on the map, which accompanies these observations. After the vegetable materials which form the coal beds, were deposited or buried under the superincumbent strata, it would seem that a strong degree of heat had been applied, in addition to the pressure, before they could assume their present bituminized appearance. As we approach the coal beds, in the transition and primitive rocks, the evidences of heat are still more apparent; removing from the anthracite beds, all, or nearly all their bituminous contents; and in the primitive, changing anthracite into graphite, or plumbago, which is almost pure carbon. It would appear, that we cannot reasonably doubt the action of heat on these coals, for the plumbago is evidently a coal, changed by heat into its present semi-metallic appearance, and it is often produced in the furnaces of the arts, by the action of heat upon carbon. A less degree of heat has been applied to the bituminous beds of "the valley of the Ohio," for they are far removed from any crystalline or transition rocks, on which the marks of heat are so apparent, and therefore could not receive a sufficiency to deprive them of their bituminous principles and change them to carbonaceous coal beds. The suggestion advanced by many geologists, and recently applied by Prof. Hitchcok, in his geology of Massachusetts, that graphite, anthracite and bituminous coals are all of vegetable origin, and changed by heat and pressure to what they now are, is a simple and beautiful illustration of a heretofore obscure and difficult subject.

Minerals associated with the Coal.

Sulphuret of iron is almost the only mineral found constantly associated with coal; and this is more or less abundant in all the beds—some possess it in large quantities, a thin stratum, often running for a considerable distance in the center of the deposit. It also appears in thin veins between the seams of the coal, as for example occupying only the thickness of the fossil leaf, which is replaced by the sulphuret; and bearing on its surface, the ribs and nervures in beautiful relief. Sometimes it is found between the laminæ of coal in filaments and dendritic fibres spreading out like the branches of a tree, and with various colors resembling fine brass, gold and silver. In coal banks, it is seldom or never, found in regular crystals, but always assumes geometrical forms in beds of blue clay and sometimes in limestone; vast quantities of it are found, on Papaw creek, a branch of Duck creek, in deposits of blue clay; shooting into the most perfect crystalline forms and possessing the lustre of burnished gold. The brown sulphuret or magnetic pyrites, is the most common in coal beds, and is used in the manufacture of copper as at Wheeling and at other places. The materials for the composition or formation of the pyrites, all exist in the vegetable matter forming the coal; and the same heat which partially fused the vegetable mass, would also set at liberty the principles necessary to the generation of the sulphurets. Argillaceous iron ores are often found in the marly clay, or clay beds below the coal, but never I believe in contact with the coal itself. In the N. E. part of Ohio, the ores thus found are used, to a considerable extent, in the manufacture of iron.

Topography of the Guyandot and Sandy River Region.

The space occupied by the tributary branches of these two streams, covers an area of about one hundred and twenty miles of latitude, and one hundred miles of longitude. Their head waters rising a little north of the thirty seventh degree, and interlocking with those of the Clinch and Holstein rivers, and some of the western tributaries of the New river or Kenawha. Their extreme branches descend from the most elevated peaks of the Cumberland group of mountains, and from the flat mountains or table lands, found between the heads of the Holstein and the Guyandot. In their descent from this elevated region, they pass through some of the most wild, broken, and picturesque country to be found in the west. Immense deposits of sandstone rocks, piled up in enormous masses to the height of fifteen hundred or two thousand feet, compose all the centre part of this region. The streams are confined to narrow ravines and valleys so deep as hardly to admit the rays of the sun at noon day. Except near the borders of the larger streams, this whole district is a perfect wilderness. The scanty population which is widely scattered over its surface, obtain their support by hunting and digging the roots of the Ginseng, an article as highly prized by the Chinese, as their more delicate teas are by us. This beautiful plant grows with great luxuriance, and in the most wonderful abundance, along the rich virgin soil of the hill and mountain sides, composed of the disintegrated sandstone, and the decayed leaves of the forest; which have been accumulating, undisturbed, for ages. For thirty years, these hills and forests have furnished a constant supply of thousands of tons of this plant to the traders stationed at remote points along the larger streams. The only currency of the country being "*Sang*" and the skins of the Bear and the Deer; and although so many years have been spent in this traffic, the hills yet furnish an undiminished supply. Cut off from all intercourse with the rest of the world, the country being inaccessible to any but hunters, with here and there a horse track, winding up the sides of the ravines and mountains, the inhabitants retain all the primitive simplicity, in manners and in dress, common to the aborigines of the country. A small "patch of corn" and potatoes furnishes them with bread; and the wild beasts of the forest with meat and with clothing; rendering them a truly independent race. The hills and mountains, although steep and broken, are covered by an immense growth of forest trees, of all the species common to the climate, which here attain an elevation, and a magnitude, not seen in any other place; rich mountain sides in a temperate climate, always affording a heavier and taller growth, than the low lands—witness "the Cedars of Lebanon." This law of nature applies as well to man as to forest trees. The tallest races being invariably found in mountainous countries; the shorter in the low lands and plains. It is but a few years since the bottom lands on the Sandy, were clothed with cane; and as late as the year 1805, boats visited that stream, as high up as they could navigate, until checked by the falls, for the purpose of collecting the stems of this gigantic grass, to be manufactured into reeds, &c. Since the ingress of domestic animals, the cane has wholly disappeared, except in some inaccessible recesses. The country on the Guyandot and Sandy, with some of the tributaries of the Kenawha, was once the favorite haunts of Bears. Enticed by the profusion of chesnuts and other favorite food, they resorted to this region in vast numbers; the caves and shelving rocks, affording them fine retreats for the winter. The best hunting months were February, March and April, when the pelt was most valuable.

Bear hunting.—I have the following interesting particulars of the amount of the trade in skins, from a man of strict veracity, who was, for a number of years, engaged in the traffic. In the years 1805, 6 and 7, there were collected from the hunters in this vicinty, no less than eight thousand skins, the best of which were worth from four to five dollars; the wars raging in Europe bringing them into great demand. Two hunters have been known to bring in one hundred skins, collected in a six weeks hunt. One man, a celebrated hunter, having assistants with him to take off their skins and secure the hams when they were fat, killed twenty five in one day. At this day they are rare and found only in the most inaccessible parts of these regions.

Its Geology.—Sandstone embracing all varieties from very fine, to coarse millstone grit, is the prevailing rock, through all this tract of country. Limestone is not seen, except it be near the heads of the rivers. Pebbles of transition rock, are found in the bed of the Guyandot, probably furnished from some disintegrated conglomerate on its heads. The mountain range approaches nearer to the Ohio river on the Sandy, than at any other point; the river here making an extensive bend to the south, and disclosing its treasures of coal in extensive and exhaustless beds. Its sandstone rocks, although forbidding and hostile to cultivation, afford a safe and lasting foothold to interminable forests, whose various families here find a safe and lasting asylum from the depredations of man. Were it not for such inaccessible spots, many of our most beautiful species of forest trees, would, in a few years, be totally destroyed. Coal is abundant on both these streams. In most places, three surface deposits are seen in the face of the hills: one near the base, from five to seven feet in thickness; a second about midway, and a third near their tops. The lower one affords much the best coal. The other two beds are thinner and of an inferior quality, being slaty and sulphureous. Fossil plants are found in the shale over the coal, and fossil trees in the sandstone rocks. Figure No. 63, (page 25 of the wood cuts,) is from the sandstone rocks on Sandy; from its imbricated surface, it appears to be a portion of a palm tree, similar to the one figured and described on the Kenawha.

Iron ores.—Iron ore is found in great quantities on the west fork of Sandy river, in the spurs of the Cumberland mountains, but is not seen in abundance on the main stream. A vast deposit is found between Little Sandy and Sandy rivers, extending along the foot of the Cumberland range into the state of Tennessee.

Salt water.—About twenty five miles from the mouth of the Sandy, and below its forks, salt water is procured in several places along the margin of the river, and several furnaces are in operation for the manufacture of salt. About the same distance up the Guyandot, salt water is found, but of an inferior quality.

Petroleum.—This singular production is seen issuing from the earth at various points along the shores of the Sandy river; and "burning springs" of carburetted hydrogen are very common, not only along the margins of the streams and at the foot of cliffs, but also at considerable heights on the sides of the mountains. One of these between the West and Tug forks of Sandy, is very noted, exciting the wonder of the wild hunters of this solitary spot. It discharges the gas through the side of a high hill, or mountain, and has been on fire for several years, blackening and scorching the earth for many feet around its mimic crater. At night it is very luminous and is seen at a great distance; by day it is distinguished only by the smoke. Between the two Sandys, twenty or thirty miles from the Ohio, is a deposit of quartz rock, forming a considerable ridge of twenty or thirty feet in height. It is seated on the borders of the iron deposit and is probably a continuation of the stratum, or deposit found in Ohio, and traced on the map of the coal region. The alluvial land on the Ohio, between these two streams, is very fertile and thickly settled by intelligent farmers. Near the mouth of Guyandot, on the higher alluvions, are seated a large number of mounds in parallel rows. The vicinity of fine hunting grounds probably attracted a thick population near them.

Great Ferruginous Deposits.

Bordering south westerly and northerly on the main coal measures of the valley of the Ohio, are found extensive deposits of the hydrate of iron. It appears in the different beds under various forms. In some an argillaceous ore; in others a brown or red oxide, but all, evidently deposited from water. Some of the deposits appear to have been made from fresh water, as fluviatile and paludine shells are found imbedded in great quantities, in one of the ore beds; which bed reposes on limestone containing marine shells. This ore bed also contains numerous remains of the branches and fragments of the roots of aquatic plants, and the remains of extinct species of trees, as will be more fully shown by drawings of some of these remains, when we describe each stratum. So far as can be ascertained from the imperfect geological surveys that have been made of this ferruginous region, the deposit extends from the base of the Cumberland mountains, on the heads of the Kentucky and Cumberland rivers, to Geauga county, Ohio, and perhaps to Lake Erie. It embraces an average width of from fifteen to twenty miles, and pursues a N. E. and S. Westerly direction. The most abundant and principal deposit seems to have been in that region whose parallel lies between the mouth of the Big Sandy and the Scioto rivers, and the foot of the Cumberland mountain in the N. E. part of Kentucky, stretching over into Ohio, the outlines of which are traced on the accompanying map. The S. W. portion of the deposit is in a very hilly, broken region ; the hills being from three hundred to four hundred feet high, based on a fine grained, argillaceous sandstone rock, containing beds of slate, and in some portions of it, numerous remains of orthoceræ, encrinites, ammonites, &c. The middle and N. E. portions above Chilicothe, are in a less broken, but still hilly country, and contain more calcareous rocks, bordering on the great tertiary deposits. Coal, is occasionally found in this part of its course, but much less abundantly than in the great coal region, east of the iron ore. *Marine* fossil shells are most abundant, both in the limestone and sandstone which accompany the ferruginous deposits in its N. Eastern portion. Throughout its whole course the deposits seem to have been made from water. In Ohio, the strata, in the iron region, dip to the S. E., at an angle of about seventeen feet in a mile. Although the face of the country is very hilly and broken, the strata are not disturbed thereby ; but when cut across by the ravines and hollows between the hills, they make their appearance in the face of the opposite hill at the same elevation, if the hills are in the line of extension ; but if in the line of dip, then at the point marked by the angle of that line ; thus proving that these deposits were once continuous and unbroken, until they were cut up, and worn away by the degradation of the superincumbent strata, from the continued action of rain, frosts and streams of water. The present appearance of the strata in the hills, is shown by the following horizontal section.

Fig. 18.

The interrupted lines representing the several strata of sandstone, slate, limestone, iron ore, coal, &c.

The hills in the S. W. part of the iron region, both on the Kentucky and Ohio sides of the Ohio river, are sterile, and unproductive.

The soil is light colored and sandy. The forest trees are chiefly oak and yellow pine on the hills, the pine being confined to the tops of the highest hills. In the ravines and narrow bottoms, between the ridges, poplar, hickory, and sugar trees are found. On Genet's creek, eighteen miles above the mouth of the Scioto, and two miles from the Ohio river, is "the Junior furnace," nearly in the center of the main iron deposits. At this spot, and for many miles above and below it, there are three distinct deposits of ore, of different varieties, and producing different qualities of iron. The first or lowest bed, reposes on a sandstone rock, about fifty feet above the *great limestone rock*, which underlies all this region. It is about eighteen inches in thickness, and intermixed with a good deal of sand. It varies considerably in quality and in thickness at different points. It has evidently been deposited from, or in water, containing fossil shells; but is the poorest of all the ores. The second bed is about one hundred and fifty feet higher in the hill, and is deposited in, or has a matrix of blueish colored clay, in kidney shaped masses. These are composed of concentric layers, that easily separate under the process of *roasting*. This bed is from five, to twenty inches thick, and affords, in the common way, about forty per cent of very pure, highly carbonated iron, of the best quality for castings. The articles formed from the pigs made at the Franklin furnace, have the color and lustre of black lead. The specific gravity of this ore is 3.02. The third bed is about ninety feet above the second, reposing on a dark carbonaceous limestone rock. It is of the quality called "brown, compact, oxide of iron," and varies in thickness, from a few inches to five feet. When well managed it affords about fifty per cent of iron, of a quality very suitable for bar, or hammered iron, possessing great tenacity and flexibility. This bed is called by the miners "block ore," from its breaking into cubic pieces; the bed being full of seams and cracks, resembling, when first uncovered, a pavement of tiles and bricks. Where the deposit is thick, it abounds in vertical, oblong cavities of several inches in length, in the center of which is a stalactitic ore, looking as if it had been melted, and while running down cooled into the shape of an icicle. At the bottom of the cavity is a depression, answering or conforming to the rounded extremity of the stalactite.

Mr. Hitchcock, in his geology of Massachusetts, takes notice of an iron ore having the same structure. At the first view we are led to conclude it to be the effect of heat, but every appearance of the rest of the bed forbids such an opinion, and it is probably the result of the slow percolation of water, charged with the iron in solution and deposited in the same manner as the calcareous stalactites, in numerous caverns and grottoes in various parts of the earth. These three are the main deposits of ore, and they are known to extend in some directions to the distance of thirty or forty miles in continuous beds. Farther up the Ohio, on Symms' creek and Raccoon creek, considerable deposits of argillaceous kidney ores, are found, imbedded in a red or brown marl; but not in quantities sufficient to warrant the erection of furnaces. In the vicinity of these beds the soil on the hills is of a red color.

Section and description of the Rock Strata in the Ferruginous Deposits.

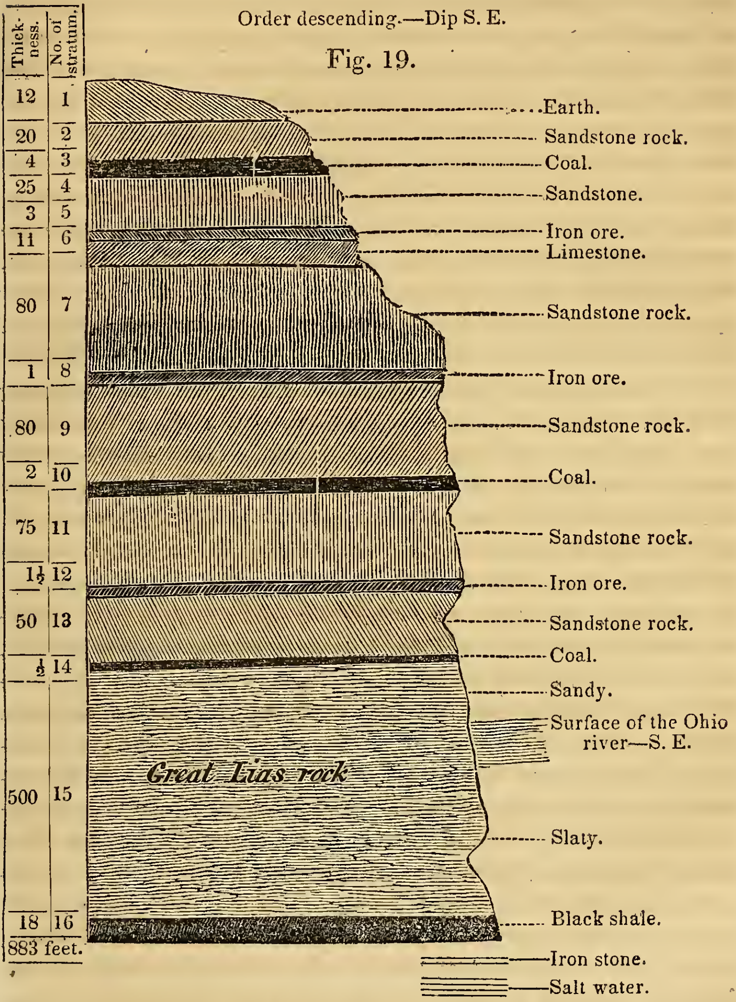
On the heads of Tyger's creek in Kentucky, rising in the same region with the Little Sandy, there is a deposit of ore fifteen feet in thickness, of a loose friable texture, having the appearance of a blueish, decomposing limestone. It affords a very soft iron of a good quality for castings of stoves, and ware for domestic uses. In a district of country embracing about twenty five miles square, taking the Ohio river below the Sandy for the center, there are at present in operation about thirty furnaces, making on an average, one thousand tons of pigs per year, or thirty thousand tons for this district. This amount can be annually enlarged to any quantity the country may require.

The following section and descriptions of strata, will give a connected view of the formations in this region. It is taken at "the Junior Furnace," twelve miles below the "Hanging rock," and two miles from the Ohio river.—Locality noted on the map.

Section of the Strata at the "Junior Furnace," Scioto Co.

Order descending.—Dip S. E.

Fig. 19.



1. Thin, poor, ash colored soil—timber, oak and yellow pine.—12 feet.

2. Coarse, ash colored, unstratified, compact sandstone rock, containing numerous white pebbles and coarse gravel, imbedded; easily crumbling and disintegrating. It is invariably the fact that the upper or surface rocks are much coarser in their composition and texture, than those that are deeper seated and deposited earlier in the series.—20 feet.

3. Bituminous coal, from four to five feet in thickness, slaty structure, with considerable sulphuret of iron—makes a tolerably good fuel, but cannot be used in the smelting of iron. The sandstone rock above, reposes on the coal, forming a solid roof. Beneath the coal is a bed of slaty shale, one foot thick, containing impressions of leaves, plants, &c.—5 feet.

4. Coarse, brown colored, sandstone rock, containing but little mica—structure compact—variegated with veins of red, passing through the rock in various directions. These are formed by the oxide of iron, contained in the sand at the period of its deposit. Fossil trees are found in this deposit, replaced by iron ore. They probably belong to the same period with those found on the tops of the hills, on the waters of the Sandy and Big Kenawha.—25 feet.

5. Iron ore deposit, from three to five feet in thickness; reposing on a bed of limestone, and covered above with a thin coat of marly clay, sometimes containing nodules of iron ore, coated with yellow oxide. This deposit is very extensive and can be traced on both sides of the Ohio, for twenty miles or more, dipping towards the S. E.—On the westerly side of this deposit, it is found near the tops of the hills, and on the easterly, at their base; finally, disappearing on the Ohio side under the bed of the river, sixteen miles above this section. It may be called a brown calcareous oxide of iron, originally deposited in a uniform continuous bed. But after the water was drained from this region, by some great, but unknown cause, probably the gradual rising of the ocean bed, from some expansive and upward force from below, the deposit dried and contracted in such a way as to produce fissures and seams through the whole mass, breaking into rhombic fragments of various sizes from a few pounds, to several hundred weight. It is a rich ore and affords about fifty per cent of iron, very malleable, and when wrought makes excellent bar iron. This deposit abounds in fossil shells, which easily separate from the ore when roasted, affording many perfect specimens of casts, both of univalve and bivalve species. The figures of shells, Nos. 28, 29, 30, 31, 32, 33, 34 and 35, (page 14 of the wood cuts,) Nos. 36 and 37, (page 26,) are from this deposit; the descriptions will be found in the appendix. The roots of several extinct species of plants, probably aquatic, are found in this bed, and trunks of fossil palm trees, nearly a foot in diameter. Figure No. 64, (page 23 of the wood cuts,) is a fragment of some aquatic root, or a portion of a large Encrinus—most probably the

former; it was several feet in length before broken; the undulating, circular annuli, are very peculiar. It is an inch and a half in diameter, and two in length; the center cavernous. No. 65, (page 15 of the wood cuts,) is evidently a fleshy root of some plant. The figure is the natural size, deep transverse folds are placed at short distances through the whole length. I have several similar ones. The fossils from this bed are all perfect iron ore. The specific gravity of this ore is 2.46.—3 feet.

6. Lime rock—oolitic, in thick beds, compact and solid, of rather a dark carbonaceous color, containing particles of white calcareous spar, and numerous species of imbedded shells of the families Producta, Spirifer, Encrini, &c. Figures of shells, Nos. 38, 39 and 40, (page 26 of the wood cuts,) are from this bed. Descriptions given as above. This bed is eleven feet in thickness and affords a supply of calcareous material, used in fluxing the ores at the adjacent furnaces.—11 feet.

7. Fine grained, argillaceous sandstone rock. The particles of sand, fine and round, cemented by a fine clay with a little iron. The upper portion of the bed is light colored; the lower, darker and variegated with different shades of brown. It resists the most intense heat and is used in the erection of furnace hearths, for which it is most admirably fitted—a few miles above Portsmouth, near the river, this deposit is found on the tops of the hills.—80 feet.

8. Argillaceous iron ore, in nodules and lumps, generally kidney shaped and flattened; imbedded in marl or fine clay, beneath the ore, there is usually a thin stratum of lime. It is a rich ore yielding forty or fifty per cent of the best quality of foundery, or cast-iron.—Bed 1 foot.

9. Sandstone rock, rather coarser than the bed above—grains more flattened and containing some mica.—80 feet.

10. Bituminous coal of a good quality, and two feet in thickness, has lying over it a bed of shale of four feet, with vegetable impressions between the layers, and below it a bed of dark colored marl and ochre, changing gradually into sandstone the entire carbonaceous deposit of coal and shale.—7 feet.

11. Argillaceous sandstone, light brown, and compact—affording good materials for architectural purposes.—75 feet.

12. Siliceous, or sandy iron ore, affording a less quantity of iron, than either of the other ores, and not much used where the others can be procured.—1½ feet.

13. Fine grained, slaty sandstone rock, in thin beds of a brown color, and argillaceous character.—50 feet.

14. A thin bed of coal of a few inches, with shale and slate. The hills, at this spot, rest on this bed of coal, under which appears the great lias limestone* deposit, that underlies all this region, and has a dip to the S. E. of about 2°, or seventeen feet in a mile. Four miles below the mouth of the Little Scioto, and six hundred yards from the river, this rock appears at an elevation of nearly two hundred feet in the face of the hills. At this spot, a shaft has been sunk to the depth of one hundred and fifty feet, and ten feet in diameter, in search of coal. A bed of ten or twelve feet in thickness having been passed through at the depth of four hundred feet by a person in boring a well for salt water, all the foregoing strata, being superior and conformable, were found to have a dip to the S. E. At the depth of one hundred and fifty feet from the surface, the proprietors became discouraged and abandoned the shaft, but proceeded yet two hundred feet further by boring, and then gave up the search—could the shaft have been completed, there is little doubt that a valuable bed of coal would have been found, and many interesting geological facts brought to light. As it was, many facts in relation to the lower strata, and rare and curious fossil shells, have been discovered, after having reposed in darkness and obscurity for ages beyond the knowledge of man; of these, I was so fortunate as to secure a number of specimens, as the work went forward. The following description of this rock, the 15th of the series, will better explain its contents and composition.

15. Argillaceous sandstone rock, very fine grained, of a light brown color—upper part tolerably hard, and affords good materials for buildings. It is easily cut with a saw, and at Portsmouth, large quantities are manufactured into slabs for grave stones, window sills, &c. at a steam mill erected for that purpose. The center portion is a soft, argillaceous rock, or compact marl; and the under portion soft and shelly, reposing on a bed of black shale. The upper half of this great deposit, contained the imbedded remains of numerous orthoceratites and encrinites, some of the former, being replaced by the sulphuret of zinc. At one hundred and twenty feet in the in-

* Not having seen either the country here described, or specimens from it, we cannot form an opinion whether the rock called lias by the author, corresponds to the lias of the English geologists, or not; the position of the latter is above the great coal deposit.—*Ed.*

durated clay, or slaty clay, were found Pectens, portions of a testaceous animal, and a bed of egg shaped fossils, of the family Echinus or Spatangus. There were nearly half a bushel of them, and the workmen called them a nest of turkey's eggs. These are represented in Figures, Nos. 41, 42 and 43, (page 26 of the wood cuts,) Nos. 44, 45, 46 and 47, (page 28.) The animal is replaced by slate in all these specimens. A few feet below, the slate became still more soft, like indurated marsh mud, and was filled with the most perfect and beautiful fossil shells of the ammonite, several species. Turrited univalves and bivalves; all replaced by rich *brass or bronze colored* sulphuret of iron. Figures, Nos. 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61 and 62, (page 28 of the wood cuts,) are from this deposit, some of the specimens have all the lustre of a gilded button.—Shaft, 150 feet—boring, 150 feet—rock above in hill side, 200 feet.—500 feet.

16. Black, bituminous shale, impregnated with petroleum and burns with a blue flame and sulphurous smell. The shale reposes on a thin stratum of iron stone, of only one or two inches; but as hard and as difficult to penetrate, as the hardest iron. Beneath this, *salt water* is found, so completely saturated, as to retain, for many hours, a small quantity of pure salt, undissolved, which was added for the experiment. The boring was continued for nearly fifty feet further, in fine grained, hard, brown, sandstone rock, containing iron pyrites, and small veins of salt water and petroleum. At this point the boring was discontinued in 1833, and has not since been resumed.—18 feet.

Iron Ores.

About twelve miles north of Portsmouth, on the heads of a small stream, which falls into the Scioto, is a deposit of iron ore, at an elevation of about two hundred and fifty feet in the hills. The bed is about three feet in thickness, and is almost a complete mass of fossil shells. It embraces many species of univalves and bivalves; perhaps all of them are oceanic, although a few strongly resemble those of fresh water genera. From its elevation it is probably a continuation of the deposit described as No. 5 in the foregoing section. The ore is not rich, and will probably yield not more than fifteen or twenty per cent. of iron; its specific gravity is about 2.43, which is nearly that of the "block ore." Some of our richest nodular iron ores, have a specific gravity of 4.16.

From the regular dip of all the strata of this region, the breadth of the surface deposits of iron ores, is limited, to what it probably would have been, had the strata pursued a horizontal direction. Persons unacquainted with this fact, have, while searching for ore beds, met with much difficulty and disappointment. Having seen the ore dug at a certain elevation in the hills near a particular furnace, they have been led to look for it at the same elevation, in a spot several miles distant, and being unable to find it, after a very diligent search, have concluded there was none; when, had they examined at the spot indicated by the angle of inclination or dip, they would have been more successful; so true is it that "knowledge is power." The extent of the iron deposits easterly, is unknown as yet; the ores, having been sought for only on the surface, or where they crop out on the sides of hills. Should shafts be sunk for them, as is the case in England and many other places, they will probably be found many miles up the Ohio, and at very great depths. The diggings for ores, have been principally confined to such parts of the deposits as appear near the surface, and can be approached by removing a few feet of the superincumbent rocks and earth. Not many, if any drifts, have been pushed to considerable distances under the hills, where it is probable the ores will be found of a richer quality than near the surface. In the eastern parts of Adams county, a few miles below the Scioto river, are very considerable beds of iron ores, that have been in use for several years, and are to all appearance, a continuation of the same deposits, found above the Scioto. Indeed, the whole eastern portion of the county is a mineral region, abounding in vast beds of aluminous slate, large hills being composed of this material. Imbedded in the slate are thousands of globular groups of crystals of iron pyrites, from the diameter of an inch to three or four feet. As the slate decomposes, these balls tumble out and roll to the foot of the hill; they are generally oblate or flattened at the poles. On the west side of this deposit, considerable beds of sulphuret of zinc are found, several specimens from this place, being in my possession. The iron ores are also impregnated with, or contain *lead* in small quantities; a number of pounds of this metal, in a very pure state, having been found in the crevices of the furnace hearths, when taken up for repairs, where, from its superior gravity, it had fallen during the smelting process. A few miles further south, in Kentucky, galena is found in considerable quantities, in limestone. On the geological map, the iron deposits are traced between the mouth of Big

Sandy and Tyger creek, and extend south to the heads of the Little Sandy. Its prolongation in this direction, is without doubt much more extensive, as I learn from travellers that it is abundant on the heads of the Cumberland river, at the foot of the mountains. The face of the country, through this region, is hilly, broken and sterile; bearing all the characteristic features of a mineral district. The operations of smelting are at present conducted altogether with charcoal; but the time is not distant when the forests will fail to afford an adequate supply for the wants of the numerous manufactures. When that period arrives, the beds of bituminous coal, that now lie neglected or unknown, will be sought for and brought into use. If those on the surface are not sufficiently pure, beds of much greater thickness and purity will be found, by sinking shafts; as has already been proved in several instances, by persons boring for salt water. West of the base of the Cumberland range, in Adair county, Ky., a bed of coal, forty five feet in thickness, was passed by a person in sinking a salt well. This material when coaked or deprived of its bituminous and sulphureous portions, by roasting, answers very well for the furnace; and all the iron manufactured in England, is extracted by the aid of coaked coal. Indeed, without her coal beds, that country would become comparatively an impoverished kingdom; while with them, she commands the trade, and the wealth, of the world.

"Hanging Rock."

Four miles above the mouth of the Little Sandy, on the Ohio side or right bank of the Ohio river, and in the midst of the iron region, is a celebrated cliff of sandstone, called the "Hanging Rock." The upper portion of the cliff, which is nearly four hundred feet high, projects over the mural face of the rock, like the cornice of a house. It is extended also for some distance up a small creek, which here puts into the river. The Ohio flows close to its base, while beneath, and under its projecting walls is erected a forge, for the refining of iron; the blasts of its immense bellows, and the thundering noise of its tremendous hammer, weighing more than a ton, echoing and reverberating under the walls of the cliff, afford no unapt emblem of the labors of the Cyclops, under the caverns of Mount Ætna. An abundance of iron ore is found in the vicinity, and a few miles back in the hills, a furnace called "the Ætna," furnishes the pigs for the anvils of these modern Cyclops. Bar iron of an excellent quality, is manufactured at this interesting spot. Near the top of the cliff, is a bed of aluminous slate, through which the water filtrates from above, and slowly evaporating below, forms stalactites of alum, impregnated with sulphate of iron. In other parts of this deposit, more sheltered from the weather, and more dry, the sulphate of magnesia is formed, in transparent, acicular crystals, of one or two inches in length. A few miles above, between Hanging rock and Burlington, is an extensive bed of very pure clay, affording an excellent material for stone ware, and for the manufacture of alum; large quantities having been shipped to Cincinnati, and used for this purpose.

I am indebted to the Rev. Dan Young and Rev. Mr. Fisher, for much valuable information on the iron deposits; Mr. Young, having been engaged for several years in searching for ores and directing the operations of furnaces.

Extent of the Coal Measures and Muriatiferous Strata, in Kentucky, on the N. W. base of the Cumberland Mountains.

Extensive deposits of coal and saliferous rocks are found stretched along at the feet of these mountain ranges, and extending to the distance of one hundred and twenty miles west of them, in the heads of Licking, Kentucky, Green and Cumberland rivers. Throughout this region, embracing the sides and spurs of the Cumberland mountains, the prevailing rock is sandstone; on its western limit, it changes to limestone; often intermixed with nodules of flint, and containing imbedded, detached masses of *galena*. On the south branch of the Cumberland river, at the salines on Goose creek, large quantities of salt are made. These salines are about twenty five or thirty miles from the foot of the mountains, amidst a hilly region. Salt water is found on all the head branches of the Kentucky river, but is most abundant on the south fork. Coal is sometimes seen on the borders at the limestone rocks, resting on slate, and covered with a calcareous roof. On Green river, coal is found to within fifty miles of its mouth; salt water is also obtained at the depth of about eighty feet, with an abundance of carburetted hydrogen and petroleum. Salt petre caves are numerous, along the limestone bluffs of this river; amongst them is "the Mammoth cave," extending for eight or ten miles under the surface, and passing beneath the bed of the stream. Lead ore is also found on this river, and was formerly worked by the hunters. In Cumberland County, salt water is reached at the depth of fifty to one hundred and fifty feet. About three miles east of Burksville, on Renwick creek, is a petroleum spring, which discharges oil in such quantities, that it floats on the surface of the water into the river, a quarter of a mile below the spring, and was set on fire by a fisherman who was following his sport by torchlight. In Adair County, Mr. Conover, in boring for salt water, about a mile from the Cumberland river, at thirty feet down, struck a bed of coal forty five feet in thickness; at one hundred and fifty feet beneath the coal, a vein of salt water was reached, into which the augur dropped, and immense quantities of gas were discharged for a number of days. On Crocus creek in Russel County, about one hundred miles from the foot of the mountain, in boring a salt well, gas issued in such force and volume, as to throw the augur and poles, out of the well into the tops of the adjacent trees. Coal and salt water, are found from the heads of the Cumberland river, to the heads of the Licking, occupying the whole of the northern and eastern borders of the state of Kentucky; west of this line, iron ore was deposited very abundantly. For the above facts, I am indebted to my friend R. Peter, M. D.

Coal Measures in Tennessee.

The following statements from Dr. Troost of Nashville, in answer to my enquiries on this subject, will be interesting, as showing the extent of the coal deposit in that direction.

"1. Respecting the extent of the coal strata. The second elevation of the Cumberland mountain, is composed of coal measures. The most southerly extremity of that formation, that I have examined, is near Battle creek, in the ridge which encloses Sequatchy valley, where it crops out at several places, also to the west of Jasper, and in several places east of that valley, as in the vicinity of Washington, McRhea co.; continuing thence in a N. E. direction, it crops out near Piney creek and Emy's river, where it takes a N. W. course, and crops out at several places near Obey's river, and on the north western declivity of the Cumberland mountain.

"I believe there are some deposits of coal in the Clinch mountain, but I have not yet visited that part of Tennessee. In fact, I have not yet investigated properly any of our coal formations. I have postponed it until I shall have it in my power to clear up some apparent anomalies, which I think I have found in the succession of the strata which compose the Cumberland range. I am well convinced that near Battle creek, about two or three miles from Tennessee river, the coal and its associating strata rest upon the upper transition, or mountain limestone. But that is not the case, (at least, as I have been able to ascertain,) near the crab orchard and near the Ohio river. There, an oolitic limestone, underlies the coal formation. Such arrangement is uncommon; it exists, as far as I know, no where. It is my intention to investigate this matter, during our spring vacation.

"2. The primitive formation is a good distance from the coal. The smoky mountains belong, principally, to the clay slate formation. I did not discover the least vestige of organized bodies in it. Some of this slate, is the roofing slate, while other has a talcose appearance. You know that some rank this formation amongst the transition, while others consider it as primitive. The formation east of that range, is undoubtedly primitive, and belongs to North Carolina. To the west, it forms an alternation of strata of graywacke, limestone and sandstone on the lower transition.

"3. No limestone strata, are found amongst the coal strata.

"4. I do not know of any salt water, at least in quantity, in our coal formation. Wells have been bored, and salt water sometimes obtained, but soon failed.

"5. Only one stratum of coal, has been found in the Cumberland mountain, and that lies above the Tennessee and Cumberland rivers.

"6. I have found only culmæ and some remains of large monocotylodonous plants in the sandstone, but no impressions in shale.

"7. I have not made any analysis of our coal—it is of a good quality and resembles Richmond coal.

"8. Iron is the only metallic substance found near our coal, particularly on the eastern declivity of the Cumberland mountains, where is found a large stratum of red oxide of iron. The coal, as generally is the case, contains a small quantity of pyrites."

"I have not met with any animal remains."

Great Silicious Deposit.—Burrh Millstone.

This interesting and valuable deposit, makes its most northeasterly appearance, so far as I can ascertain, in Coshocton county, Ohio, on the Tuscarawas river, and pursuing a southwesterly course, generally, near the westerly limits of the coal measures, crosses the counties of Licking, Muskingum, Perry, Hocking and Jackson, terminating in Scioto; although there are many reasons for believing that the same deposit is continued into Kentucky. It spreads out to its greatest width, being only four or five miles, in Muskingum and Jackson counties, and is usually found on the highest, or dividing ridges. It assumes various appearances in different places, as to texture, composition and color. At certain points of the deposit, it is compact and splits into conchoidal or splintery fragments. At others, it is cellular, or rather filled with small winding passages, as if made by *a worm* while in a soft or plastic state. Portions possessing this character, are usually selected for manufacture, as they make the best millstones. At the S. W. extremity of the deposit, there is less of this vermicular appearance; and the rock abounds more in *cells*, like the french stones, and also in numerous fragments of fossil shells. Near the spot where it crosses the Hocking river, it seems to have been deposited in the state of a fine powder, as if precipitated from a fluid which held it in solution. It is also here mixed with a portion of lime, and oxide of iron, disposed in veins of yellow and white; parts of which are as white as chalk. This variety, when first taken from the earth, is cut with an iron hoop, or other bit of soft iron, into whet stones and hones. In Muskingum county, and north part of Perry county, the upper portions of the rock, are partially crystalline, and must have been deposited in a fluid state; or it has been subjected to a heat sufficient to melt it, after it was deposited, for it abounds in different colored veins, passing through the stone in various directions. The most predominant colors, are red, blue, yellow, black and brown. These high colored portions generally split with freedom, and were much sought by the aborigines for arrow heads, knives, &c. In Jackson and Muskingum counties, the earth over these flint deposits, is full of cavities, dug to the depth of six or eight feet, in search of the fresh quartz, as that just taken from the earth splits much more easily and smoothly, than the blocks which lie on the surface.

In favorite spots, these cavities occupy the ground for miles in extent, and are many thousands in number. It was supposed by the neighboring inhabitants, that these cavities were made in search of copper or silver ores; and some years since, a company united and sunk a shaft to the depth of fifty feet. Nothing was discovered but flint rocks and earth. Metals could have been of no use to the aborigines, for they had no knowledge of the art of smelting them, or working them when smelted into useful articles. But the quartz was already prepared for use, and more valuable to them than a mine of gold; with the tip of an elk's horn, and one of their stone axes, the flint was wrought into articles of indispensable utility in the chase, and in war. A large proportion of the arrow heads found in the Muskingum valley, are from this place, which furnished articles not only of necessity, but also of great beauty, many of them being variegated with rich colors, always in high estimation with the savage. Another object of search, may have been, the splendid crystals of limpid and colored quartz, which abound amongst the flint, covering spaces of more than a foot square with hexagonal pyramids, united at their bases, and sometimes nearly an inch in length, but generally about half an inch. Fragments of these are often found in mounds, buried with other curious relics, precious in the eyes of an Indian. Veins of very pure chalcedony, traverse many parts of the rock; and large amorphous fragments of sulphuret of barytes are common, intermixed with the flint or hornstone. I have in my cabinet, several specimens from this place. Fossil shells, are found in all parts of the deposit, partaking of the character of the rock in which they lie imbedded. Some are replaced by pure chalcedony—others by crystalline quartz, so pure as to be nearly transparent—others again, are hollow and filled with small drusy crystals of limpid quartz, and in one instance, containing the outlines of a Spirifer, or rather the replaced animal itself. Figures of several from this bed are given in the section of "Putnam hill," as the shells are similar in both localities, and only about six miles distant. This stratum varies in thickness at different points; in some, it is eight or ten feet, at others considerably more. In all its extent, it is stratified, or lies in separate beds, but is much broken into large blocks and fragments by vertical seams, so that, when uncovered, it is easily removed from the quarry. It varies much in its structure, some portions being crystalline and others mechanical. Whether this silicious bed is the westerly termination of that extensive stratum known to exist in the series of muriatiferous rocks, and penetrated by salt wells in so many places, is not yet known; and can be decided only, by a careful examination of its dip and association with other rocks, through its whole course, although my present opinion is, that it is a distinct deposit. If so, it must have been made in the bed of the ancient ocean, from a combination of minerals held in solution by hot or boiling water, ejected from the interior of the earth through some extensive crevice in the strata below, at the period when the rocky beds were thrown into their inclined state, in which they now lie about the salines on the Muskingum river. We have proof that this stratum was formed under water, from the imbedded animal remains, found through its whole length, and also that these are marine shells, and of course lived in salt water. Mr. Bakewell, when speaking on the subject of silicious deposits, says, "we know no instances in nature, of silicious earth being held in aqueous solution, except in waters of hot or boiling springs; and hence it seems reasonable to infer that many silicious rocks and veins have been deposited from subterranean waters at high temperatures. In other instances, silicious earth, rendered fusible by an intermixture with alkalies and earths, may have been poured over the bed of the ocean, and by gradual refrigeration, the constituent parts may have separated and formed granite rocks, composed of quartz, feldspar, mica and hornblende. Beds of limestone may have been formed by similar calcareous eruptions, in which the lime was sometimes in solution, and sometimes mechanically suspended. Nor is it necessary to suppose, that these aqueous eruptions were always sudden, and attended with violent convulsions; for when a passage was once opened, they may have risen slowly, and been diffused in a tranquil state, and by gradual condensation, may have enveloped the most delicate animals and vegetables, without injuring their external form. The long intervals of repose, between these aqueous eruptions, saturated with mineral matter, may have allowed time for the growth and decay of animals whose remains are found in different strata, whilst the formation of others may have taken place under circumstances incompatible with organic existence, and accordingly we find in the rocks most abounding with organic remains, certain strata, in which they rarely, or never occur. The same agent which envoloped living animals in mineral matter without injuring their external form, appears in some instances to have immediately arrested vitality. Petrified fish have been discovered in solid rock, which appear to be in the very attitude of seizing and swallowing their prey.* A sudden eruption of hot fluid, saturated with the different earths, might destroy in a moment, the animals previously existing, and form around them a sili-

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* Mr. Bakewell examined the celebrated specimen here alluded to, which is in one of the museums of Paris, and concluded that the heads of the fishes were merely pressed against each other.—*Ed.*

cious or calcareous incrustation, which would protect their remains from further destruction." "Ages of comparative tranquility might elapse in the interval between these eruptions, and beds of gravel and breccia be formed by the disintegration of the higher parts of the earth; and may we not in this manner explain the alternations, or intermixture of crystalline rocks with those of mechanical formation?" In this manner, may we not suppose were formed several of the strata described in these observations, especially the silicious beds, and some of the very hard and almost crystalline rocks, both of sandstone and limestone? According to some recent experiments of Sir James Hall, the vapor from salt water, intensely heated under pressure, will, by passing through loose sand, agglutinate the particles, and form solid sandstone. Thus, the heated and compressed water of the ocean may have consolidated the loose sand on its bottom, and formed the strata of sandstone in the coal measures of the valley of the Ohio.

Remains of Fossil Mammalia, Fish, &c.

Throughout the secondary deposits, which accompany the coal measures, few fossil remains are found, excepting those of vegetables, and crustaceous animals. It is possible, but not very probable, that as more extensive openings are made in our strata, these remains may come to light, although it is more in accordance with geological facts, to say that during the period of the formation of the coal measures, animals of the class Mammalia, were not in existence. Shells, the production of the water, we find in abundance, and it is said, some remains of fish, but I have *seen* nothing that could be properly called an Ichthyolite. In the alluvial and tertiary deposits, bordering on the coal region, and sometimes, within the coal measures, the remains of the mastodon, elephant, horse, and extinct species of sheep are frequently found, but always in alluvium, diluvium, or recent tertiary deposits. A number of these ancient fossils have been exhumed in excavating the Ohio canal, which lies all along on the borders of the tertiary formation. I have seen a fossil tooth of some animal of the seal family, known by its grooved, lateral surfaces, which was found in the slate, on Duck creek, a few miles north of Marietta, and in the dark carbonaceous limestone rock, which forms the bed of that creek, a few miles from its mouth, I have seen the claws of some animal, perhaps a turtle, retaining their perfect form and lustre. They were about three fourths of an inch in length, and of a proportionate thickness. These are the only instances, which have come to my knowledge, where fossils of this class have been found in secondary rocks. In a sandstone cave, in Wood County, Virginia, bones are found in the rock on the bottom, but they are the bones of deer, which stalagmites have enveloped; a solution of the carbonate of lime, dripping through the sides of the cave has slowly concreted over them. Extensive salt petre caves are not common in the coal measures; there are therefore no receptacles of this kind, for fossil bones. Granite bowlders, so abundant all over the tertiary region, are very seldom seen in the secondary portions of "the valley."

A tabular view of the specific gravity, and combustible qualities of the Bituminous Coals, from different places in the coal measures of the valley of the Ohio.

Places.	Per cent of charcoal.	Per cent of bitumen and earth.	Per cent of coak.	Specific gravity.	
Zanesville, upper bed, last deposit,	60.	40.	53.	1.22	
Carr's run, Pomeroy's bed, Ohio,	60.	40.	50.	1.27	
Bed of Muskingum river, at Coal run.	50.	50.	53.	1.31	
Kenawha salines, upper bed,	65.	35.	60.	1.25	under the silicious slate.
" " middle bed,	64.	36.	55.	1.29	under sandstone rock.
" " lower bed,	60.	40.	54.	1.25	under shale.
Clarksburgh, Va., Monongahela valley,	55.	45.	53.	1.22	
Pittsburgh, Pa., outlet of Monongahela valley,	60.	40.	55.	1.28	
Brownsville, Pa., Monongahela valley,	60.	40.	53	1.30	
Pipe Creek, twelve miles below Wheeling, Va.,	60.	40.	53.	1.23	
Wheeling, Va., same bed,	60.	40.	53.	1.23	
Clearfork, Little Muskingum creek, Ohio.	55.	45.	53.	1.38	under limestone rock.
Cambridge Slaty Cannel Coal, Ohio,	50.	50.	50.	1.41	
West Fork of Duck creek, Ohio,	50.	50.	53.	1.61	
Hockhocking river, near Nelsonville, above and near the salines,	55.	45.	40.	1.26	
Near to Jacksonville, Illinois,	55.	45.	50.	1.20	amidst limestone.

The following is a list of English Bituminous Coals; copied from Dr. Ure.

	Per cent of charcoal.	Per cent of bitumen and earth.	Per cent of coak.	Specific gravity.
100 parts of best English coal, give - - - -			63.	
" " of Newcastle " " - - - -	58.	40.	58.	1.27
" " of Wigan " " - - - -	61.73	36.		1.26
" " of Slaty cannel " " - - - -	47.62	32.		1.42

The above comparison, shows a great similarity in the specific gravity and the combustible contents of the English coals and those of the valley of the Ohio. Their best cannel and anthracite coals contain a much larger proportion of charcoal. Had the process of coaking, been conducted in the usual way, in close covered vessels, or in the mode pursued in making charcoal from wood, the amount would have been much greater; a part of the charcoal being consumed with the bitumen, and all the earth and ashes left remaining with the coak. By deflagrating the coals with the nitrate of potash, it is seen, that the proportion of charcoal, or coak, is much greater than here given. Fourteen grains of the purest of this coak, decompose one hundred of nitre, which shows it to be nearly pure charcoal. According to Dr. Ure, one ton of English coal, produces from 1100 to 700 pounds of coak, by the usual process, which is detailed in his chemical dictionary. The bituminous coal of the valley of the Ohio, it is believed, will, whenever the wants of the manufacturer, shall demand its use, more than average this amount.

Note.—After the description of the coal deposits, in the Monongahela valley, add the following, which was accidentally omitted in its proper place.

On the north branch of the Potomac, which rises in the Alleghany range, near the line of the Ohio and Potomac canal, especially in the vicinity of the western part of the Savage mountain, a spur of the Alleghany, the deposit of coal is from twelve to twenty feet in thickness—and is said by the Engineer, in one of his reports to the canal commissioners, to average thirteen feet, over an extent of two hundred square miles; and so near to the route of the canal, that it may be passed from the coal mines into boats by means of a slide. The same deposit is continued westward, through the Laurel and Chesnut ridges, but not so thick. It is without doubt a continuation of the Monongahela valley deposit, and may be traced north and east, over on to the heads of the Susquehannah river, where it is found in great abundance. In that part of the south branch of the Potomac, which traverses the transition rocks, anthracite coal has been discovered, but to what extent, I have not yet learned.

APPENDIX.

Being a notice and description of the Organic Remains embraced in the preceding paper; by Samuel George Morton, M.D.

Note.—I have had a good deal of hesitation in naming the *Spirifers* and *Producti* of this paper, because many species have been already described by naturalists, to whose works I could not gain access in time, to avail myself of them; such names are, therefore, to be considered *provisional* only. The Uniones and Ammonites, on the other hand, are decidedly new. With respect to the vegetable remains, I have compared them with the figures given by Sternberg, Brongniart, and Lindley, but in many instances without success. This department will require much more time, and a diligent comparison of specimens.

PLATE I.

Unio petrosus.* (S. G. M.) Fig. 17. Shell subovate, compressed; disks somewhat flattened, cuneiform inferiorly; posterior side subcuneate.

Unio tumulatus. (S. G. M.) Fig. 18 and 21. Shell subovate, compressed; posterior end cuneiform; umbonial slope angular; margin swelling anterior to the middle.

Unio terrenus. (S. G. M.) Fig. 19. Shell elliptical, elongated; anterior end rather narrower than the posterior; umbonial slope rounded, indistinct.

Unio saxulum. (S. G. M.) Fig. 20. Shell elliptical, elongated, compressed; posterior side cuneiform; extremity acutely angular.

Anodonta? abyssina. (S. G. M.) Fig. 22. Fig. 23, view of the basal margin. Shell elliptical, ventricose; beaks rather prominent, pointed; umbonial slope not prominent.

Ammonites Hildrethi. (S. G. M.) Fig. 24. Smooth, ventricose, with two or three volutions: sutures jugiform, crowded: diameter, two inches and a half.

This fossil is a silicious cast: it is one of the most remarkable species I have ever seen, and I have much pleasure in giving it the name of the intelligent author of the preceding paper.

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* In determining these species of Unio, I have availed myself of the superior judgment of Mr. T. A. Conrad.

PLATE II.

Spirifer fimbriatus. (S. G. M.) Fig. 1. Shell oval, elliptical, compressed, with decussated striæ, and concentric distant ridges; radiating series numerous, prominent; decussating striæ minute.

Productus pocillum. (S. G. M.) Fig. 2. Shell suborbicular, decussated, with a sinus in the larger valve; superior valve very concave.

Spirifer cameratus. (S. G. M.) Fig. 3. Shell triangular, with radiating costæ, and a central ridge on one valve, corresponding to a sinus in the opposite valve.

The lower figure represents, although very inadequately, a perfect interior of this extraordinary fossil, now in my possession. Each of the two cones is formed of a single spiral tube, replaced by quartz crystals.

Terebratula bovidens. (S. G. M.) Fig. 4. Shell longitudinally subcordate, with a broad sinus on the larger valve; lesser valve convex; base emarginate.

Terebratula nuciformis. (S. G. M.) Fig. 5. Shell suborbicular, ventricose; lesser valve with a slight ridge in the centre, corresponding to a superficial sinus on the opposite valve; base truncated in the middle.

Fig. 6. An indeterminate cast.

Fig. 7. Spire of a univalve, indeterminate.

Fig. 9. *Anthophyllum.* (Goldfuss.) The fossil figured by Dr. Goldfuss, under this name, is from the vicinity of Niagara falls.

Fig. 10. *Turbinolia.*

Fig. 11. *Cyathocrinites pinnatus?* (Goldfuss.) If so, the drawing is defective, for the stellæ should be bounded by a perfect ring.

Fig. 12. *Productus:* indeterminate.

Fig. 13. Cast of a *Trochus.*

Fig. 14. Indeterminate univalve: a furruginous cast.

PLATE III.

Ammonites bellicosus. (S. G. M.) Fig. 8. Shell armed at its external margins with profoundly elevated, robust nodes: back entire, and slightly convex: sutures not visible. Diameter about five inches.

Fusus? inhabilis. (S. G. M.) Fig. 14. Shell short, fusiform, ventricose: whirl of the spire convex; spire conical; labium thickened; aperture elliptical.

Donax rusticus. (S. G. M.) Fig. 15. Ovato-triangular, convex, with obsolete concentric undulations: posterior side produced, cuneate.

Fig. 16. *Venus.* Lin.

PLATE IV.

Fig. 5. See Sternberg, Tab. 5.
Fig. 6. Uncertain.
Fig. 8. Pecoptoris; near P. Serlii. (Brong. pl. 85.)
Fig. 9. Uncertain.

PLATE V.

Fig. 7. Compare with *Stigmaria ficoides.* (Lindley, Tab. 31.) one of the commonest fossils of the coal formation.
Fig. 11 and 15. Uncertain.

PLATE VI.

Fig. 12. Phytolithus cancellatus. (Steinhaur, Am. Phil. Trans.)
Fig. 13 and 14. Uncertain.

PLATE VII.

Fig. 16. Uncertain.
Fig. 17. Calamites.
Fig. 18, 19, 20, and 21. Uncertain.

PLATE VIII.

Fig. 34. Uncertain.
Fig. 36. Calamites; near G. cannæformis. (Brong. pl. 21.)
Fig. 37. Calamites.
Fig. 38 and 39. Calamites; near C. ramosus. (Brong. pl. 17.)

PLATE IX.

Fig. 30. Asterophyllites? (Sternberg, Tab. 51, Fig. 2.)
Fig. 32. Calamites? also approaches Sigillaria.
Fig. 33. Uncertain.

PLATE X.

Fig. 22. Uncertain.
Fig. 23. Pecopteris: near P. cyathea. (Brong. pl. 101.)
Fig. 24. Pecopteris—on the upper part of the figure.

PLATE XI.

Fig. 25. Pecopteris?
Fig. 26. Left hand figure, near Tæniopteris; but the frond is more elongated, and less dilated towards the base.

PLATE XII.

Fig. 27. Mutilated Pecopteris?
Fig. 28 and 29. Pecopteris.

PLATE XIII.

Fig. 31. Pecopteris: near P. Cistii, (Brong. pl. 106) or perhaps P. punctulata. (Brong. pl. 93.)

PLATE XIV.

Fig. 25. *Stylina.*

Fig. 26. *Madrepora.* Lin.

Fig. 28, 29, 30. Indeterminate casts.

Fig. 31. Cast of a *Delphinula.*

Fig. 32. Cast of a *Nautilus.*

Fig. 33. Indeterminate univalve.

Spirifer rostratus. (S. G. M.) Fig. 34. Shell triangular, with concentric undulations; one valve much elevated in the middle, the opposite valve with a corresponding sinus, profound at base: base tapering to the middle, where it is slightly emarginate.

Spirifer fastigatus. (S. G. M.) Fig. 35. Shell triangular, with radiating profound sulci: one valve with a triangular ridge in the middle, bounded on each side by a deep groove; the opposite valve with a broad sinus having angular margins.

PLATE XV.

Fig. 57 and 65. Uncertain.

Fig. 61, *a.* Pecopteris.

" " *e.* Resembles Tæniopteris, but is rather small, and the geological position, according to Brongniart, does not agree.

" " *f.* Sphenopteris? near Myriophylla and Delicatula, (Brong. pl. 55 and 58) but the divisions of the frond, seem too delicately pinnate.

" " *g.* Pecopteris? compare P. punctulata, (Brong. pl. 93) but perhaps the dividing of the frond, is represented inaccurately.

PLATE XVI.

Fig. 40. Calamites? yet differs in some respects from that genus.

Fig. 41. Calamites ramosus. (Brong. pl. 17.)

Fig. 42. Near the preceding, but perhaps different.

PLATE XVII.

Fig. 43 and 44. Lepidodendron.

PLATE XVIII.

Fig. 45. Sphenopteris?

Fig. 47. Pecopteris. (See Lindley, Tab. 153.)

PLATE XIX.

Fig. 46. Neuropteris?

Fig. 50. Lepidodendron.

Fig. 51. Uncertain.

PLATE XX.

Fig. 48. Sphenopteris?

PLATE XXI.

Fig. 49. Bothrodendron. (Lindley, Tab. 80.)
Fig. 52. Uncertain.

PLATE XXII.

Fig. 53. See Lepidodendron selaginoides. (Lindley, Tab. 12.)
Fig. 54. Compare with Stigmaria ficoides. (Lindley, Tab. 31.)
Fig. 55. Calamites.
Fig. 56 and 58. Uncertain.

PLATE XXIII.

Fig. 35. Calamites.

PLATE XXIV.

Fig. 59. Pecopteris dentata? (Lindley.)
Fig. 60. Uncertain.

PLATE XXV.

Fig. 63. Lepidodendron.

PLATE XXVI.

Terebratula lapillus. (S. G. M.) Fig. 36. Shell suborbicular; superior valve gibbous in the middle; inferior valve with a broad sinus in the middle; center of the base gibbous.

Pholadomya elongata. (S. G. M.) Fig. 37. Shell much elongated, ventricose, with rather regular, broad, longitudinal sulci; anterior side very short, obliquely truncated; beaks tumid.

Productus punctatus? (Sowerby) Fig. 38. Shell suborbicular, decussated; inferior valve ventricose, with a broad central sinus.

Productus hepar. (S. G. M.) Fig. 39. Shell suborbicular; inferior valve with numerous transverse sulci, and a broad, but not profound sinus: umbo profoundly gibbous, divided by a deep sinus.

Fig. 40, 41. Vertebræ of Encrini.
Fig. 42. Indeterminate.
Fig. 43. Indeterminate cast in slate, probably of a vegetable production.

PLATE XXVII.

Fig. 64. Uncertain.

PLATE XXVIII.

Fig. 44 and 45. Indeterminate casts.

Fig. 46. *Productus.* This species, of which the name cannot at present be recollected, has been described and figured in Europe, where it is a common fossil.

Fig. 47. Indeterminate cast.

Ammonites Hildrethi. (S. G. M.) Fig. 48. See Pl. I, Fig. 24. A silicious cast.

Ammonites colubrellus. (S. G. M.) Fig. 49. Shell discoid, much compressed, with numerous slightly convex volutions: sutures sigmoidal.

Fig. 50. Pyritous cast of *Ammonites Hildrethi.*

Fig. 51. Pyritous cast of *Ammonites colubrellus.*

Fig. 52. Indeterminate cast of a univalve.

Fig. 53. Pyritous casts of *Ammonites Hildrethi*, compressed and distorted.

Fig. 54. Sections of same fossil.

Fig. 55 and 56. Pyritous cast of *Turritella?*

Fig. 58. Indeterminate, cast of a bivalve.

Fig. 59. Pyritous cast of a *Terebratula.*

Fig. 60. Pyritous cast of another species of *Terebratula.*

Fig. 61. Cast of a *Nautilus.*

Fig. 63. *Depleura Dekayi.* (Green, Monog. Trilob. p. 79.)

Fig. 64. *Calymene callicephala.* (Green, Monog. Trilob. p. 30.)

Fig. 65. *Calymene bufo.* (Green, Monog. Trilob. p. 41.)

PLATE XXIX.

Fig. 65. Uncertain.

PLATE XXX.

Fig. 1. Lepidodendron.

Fig. 2. Uncertain.

Fig. 3 and 4. Pecopteris.

Fig. 10. Uncertain.

PLATE XXXI.

View of Pomeroy's Coal Bed, at Carr's Run, Ohio.

PLATE XXXII.

View of Marshall's Pillar—Cliffs of New River, Va.

PLATE XXXIII.

View of the Falls of the Kenawha, Va.

PLATE XXXIV.

View of the Kenawha Salines.

PLATE XXXV.

View of Putnam's Hill from West Zanesville.

PLATE XXXVI.

View of Putnam's Hill and the upper Bridge at Zanesville, on the Muskingum River.

MISCELLANIES.

1. *Halley's Comet.*—Agreeably to the predictions of astronomers, Halley's Comet has revisited our sphere, bringing along with it the most triumphant confirmation hitherto afforded, of the truth of the Newtonian philosophy. For several evenings past, it has presented a most striking feature in our evening sky, as it moved along above the bright stars in Ursa Major, with a train which has been constantly enlarging, with its vertex reaching nearly to the tail of the Northern Dragon.

This interesting body was first observed in this country, by Professor Olmsted and Tutor Loomis of Yale College, on the morning of the 31st of August. While they were reconnoitering for the expected visitant, with Clark's telescope,* they descried something which they suspected was the comet; but, from the possibility of confounding it with a nebula, they impatiently waited for the next night to see whether it changed its place among the stars. An observation repeated on the morning of September 1st, plainly indicated a proper motion, the body during the interval having passed quite out of a trapezium which, when first seen, it formed with three small stars.

The position of the comet, when first observed, was north of the Bull's horns, a little below the vertex of an equilateral triangle formed with those two stars. Or, more particularly, at 2 o'clock, on the morning of August 31st, its Right Ascension was 5h. 50.5m., and its Declination N. 24° 46.8′. Its place, therefore, coincided very nearly with the last results of calculation, derived from the elements of Pontécoulant, and given in the Connaissance des Tems for 1837. According to that authority, the place of the comet, on the first of September, would be, in R. A. 5h. 52′, and in Declination, 25° 32′,—a coincidence probably the most remarkable of any ever exhibited under difficulties equally formidable.

The appearance of the comet, at first, was that of a dim cloud, or halo, nearly circular, denser towards the central parts, and fading

* This instrument was made by Dollond in 1831, expressly for Yale College. It is an achromatic, having a focal length of ten feet, and an aperture of five inches. The power employed on this occasion, was fifty five, being the lowest astronomical eye glass. This fine telescope was presented to Yale College by Sheldon Clark, Esq. of Oxford, Conn. who has also laid the foundation of a professorship and of a scholarship in Yale College.

into an ill defined margin, the whole occupying a space of about two minutes in diameter.

For several nights succeeding the 31st of August, the sky was remarkably serene, and Messrs. Olmsted and Loomis examined the comet every morning from one to three o'clock, until the 4th of September, when the presence of the moon rendered their opportunities less favorable. On the 4th, its position was peculiarly fortunate, being in the same field (in the finder) with a fine cluster of stars, marked No. 377 in Herschel's Catalogue.

On the 21st of September, the comet was observed about two degrees to the north of Kappa Aurigae, having, by this time, so much increased in magnitude and brightness, as to be visible in the smallest telescopes, and even faintly discernible to the naked eye. Professor Anderson, of Columbia College, announced that it could be seen, by unassisted vision, as early as the 19th.

The observations made at Yale College, and published on the first of September, were confirmed by different observers, particularly by Mr. S. C. Walker of Philadelphia, and by Mr. William Mitchell of Nantucket, who first saw the comet on the 4th of September, before he had heard of the observations made at New Haven.

According to the English newspapers, it appears, that the first sight of the comet in England, was obtained on the morning of the 23d of August, by Sir James South.

Since the comet has been visible, without the aid of a telescope, it has increased rapidly in brightness to the present time. On the evening of the 10th of October, it first exhibited to the naked eye a slight elongation, in a direction opposite to the sun, which, on the next evening was unexpectedly extended into a train eight or ten degrees in length, having its vertex a little below Kappa Draconis. On the 12th, at 7 o'clock in the evening, the nucleus appeared remarkably bright, and exhibited on the upper side (in the astronomical telescope) *a peculiar emanation of light*, resembling the brush of electric light from a pointed wire when highly charged and seen in a dark room. It seemed like the beginning of a new and more brilliant train. On the 13th, this luminous pencil had disappeared, but the coma had sensibly increased in brightness and density, and the tail was elongated to twelve degrees, reaching towards the star Iota Draconis. The comet is now beginning to recede rapidly from the earth, and will come to its perihelion on the 16th of November.

Yale College, October 14, 1835.

2. *Coins and Medals;* by John W. Draper.—Cuvier, from a minute examination of insulated fossil bones, deduced the form and structure of antediluvian animals. It was an example of deep interest to antiquarians. Records, both oral and written, are subject to dismemberment and falsification, in the remains of science and art, we find, however, faithful witnesses. A solitary medal, a ruined arch, or a broken sundial, are evidence equally good, as a fossil shell, or a Saurian remain.

Coins are valuable not only to antiquarians, but also to natural historians, the inscription, legend, and reverse, vouch for their age, and the marks they bear, are too numerous and too plain, for any experienced eye to be deceived in their authenticity. They have, however, hitherto been much neglected, it is not more than four hundred years since cabinets of them began to be formed, and as yet they have been only in the hands of literary men. A mere classical scholar may decypher their inscriptions, and assign their age, but that is not all the intelligence they contain. It is reserved for the scientific chemist, by a rigid analysis of an authenticated collection of coins, to cast light on many questions, of the geography, history, and arts of the ancients.

Nor is that all,—general science may receive much benefit from such an examination. It was from an analysis of a silver denarius of the Emperor Trajan, that I first found, that endosmosis of one solid could take place, in lapse of time, through another. This denarius was brought from Malta, and had thrown off nearly all its alloy, in the form of purple and green Neapolitan patina. The proportion of copper in the coin was originally as one to nine. This patina was as hard as, or harder than, the metal itself. In the course of ages, the copper had removed from the most internal parts of the coin, and become crystallized on its surface, showing that a slow movement may take place in the substance of the densest textures; the whole amount of copper left in this coin, did not exceed one part in seventeen. Pliny says, that Mark Antony mixed iron with his silver money, and such of it as is extant, is attracted by a magnet: a coin of that description, fell into the hands of Mr. Pinkerton; it is however doubtful, whether the Romans of that age, could alloy iron and silver, these coins are, perhaps, a mixture of silver, copper, and nickel.

We have not access to the gold mines of Phillippi in Thrace, but the coins of Alexander can reveal to us their contents. Roman gold, before the reign of Titus, was brought chiefly from Dalmatia; in aspect it strongly resembles the gold of Gongo-Soco, which contains palladium. The coins of Crœsus king of Lydia, are of a very pale color, due to some unknown alloy of the gold. In this manner we might obtain important notices of the mineralogical localities of the ancients, and discover the contents of mines, which are now either lost, or closed, or situated in inaccessible countries. If Wollaston, Descotils and Tenant, from the platina grains of South America, recovered so many new metals, what might not reasonably be expected, from an analysis of all kinds of coins, from the Charon's face of gold, still found in the mouths of the older Egyptian mummies, to the modern money of Europe. There are extant coins of gold, silver, copper, lead, zinc, brass, electrum, Corinthian brass, pinchbeck, bell metal, and all kinds of mixed alloys. These have been brought from mines in the heart of Asia, Africa, and the Sea islands, wherever the ambition and power of ancient conquerors led, or their cupidity could extort. Some of those old Hindostanee coins, brought from Calcutta, which are supposed to be of the age of the cave of Eliphanta, are said to be a mixture of gold, silver, copper, and tin, in unknown proportions. The Egypto-Roman coins, some of which were struck at Alexandria, are made chiefly of speculum metal, or a compound of copper, tin and arsenic, analogous to the tam-tam of the Chinese, of which gongs are made. Now the workmanship of these coins, which have been struck with a hammer, involves the discovery of a fact, which although long ago made in China, is only very recently known in Europe. It is commonly known, that steel which has been heated red hot, and suffered to cool slowly, is soft; but if exposed to a sudden chill, it becomes exceedingly hard and brittle; the reverse, however, obtains with this alloy—tam-tam, slowly cooled, is as brittle as glass, but if quenched, it is soft like silver; in the former state it would be impossible to strike it with a hammer. The method of coining, was to cast the metal into spheroidal masses, these were then put into the die, and impressed by the blow of a hammer. The ancients, themselves, were aware that foreign substances often alloyed their money metals, but they had no means of finding what they were, or in what proportion. Thus, although the average value of gold, at Rome, was generally twelve times its weight of silver, yet the gold that Cuvier brought from France, was so much debased, that it never sold for more than nine times its weight of silver. The denarius of Dioclesian, is of very pure metal, much purer than those of his predecessors, although the silver of which they were formed, was brought chiefly from the Spanish mines; before his reign both copper and brass, in variable, but large quantity, were melted up with the silver. Even the less valuable metals were subject to much adulteration; the small brass coins contain arsenic, along with unknown metals, this alloy sometimes replaced the cyprian copper, in the smaller division of the *as*. In the larger sort, as the dupordearii, we find it nearly a pure alloy of copper and zinc. No iron coins are extant, but it is said Spartan money was made of that metal. The tin coins of Dionysius are likewise wanting, but the leaden money of Armenia, is occasionally met with.

Besides, alloyed coins, such as electrum and brass, there was another species of medals, as the Follis of Dioclesian, which was of copper or tombac washed over with silver or tin. Ancient plated coins are by no means uncommon.

The composition of the alloys mentioned here, is given on the authority of antiquarians, not chemists. Indeed, hitherto there have been few or no analyses of ancient money, the nature of these compounds is only guessed at, and that by those, who were not perhaps, competent judges of the matter. Except an analysis of a gold coin of Vespatian, by the Parisian goldsmiths, and some few by European connoisseurs, I know of none that can be depended on—there can however, be no doubt, that an extended enquiry would result in the discovery of new facts. Impressed with this view, an English gentleman commenced a collection. His casket, which is contained in a silver vase, consists of about two hundred and fifty specimens, embracing coins of every age, and many countries. Its value is about one thousand dollars. On his decease, it was committed to my charge, by his representatives, to be disposed of for the benefit of his family. I have thought that the testators original views might in a manner be gratified, and the interest of his legatees likewise consulted, by publishing an account of such of these coins as have been assayed. The collection, I hope will fall into the hands of those who are willing to follow out the original views of the collector. If purchased by any of our colleges or public institutions, it will lose none of its value, if each coin intended for analysis, is clipped in halves, and duly registered or sulphur casts taken.

A silver coin of the Emperor Domitian weighing $48\frac{4}{4}\frac{1}{5}$ grains was cupelled, the resulting button weighed 39 grains, it was very good silver, and dissolved completely in nitric acid, making a colorless solution.

A coin of Hadrian weighing 48 grains, was dissolved in strong nitric acid, at a boiling temperature, and on cooling, the nitrate of copper crystallized out from the silver. It was dissolved in distilled water, and the silver precipitated as a chloride, its weight was estimated from the dry horn silver at 40.25, the remaining liquid contained 6 grs. of copper and 1.4 of lead.

A Saxon Abbey piece, weighing 26⅝ grs. contained copper 12 grs. zinc 9? and lead 4.

A copper coin of Constantinus, was found to be nearly pure, there was however a trace of iron.

A defaced copper of one of the Ptolemies, contained so much arsenic, that it was brittle under the hammer, there was also some volatile ingredient to a large amount, presumed to be sulphur; the copper being probably an imperfectly reduced sulphuret.

In this collection there are about forty picked Roman coins, from the date of Cæsar downwards; some Egyptian of the Ptolemies, and a few Greek. The remainder is European and Asiatic money, but chiefly the former, consisting of all kinds that could be met with both public and private, illustrative of a range of about one thousand years. Nearly half the whole collection is silver, the remainder is copper, brass, tombac, pinchbeck, &c.—there was at one time a valuable collection of gold, but that has been disposed of,—there remaining only four or five specimens, consisting of the deep yellow gold of the later Romans, as Honorius, contrasting with the pale gold of Charles the 1st of England. Had the ingenious collector of these curiosities survived, his casket would doubtless have been more perfect then even now: his enthusiasm may be estimated from some of the medals then destined to destruction. There is the Marengo silver medal of Napoleon, weighing several ounces; the Dutch medal of Admiral Lonk; a whole series of papal medals, of the first Italian artists; and above all, Dassier's medal of Charles William, with the Lion on the reverse; this, of thirty thousand or forty thousand coins and medals, I have had an opportunity of inspecting, is decidedly the best executed; Dassier was a Genevese.

I intend spending the ensuing winter in Philadelphia, to which city, any communication to me may be addressed.

Christiansville, Va., Sept. 1, 1835.

3. *List of New Publications since the commencement of the present Year.—American.*

Hare, (Rob.) M. D. A brief exposition of the science of Mechanical Electricity, 48 pp. 8vo., 1835, in connection with a Compendium of the course of Chemical Instruction in the Medical department of Pennsylvania, 260 pp., 1834. The whole in one Vol. 8vo. *Philadelphia,* second edition.

Johnson, (Walter R.) A. M. Prof. of Mech. and Nat. Phil. in the Franklin Institute of Pennsylvania. The Scientific Class Book or a familiar introduction to the principles of Physical Science, for the use of Schools and Academies; on the basis of I. M. Moffat. Part I. comprising Mechanics, Hydrostatics, Hydraulics, Pneumatics, Acoustics, Pyronomics, Optics, Electricity, Galvanism and Magnetism, 12mo., 473 pp. *Philadelphia,* Key & Biddle.

Shepard, (C. U.) Treatise on Mineralogy, consisting of descriptions of the species, with 500 wood cuts, two Vols. 12mo. Vol. I. xliv. and 300 pp. Vol. II. 331 pp. Pr. $3. *New Haven,* H. Howe & Co.

Featherstonhaugh, (G. W.) Geological Report on the elevated country between Missouri and Red River, from an examination in 1834. 8vo. 99 pp. *Washington,* Gales & Seaton.

Olmsted, (Denison,) A. M. An introduction to Natural Philosophy, designed as a text Book for the use of the Students in Yale College, two Vols. 8vo. 2nd Ed. Vol. I. Mechanics and Hydrostatics, 242 pp. Vol. II. Pneumatics, Electricity, Magnetism and Optics. 347 pp. plates. Pr. $4 50. *New Haven,* H. Howe & Co.

Gibbons, (W. P.) Advocate of Science and Annals of Natural History, Vol. I. Nos. 6, 7, 8 and 9, for Jan., Feb., March and April, a monthly periodical of 50 8vo. pages. Commenced Aug. 1834. *Philadelphia.*

Journal of the Academy of Natural Sciences of Philadelphia. Vol. VII, part I, 8vo. Oct. 1834. *Philadelphia.*

Contents.—Catalogue of plants in the valley of the Rocky Mountains, towards the sources of the Columbia; by Nathan B. Wyell. Described by T Nuttall, p. 5. Description of the rare or little known plants, indigenous to the United States; by T. Nuttall, p. 61. Observations on the tertiary and more recent formations of a portion of the United States; by T. A. Conrad, p. 116. Descriptions of New Tertiary Fossils, from the Southern States; by T. A. Conrad, p. 130. Analysis of some of the Coals of Pennsylvania; by H. D. Rogers, and A. D. Bache, p. 158. Description of a new genus, (Pleiodon,) of Fresh water shells; by T. A. Conrad, p. 178. Description of a new species of Hinnita; by T. A. Conrad, p. 182.

Chaptal, (John.) Chemistry applied to Agriculture, 1st. American, from the 2nd French edition. 12mo. 365 pp. *Boston*, Hilliard & Gray.

General Natural History.—Foreign.

Continuation of Buffon's Natural History.—The following are the contributors to this continuation; Desmarest on the Natural History of Fishes, F. Cuvier on the Cetacea, Duméril on the Reptilia, De Blainville on the Mollusca, Milne-Edwards on the Crustacea, Walckenaer on the Arachnides, Boisduval, Comte Dejean, Lacordaire, Macquart, De Saint-Fargeau and Serville on Insects, Lesson and Rang on the Zoophyta, Audouin on the Annelides, Alph. de Candolle, Spach and de Brebisson on Botany.

The following works of this continuation, have been published.

Introduction à la Botanique, ou Traité élémentaire de cette Science, contenant l'Organographie, la Physiologie, la Methodologie, la Geographie des Plantes, un aperçu des Fossiles Végétaux, de la Botanique Médicale, et de l'Histoire Botanique; par Alph. de Candolle, Prof. à l'Acad. de Genève, 2 vols in 8° et Atlas.

Histoire Naturelle des Végétaux Phanérogames, par E. Spach, aide-Naturaliste au muséum, membre de la Société des Sc. Nat. de France, et correspond. de la Soc. de Bot. Med. de Londres; T. 1—4 avec six livraisons de planches.

Histoire Naturelle des Crustacés, Comprenant l'Anatomie, la Physiologie, et la classification de ces Animaux; par Milne-Edwards, Prof. d'Hist. Nat.; deux tomes, avec planches.

Histoire Naturelle des Reptiles, par Duméril, membre de l'Institut, Prof. à la Faculté de Médecine, Professeur-administrateur du Museum, d'Hist. Nat., et Bibron, Aide-naturaliste au Mus. d'Hist. Nat. T. I. et II. avec 2 livraisons de planches.

Histoire Naturelle des Insectes, Introduction à l'Entomologie, comprenant les principes généraux de l'Anatomie et de la Physiologie des Insectes, des détails sur leurs mœurs, et un résumé des principaux systèmes de classification proposés jusqu' à ce jour pour ces animaux; par Lacordaire, membre de la Soc. Ent. de France. Tomes I. and II. avec 2 livraisons de planches.

Histoire Naturelle des Insectes Diptères, par M. Macquart, directeur du Muséum de Lille membre d'un grand nombre de sociétés savantes T. I. et II. avec deux livr. de planches.

This continuation of Buffon, will be composed of about 45 octavo volumes. It was commenced in January, 1834, and according to the plan at the time, was to be issued monthly. Price per volume 4 fr. 50 c.; of each livr. of plates, colored, 6 fr. uncolored, 3 francs. Separate volumes are sold for 6 francs each.

Thomson, (Rob. D.) Records of General Science, by R. D. T. with the assistance of Thos. Thomson of Glasgow. No. I. January, 1835. 8vo. 80 pp. *London*, J. Taylor. A monthly periodical.—Manuel Encyclopédique et pittoresque des Sciences et des Arts par une Société de Gens de lettres et d'Artistes. Tom. I. Liv. 1, 2 and 3. 4to. *Paris.*—Verhandlungen der K. Leop.-Carol. Akademie der Naturforseher. XVI. Bd. der suppt. 4to. *Bonn.* —Orbigny, (A. d') Voyage dans l' Amerique Meridionale, (le Bresil, la Republique Oriental de l'Uraguay, la Patagonie, la Republique Argentine, les Republiques du Chile, du Peru, de Bolivia,) exécuté dans les cours des années 1826—1833, in 4to. de 2*f.* *Paris.*—Transactions of the Cambridge Philosophical Society, Vol. V. part III.—Philosophical Transactions of the Royal Society of London for the year 1835. Part I.—Jesse, (Edward) Esq. Third and last series of Gleanings in Natural History, in 1 vol. post 8vo. 108 p. *London.*—Transactions of the Zoological Society of London, Vol. I. Part III.—Third volume of Reports of the British Association for the advancement of Science; includes Geology of North America, H. D. Rogers; Laws of Contagion, Dr. C. Henry; Animal Physiology, Prof. Clark; Zoology, Rev. L. Jenyns; Capillary Attraction, Rev. J. Challis; Physical Optics, Prof. Lloyd; Hydraulics, Part II. G. Rennie. 1 vol. 8vo. pr. 15*s.*—Virey, (J. J.) Philosophie de l' Histoire Naturelle, ou des Phénomènes de l' organisation des animaux et des végétaux. 8vo. *Paris.* 7*f.* —Swainson, (Wm.) A preliminary discourse on the study of Natural History. Vol. LIX of Dr. Lardner's Cyclopædia. 12mo. 470 pp. *London.*—Arcana of Science—or an annual Register of Useful Inventions and Improvements, Discoveries, and new facts in Mechanics, Chemistry, Natural History and Social Economy; with engravings. 12mo. 310 pp. 8th year. *London.* Limbird. pr. 5*s.*—Fischer, Beschreibung Naturhist. Gegenstande. 5r Band. 8vo. *Leipzig.* —Naturgeschichte der Vögel. 20—22 Heft. 4to. *Berlin.*—Gloger, Naturgeschichte der Vögel. 1r. Band. 3—5s Heft. 8vo. *Breslau.* —Wandtafeln, der Naturgeschichte. 4s. Heft. Fol. *Leipzig.*—Wernhard, Katechismus der Naturlehre. 8vo. *Augsberg.*—Reichenbach, Das Universum der Natur. 3te. Lief. Thierreich. 4to. *Leipzig.* —Howitt, (Mary) Sketches in Natural History. *London.*—Royle, (J. Forbes) F. L. S. &c. Illustrations of the Botany and other branches of the Natural History of the Himalayan Mountains, and of the Flora of Cashmere, in 4to. parts. 20*s.* each. Part V. January, part VI April, part VII June. To be completed in 20 parts.

Mineralogy and Geology.

Speyer, (A. F.) Deutschlands vorzuglichste Mineralquellen nach ihren physischen, chemischen und therapeutischen Eigenschaften, in 4 Tabellan, 8°. Hanau. 1834. 54 kr.—Pelouze, Mineralogie Industrielle. 1 vol. in 12mo. *Paris.*—Keferstein, Die Naturgeschichte des Erdkörpers in ihren ersten Grundzügen. 2 Thle. 8°. *Leipzig.* —Karsten's Archiv für Mineralogie, &c. 8r Bild. 1s Heft. 8vo. *Berlin.*—Richard, (A.) Précis élémentaire de Minéralogie, in 8° de 28f. avec 2 tab. et 2 pl. *Paris.* Bechet. Pr. 6*f.*—Le Play, (F.) Observations sur l' Histoire Naturelle et sur la richesse minérale de l' Espagne: par M. F. Le P. ingenieur des mines; in 8°. de 16*f.* avec une carte géologique et 3 pl. de coupes et de vues. *Paris.* Carilian-Gœury.—Fournet, (J.) Etudes sur les depots metallifères: in 8° de 15 1-2*f.* *Paris.* Levrault.—Beaumont, (L. Elie de) Extrait d' une Série de recherches sur quelques unes des révolutions de la surface du globe; in 8° de 6 1-2*f.* *Paris.* Levrault. pr. 2*f.* 50 c. –Kühn, Handbuch, der Geognosie, Band 1, 8vo.–Laurance, Geology in 1835. 12mo. *London.*—Montlosier, (Le comte de) du Cantal, du Basalte et des Anciennes Revolutions de la Terre, en response à un nouvel écrit de M. Elie de Beaumont, in 8°. de 6 1-2*f.* Clermont Ferrand.—D'Aubuisson, Traité de Géognosie, continué par Burat, T. III. et dern. 8vo. *Paris.*—Brown, Lethæa Geognostica, &c. 1 Lief. 4to. *Stuttgart.*—Von Buch, Ueber Terebrateln, m. e. Versuch sie zu classificiren und zu beschreiben. 4to. *Berlin.*—Meyer, Die fossilen Zahne und Knochen, und ihre Ablagerung in der Gegend von Georgensmund in Bayern, mit 14 Tafeln und Abbild.—Allies, (Jabez) Esq. Observations on certain curious indentations in the old red sandstone of Worcestershire and Herefordshire, considered as the tracks of Antediluvian Animals; and the objections made to such an hypothesis refuted: with an addenda on various other facts in Natural History, Geology, Meteorology, &c. demi 8vo. 3 Lith. *London.* Wm. Edwards. Pr. 3s. 6d.—Phillips, (John.) F. R. S. Guide to Geology. 12mo. 2d Ed. *London.*—Murchison, (Roderick Impey,) F. L. S. Geology of the counties of Salop, Hereford, Radnor, Montgomery, Brecknock, Caermarthen, Monmouth, Worcester and Gloucester, with Geological maps. *London.* J. Murray.—Longchamp, Trois mémoires sur les eaux minérales, in 8vo. de 2*f.* *Paris.* impr. de Bourgogne.—Freisleben, Magazin für Oryktographie. 6s. Heft. 8°. *Freiberg.*—Lyell, (Chas.)

Principles of Geology, with a glossary containing an explanation of scientific terms, and a copious index. 4 vols. 12mo. with 147 wood cuts, 13 plates and maps. 4th Ed. *London.* J. Murray. Pr. 24*s.* —Studer, Géologie der westl. Schweizer-Alpen. 8°. *Heidelberg.* —Rozet, Description Géologique de la partie méridionale de la chaîne de Vosges, in 8°. de 9*f.* avec une pl. *Paris.* Roret.—Deshayes, (G. F.) Description des Coquilles fossiles des environs de Paris. 37me. liv. in 4to. de 3 1-2*f.* avec 4 pl. *Paris.* Levrault. 5*f.*—Bouillet, (J. B.) Description històrique et scientifique de la Haute Auvergne (department du Cantal) suivie d' un tableau Alphabétique des roches et des minéraux du même departement avec l' indication de leurs gisemens, in 8°. de 28*f.* avec un atlas de 5*f.* et 35 pl. gravées ou lithog. Impr. à Clement. *Paris.* Baillière. 16 fr.—Barruel, (G.) Traité élémentaire de Géologie, minéralogie et géognosie suivi d' une statistique minéralogique des departemens, par ordre alphabetique, in 8°. de 31*f.* 6 pl. *Paris.* Levrault. 5*f.*—Cuvier, (G.) Recherches sur les ossemens fossiles, etc.; 4th Ed. T. V, 1re partie. in 8°. de 5 1-2*f.* Atlas, 9 livr. in 4to. de 2*f.* avec 14 pl. *Paris.* Levrault. 7*f.* 50 c.—Cotta, (Dr. Bernh.) Geologisches Glaubens-bekenntniss in Jahre 1835. 8°. 39 ss. nicht in Buchhandel. *Dresden.*—Marx. (C. M.) Geognostische Skizze der Umgegend von Baden in Grossherzogthum. 18°. 72 ss. mit. 6 lithog. Ansichten. *Carlsruhe* und *Baden.*—Phillips, (J.) F. G. S. Illustrations of the Geology of Yorkshire, 2d Ed. 4to. with maps. 1*l.* 11*s.* 6*d.* —Grateloup, Précis des travaux géologiques de la Soc. Lin. de Bordeaux, depuis sa fondation jusqu' à ce jour. 62 pp. in 8°. *Bordeaux.*—Kayser, (Ed.) de Cyclo quodam legum duodecim secundum quas Crystalli generum Feldspathi familiæ singulæ geminatim conjunctæ inveniuntur. 1 kup. 4to. *Berlin.*

*Zoology.**

Sancerotte, Elemens d'Histoire Naturelle. Zoologie, 4to. *Paris.*—Lesson, Illustrations de Zoologie, Livr. xv. 8°. *Paris.*—Swainson, (Wm.) A treatise on the Geog. of Animals, the Natural System, and the principles of classification. Being Vol. II. of the System of Zoology, and forming Vol. LXVI. of Dr. Lardner's Cyclopædia. *London.*—Kirby, (Rev. Wm.) F. R. S. On the history, habits, and

* Works on Entomology, are deferred until the next number, when will be given a brief sketch of the science for a few past years.

instincts of Animals. (Bridgewater Treatises.) 2 Vols. 8vo. *London.*—Reichenbach, der Hund. Mit 139 Abbild. 4to. *Leipzig.* Chesnon, Essai sur l'Histoire Naturelle de Normandie, 1re partie, Quadrupèdes et Oiseaux, 8°. *Paris.*—Gardens and Menagerie of the Zoological Society, delineated, 8vo. 2 Vols. 24*s.* Vol. I. Quadrupeds. II. Birds. *London.*—Siebold, Temminck, Schlegel et de Hann, Fauna Japonica, notis, observationibus, et adumbrationibus. Fasc. I. 4to. *Amsterdam.*—Götz, Monographie des Hundes, 8vo. 1834. Lorek, Fauna Prussica. 2*s.* Heft. 4to. *Köngsberg.*—Jenyns, (Rev. Leonard,) M. A., &c. A systematic Catalogue of British Vertebrate Animals, 8vo. 1*s.* 6*d.* *London.*—Lesson, Histoire Naturelle des Oiseaux de Paradis, desSéricules, et des Epimaques, II.—VI. Livr. 8°. pl. 1835.—Percheron, Monographie des Passales et de genres qui en ont été separés, 8°. *Paris.*—Temminck, Manuel d'Ornithologie, ou Tableau Systematique des Oiseaux qui se trouvent en Europe, III. partie, 8°. *Paris.*—Baker, (T. B. S.) An Ornithological Index, arranged according to the Synopsis Avium of Mr. Vigors, 8vo. 187 pp. *London.* Wood.—Jardine, Naturalist's Library, Vol. IX. (Pigeons,) 12mo. *London.*—Bechstein, (J. M.) M. D., &c. Cage Birds; their natural history, management, habits, food, diseases, treatment, breading and the methods of catching them with notes, by the translator, post 8vo. 434 pp. *London.* Orr & Smith. —Perrott, (Mrs.) A selection of British Birds, frequenting Worcestershire and the adjoining counties, illustrated by drawings from nature, with observations on their habits. This work will be published in parts, each containing 5 plates; price 14*s.* plain, 1*l.* 1*s.* colored.—Yarrel, (Wm.) F. L. S. A history of British Fishes, illustrated by wood cuts of all the species, and numerous vignettes. Part I. *London*, J. Van Voorst. To be completed in 14 monthly parts.— Schinz, Reptilien, 13 und 14*s.* Heft 4to. *Leipzig.*—Wiegmann, (Dr. A. F. A.) Herpetologia Mexicana, seu Descriptio Amphibiorum Novæ Hispaniæ, quae itineribus, de Sack, Deppe, et Schiede, in Museum Zoologicum Berolinense pervenerunt. Part I. Saurorum species complectens. Fol. *Berlin.*—Spix et Martius, Delectus Animalium Articulatorum. Fasc. 3 et ult. 4to.—Lamarck, (J. B. P. A. de). Histoire Naturelle des Animaux Sans Vertèbres présentant les caractères généraux et particuliers de ces animaux, leur distribution, leurs familles, leurs genres, et la citation des principales espèces qui s' y raportent; précédée d' une introduction offrant la determination des caractères essentiels de l'animal, etc; 2nd Ed. revue et augmentée de notes presentant les faits Nouveaux dont la Science s' est enrichie jusqu' à ce jour par MM. C. P. Deshayes et H. Milne Edwards, T I. in 8°. de 28*f.*; T. VI. in 8°. de 38*f.* *Paris.* Baillière: pr. de chaque vol. 8*fr.* This work is to be issued monthly, and will consist of 8 vols.—De Ferussac, et d'Orbigny, Histoire Naturelle generale et particulière des Mollusques, etc., publiée par Monographie. *Cephalopodes Cryptodibranches,* livr. 4, 5, and 6; un cah. in 4to. 7*f.* avec 29 pl. *Paris,* Baillière. Pr. de chaque livr. 20*f.*—Rüppel, Neue Wirbelthiere. 1te Lief. Fol. *Frankfort.*

Chemistry.

Guillond, Traité de Chimie appliquée aux arts et metiers. 2 vols. 12°. *Paris.*—Fechner, Repertorium der neuen Entdeckungen in der organischen Chemie. 2 vols. in 8°.—Köhler, Die Chemie in technischen beziehung. 8°.—Despretz, Supplement au traité élémentaire de Chimie. 8°. *Paris.*—Bouchardat, Cours de Chimie elementaire. 8°. *Paris.*—Fremanger. (J. F.) Recherches et observations sur la Creosote; *Paris.* Baillière. Pr. 1*f.* 50*c.*—Dumas, Traité de Chimie appliquée aux arts. T. V. in 8°. de 51¾*f.* *Paris.* Bechet. Pr. 9*f.*—Thenard. (L. J.) Traité de Chimie élémentaire, theorique et pratique, etc. 6 edition, T. IV. in 8°. de 43*f.* *Paris.* Pr. 7*f.* 50*c.*—Dulk, Handbuch der Chemie. Band II. 8°.—Fromherz, Medizinische Chemie. B. II. H. 1.—Witting, Grundzuge der Chemie. B. II. 8°.—Hume, Essay on Chemical Attraction. 8°. *London.*—Runge, Farbenchemie. B. I. 8°. Colored plates.—Du Ménil, Reagenbenlehre für die Pflanzen analyse. 12mo. 1834.—Berzelius, (J. J.) Theorie des proportions Chimiques et table synoptique des poids atomiques des corps simples et de leurs Combinaisons les plus importantes. 2nd Ed. revue, corrigée et augmentée, in 8°. de 30½*f.* *Paris.* F. Didot. Pr. 8*f.*

Botany.

Kunth, Agrostographia Synoptica. T. II. gr. 8°. *Stuttgardt.*—Petermann, De Flore gramineo. 8°. *Lipsia.*—Krüger, Naturgeschichte. 2r. Thl. Das Pflanzenreich. 8°. *Quedl.*—Reichenbach, Flora Germania exsiccata, Cent. IX. Fol. *Lipsia.*—Zuccarini, Unterricht in der Pflanzenkunde. 8°. *Landshut.*—Dietrich, Deutschlands Flora. 2 und 3*s.* Heft. 8°. *Jena.*—Burnett, Outlines of Botany. 2 vols. 8vo. *London.* 3*s.*—Agardh, Lehrbuch der Botanik. Heft. 2. Biologie, 8°. 1834.—Mutel, Flore Française destinée aux herborisations. 18mo. *Paris.*—Kunth, Distribution methodique de la famille des Graminées; liv. I—V. (to be completed in 44.) Fol. *Paris.*—British Botany familiarly explained and described, in a series of dialogues, with 28 colored plates. 12mo. 10*s.* 6*d.* *London.*—Main, (J.) Popular Botany. 16mo. plain, 4*s.* 6*d.* colored, 7*s.* boards.

Natural Philosophy, &c.

Bernouilli, Elementarisches Handbuch der Industriellen physik, mechanik und hydraulik. I. B. 8vo.—Becquerel, Traité expérimentale de l'Electricité et du Magnetisme. Vol. II. 8°. *Paris.*—Marbach, Physical. Lexicon. 2r. Band. 3 und 4*s.* Heft. 8vo. *Leipzig.*—Tabellarische Uebersicht aller elektrischen Versuche. Fol. *Leipzig.*—Comte, (M. Auguste,)Cours de Philosophie positive. 8°. *Paris.* Bachelier.—Ure, (Andrew, M. D.) F. R. S. The Philosophy of Manufactures, or an Exposition of the Scientific, Moral, and Commercial Economy of the Factory System of Great Britain. Post 8vo. 480 pp. *London,* Ch. Knight.—Dictionnaire Technologique universel des arts et Métiers, etc. T. xxii. (VR—Z.) in 8°. de 27*f.* et planches (liv. 40, 41, et 42.) Prix du volume 7*fr.* 50, de la liv. de planches 2*f.* 50*c.* This volume terminates the work. A supplement will complete it. A second edition, which was announced, will not appear.—Purthl, Technologisches Encyclopedie. 5 Bande. 8°.

4. *Facts respecting the Meteoric Phenomena of November 13th,* 1834. Communicated by Denison Olmsted, Professor of Natural Philosophy in Yale College.

I. Foreign testimonies.

1. By the *Rev. W. B. Clark,* A. M. F. G. S., &c. (England.)

"On the return in 1834 of the period when the meteors were seen in 1799, 1832 and 1833, [and also in 1831, Amer. Journal, Jan. 1835,] I felt naturally anxious, to watch the atmosphere. My health, however, did not allow me to remain up all night, but on rising at 3 o'clock in the morning of Nov. 13th, I saw from my window in fifteen minutes' time, by the watch, *fifteen falling stars* in the direction of a line from Leo to the star Mirza in Ursa Major. The night was cloudless, and the moon so bright, that the constellations could be scarcely seen; but the meteors were very red and brilliant.—(*Loudon's Magazine of Natural History for Dec.* 1834, p. 654.)

In Vol. VIII of the same Journal, p. 139, Mr. Clark, after having collected various accounts, says: "On the night of the 13th of Nov., there was a brilliant exhibition of meteors, from 11 P. M. of the 12th, to near daylight of the 13th."

2. From *W. H. White*, Esq. (England.)

"I have extracted the following observations from my journal, relative to the meteoric appearances on the morning of Nov. 13, 1834, which, I regret, were both accidental and very limited, owing to the ill state of health, I was in at that time. I have kept a journal of atmospheric and meteoric phenomena for some years, with the hope of deducing accurate conclusions on their origin, properties and effects."

"*Extract.*—Finding myself unable to sleep, I arose at half past 1 o'clock this morning, (Nov. 13, 1834.) The moon was shining with such peculiar brilliancy, that I was induced to take a survey of that portion of the heavens which my windows commanded, the north and east. After looking in the direction of *Leo* and *Ursa Major* for a few minutes, I observed a few small meteors, perhaps five or six; (I did not note the number;) but they presented nothing unusual in their appearance. I retired from the window about a quarter of an hour; but my interest in a subject at all times so highly gratifying to my mind, induced me to take another survey. I then saw in the space of half an hour, ten meteors, all of them highly electrical, of a red color, and very brilliant: they were without trains or sparks; and most of them between *Leo*, *Virgo*, and *Ursa Major*. In a few minutes, another meteor, of a paler color than any I had observed before, glided almost perpendicularly towards the earth: this was succeeded by another of more brilliant appearance, which took a westerly direction. This meteor cast a brilliant blue light, and had a short or truncated train, which was of a paler light than the meteor itself, and gradually shaded off into a yellowish red: it appeared, in fact, like a stream of light which the meteor, in its velocity, left behind. My health would not allow me to pursue these interesting phenomena longer, and I reluctantly retired to bed."

Old Kent Road, Dec. 10, 1834. (*Loudon's Mag.* 8.97.)

II. Domestic Testimonies.

1. From the *St. Louis* (Missouri) *Observer.*

"Mr. Editor—It was remarked in the last Observer, that nothing had been heard of the meteors here this year, although they had appeared at the east.

"On the 13th of November, at 5 o'clock in the morning, there was quite a display of meteors, or shooting stars, as they are sometimes improperly called. Happening to be out, at this time, I observed an unusual number of these meteors, and was immediately reminded of the celebrated meteoric display a year ago. I continued to gaze some fifteen or twenty minutes, and during that time, saw perhaps thirty or forty of these shooting bodies. The display was small compared with that of last year; yet it was sufficient to render it an object of interest. The temperature, the stillness of the atmosphere, and the clearness and serenity of the sky, were very similar to the appearance last year.—Bond Co. Ill., Dec. 15, 1834.—L."

2. From *Charles B. Goddard*, Esq., Zanesville, Ohio.—Addressed to Professor Silliman.

"*Dear Sir*,—On the morning of the 13th November last, a female servant in my family witnessed a meteoric appearance, similar to that so generally seen at the same period of 1833. It was not so extensive, nor did it endure so long. She communicated this to my wife on that day, and I questioned her respecting it. I have no reason to doubt her veracity.—Zanesville, Aug. 12, 1835."

3. From Mr. *A. K. Wright*, Member of the Theological Seminary, Andover, Mass.

"To Professor Olmsted,—*Dear Sir*,— (Extract.)

"It may be interesting to you to know, that the meteoric exhibition was noticed here this year, as well as in other parts of the country.—Andover, Dec. 10th, 1834."

4. For the observations made at New Haven, and at West Point, see *American Journal of Science* for January, 1835.

Remarks.—1. My respected friend, Professor Bache, has collected and published in the last No. of this Journal, a long list of testimonies of those who *did not* see the foregoing meteoric exhibition, derived from sentinels at military posts in the United States. The preceding statements show that there were many, on both sides of the water, who *did* see it as well as the New Haven observers. Sailors are better observers of *celestial* phenomena than soldiers. Stars must fall thick and bright, to surprise the vigilance of a sentinel in time of peace.

2. Whereas the American Philosophical Society ordered it to be entered on their records, "that no unusual meteoric display was seen at Philadelphia on the 13th Nov. 1834," it is to be presumed that, with the impartiality expected from learned bodies, they will also record the fact, that such a display *was* seen at various other places, in both hemispheres.

NOTICES OF SCIENTIFIC WORKS,

for sale by HERRICK & NOYES, *Booksellers, New Haven.*

THE EDINBURGH ENCYCLOPÆDIA, conducted by David Brewster. American edition, Philadelphia, 1832, 18 vols. of letter press and 3 of plates. calf, $100. Nos. 32, 33, 34, 35, 36 of the same work, separately, $4 each.

VALMONT-BOMARE: Dictionnaire Raisonné Universel d' Histoire Naturelle, contenant l' Histoire des Animaux, des Vegetaux, and des Mineraux, et celle des corps célestes, et des Météores. 4me edition. A Lyon, 1791. 15 vols. 8vo. sheep. $7.50.

GEORGE CRABB: Universal Technological Dictionary, or familiar explanations of the terms used in all Arts and Sciences, illustrated by Plates, Diagrams, Cuts, &c. London, 1823. 2 vols. 4to. sheep $22.

ALEXANDER JAMIESON: Dictionary of Mechanical Sciences, Arts, Manufactures and Miscellaneous Knowledge, illustrated with many hundred engravings. London, 4to. 1827. calf back, $13.50.

THOMAS THOMSON: Annals of Philosophy; or Magazine of Chemistry, Mineralogy, Mechanics, Natural History, Agriculture, and the Arts. London, 1813—1820. 28 vols. 8vo. cloth, $42.

Mineralogy and Geology.

WILLIAM BUCKLAND: Reliquiæ Diluvianæ; or Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel, and on other geological phenomena, attesting the action of an Universal Deluge. 2d ed. London, 1824. 4to. 27 plates. $9.

ROBERT BAKEWELL: An Introduction to Geology: intended to convey a practical knowledge of the science, and comprising the most important recent discoveries. 4th edition, greatly enlarged. London, 1833. 8vo. with 8 plates. $5.

The same work, edited by Prof. B. Silliman, New Haven, 1833. 8vo. $2.50.

ANDREW URE: A New System of Geology, in which the great revolutions of the Earth and Animated Nature, are reconciled at once to modern science and sacred history. Lond. 1829. 8vo. $6.

H. T. DE LA BECHE: A Geological Manual. Phil. 1832. 8vo. $3.

" " A selection of the Geological Memoirs contained in the Annales des Mines, together with a synoptical table of equivalent formations and Brongniart's Table of the Classification of mixed rocks. Lond. 1824. 8vo. $3.

H. T. DE LA BECHE: Geological Notes. Lond. 1830. 8vo. $2.

CONYBEARE and PHILLIPS: Outlines of the Geology of England and Wales, with an introductory compendium of the general principles of that science, and comparative views of the structure of foreign countries. Part I, (all that has been published,) Lond. 1822. 8vo. $4.75.

Edward Hitchcock: Report on the Geology, Mineralogy and Zoology of Massachusetts. Amherst, 1833. 8vo. and atlas of plates $5.

J. L. Comstock: Outlines of Geology. Hartford, 1834. 12mo. $1.25.

John Williams: The Natural History of the Mineral Kingdom, relative to the state of coal, mineral veins, and the prevailing strata of the Globe. 2d ed. by Millar. Edinburgh, 1810, 2 vols. 8vo. $5.

C. U. Shepard: Treatise on Mineralogy, with 654 wood cuts. New Haven, 1832-5. 3 vols. 12mo. $4.37 1-2.

Delvalle Lowry: Conversations on Mineralogy, with plates. 12mo. Phil. $1.25.

N. F. Moore: Ancient Mineralogy, or an Inquiry respecting mineral substances mentioned by the ancients; with occasional remarks on the uses to which they were applied. New York, 1834. 12mo. $.75.

G. Poulett Scrope: Considerations on Volcanos, the probable causes of their phenomena, the laws which determine their march, the disposition of their products, and their connexion with the present state and past history of the Globe, leading to the establishment of a new theory of the Earth. London, 1825. 8vo. $3.75.

Granville Penn: A Comparative Estimate of the Mineral and Mosaical Geologies, revised and enlarged with relation to the latest publications on Geology. London, 1825. 2 vols. 8vo. $6.75.

Botany.

Al. de Humboldt et A. Bonpland: Monographie des Melastomacées. London, 1833. folio. with 45 colored plates of Melastomæ, and 19 of Rhexiæ. $15.

A. P. De Candolle: Prodromus Systematis Naturalis Regni Vegetabilis, sive enumeratio contracta Ordinum, Generum Specierumque Plantarum huc usque cognitarum, juxta Methodi Naturalis normas digesta. Tomi I, II, III, IV. Paris, 1824–1830. 8vo. $18.

Jaume St. Hilaire: Exposition des Familles Naturelles et de la germination des Plantes; contenant la description de deux mille trois cent trente sept genres, and d' environ quatre mille espèces, les plus utiles and les plus intéressantes. Cent dix-sept planches, dont les figures ont été dessinées par l' Auteur, représentent les caractères des Familles et les différens modes de germination des Plantes Monocotylédones et Dicotylédones. Paris. 1805. 2 vols. 8vo. $9.

Thomas Green: Universal Herbal, or Botanical, Medical and Agricultural Dictionary, containing an account of all the known plants in the World, arranged on the Linnæan System, specifying the uses to which they are or may be applied, as food, as medicine, or in the arts and manufactures, with the best method of propagation. London, 1824. 2 vols. 4to. 2d edition, revised and improved, with 107 copper plates. $21.

Frederick Pursh: Flora Americæ Septentrionalis; or a Systematic arrangement and description of the plants of North America. London, 1814. 2 vols. 8vo. with 24 engravings. $8.

Roemer et Schultes: C. a Linné Systema Vegetabilium secundum Classes, Ordines et Genera; ed. nova. Stuttgardtiæ, 1820. Vol. I. sect. 1. $1.

A. Richard: New Elements of Botany, containing the characters of the natural families of the vegetable kingdom, with plates exhibiting the principal modifications of the organs of vegetables; translated by P. Clinton. Dublin, 1829. 8vo. $4.

J. E. Smith: A Grammar of Botany, illustrative of artificial, as well as natural classification, with an explanation of Jussieu's system, with additions by Henry Muhlenburg. New York, 1822. 8vo. $2.

A. P. De Candolle and K. Sprengel: Elements of the Philosophy of Plants, containing the principles of scientific Botany; nomenclature, theory of classification, phytography, anatomy, chemistry, physiology, geography, and diseases of Plants. Translated from the German. Edinburgh, 1821. 8vo. $4.50.

John Lindley: An Introduction to the Natural System of Botany; first American edition, by John Torrey. New York, 1831. $2.50.

W. P. C. Barton: Compendium Floræ Philadelphicæ: containing a description of the indigenous and naturalized plants found within a circuit of ten miles around Philadelphia. Phil. 1818. 2 vols. 12mo. $1.25.

Amos Eaton: Manual of Botany of North America, containing generic and specific descriptions of the indigenous plants and common cultivated exotics, growing north of the Gulf of Mexico. Albany, 1833. 6th edition, 12mo. $2.50.

" " Botanical Grammar and Dictionary, translated from the French. Albany, 1828. 3d ed. 12mo. $.62.

Almira H. Lincoln: Familiar Lectures on Botany. Hartford, 1835. 4th ed. 12mo. $1.50.

Conversations on Vegetable Physiology: comprehending the elements of Botany, with their application to Agriculture. New York, 1830. 12mo. $.87 1-2.

The same, adapted to the use of schools, by Rev. J. L. Blake. Boston, 1830. 12mo. $1.

Natural Philosophy and Mathematics.

J. A. De Luc: Recherches sur les Modifications de l' Atmosphere, contenant l' Histoire critique du Baromètre et du Thermomètre. 4 vols. 8vo. Paris, 1784. sp. $5.

Newtonus: Philosophiæ Naturalis Principia Mathematica; perpetuis commentariis illustrata communi studio PP. Le Seur et Jacquier. 4 tomi. R. 8vo. Glasguæ, 1822. bds. $12.

Newton: The Mathematical Principles of Natural Philosophy, translated into English by Andrew Motte. 2 vols. 8vo. London, 1729. cf. $5.

J. M. F. Wright: A Commentary on Newton's Principia, with a supplementary volume. 2 vols. 8vo. London, 1828. bds. $9.

L. B. Francoeur: Cours Complet de Mathématiques Pures. 2de ed. 2 tomes. 8vo. Paris, 1819. paper, $4.

M. F. Canard: Traité Elémentaire du Calcul des Inequations. 8vo. Paris, 1821. paper, $1.50.

Lardner: A System of Algebraic Geometry. 8vo. London, 1823. cloth, $3.

Larkin: Introduction to Solid Geometry, and to the study of Crystallography, &c. 8vo. London, 1820. bds, $1.

John Warren: Treatise on the Geometrical Representation of the Square Roots of Negative Quantities. 8vo. Cambridge, 1828. bds. $1.50.

Lacroix: Cours de Mathematiques. 8 vols. 8vo. Paris, 1802—1808. bds. $6.

Demonferrand: Manuel d' Electricité Dynamique. 8vo. Paris. 1923. paper, $1.

Baden Powell: A short Elementary Treatise on Experimental and Mathematical Optics. 8vo. Oxford, 1833. bds. $3.

W. M. Higgins: An Introductory Treatise on the Nature and Properties of Light and on Optical Instruments. 8vo. London, 1829. cloth, $1.25.

Hauy: Traité Elémentaire de Physique. 3me ed. 2 vols. 8vo. Paris, 1821. sp. $3.50.

James Wood: The Elements of Optics. 4th ed. 8vo. Cambridge, 1818. paper, $1.50.

Thomas Exley: Principles of Natural Philosophy, or a new theory of Physics founded on Gravitation and applied in explaining the general properties of matter. 8vo. London, 1829. bds. $4.

Wm. C. Wells: Two Essays; one upon Single Vision with two eyes; the other on Dew, &c. 8vo. London, 1818. bds. $2.75.

Thos. Thomson: Outline of the Sciences of Heat and Electricity. 8vo. London, 1830. bds. $4.

Partington: A Manual of Natural and Experimental Philosophy. 2 vols. 8vo. London, 1828. bds. $5.

Viallon: Philosophie de l' Univers, ou Théorie Philosophique de la Nature. 1re partie. 8vo. Bruxelles, 1782. $.75.

James Smith: The Mechanic, or Compendium of Practical Inventions, containing 215 articles, with 108 copper plate engravings. 2 vols. 8vo. London, 1825. bds. $9.

Tredgold: Practical Essay on the Strength of Cast Iron and other metals; intended for the assistance of Engineers, &c. 8vo. London, 1831. bds. $3.25.

LESLIE: Elements of Natural Philosophy, Vol. I, including Mechanics and Hydrostatics, 2d ed. 8vo. Edinburgh, 1829. bds. $4.25.

LESLIE: Elements of Geometry, Geometrical Analysis, and Plane Trigonometry. 8vo. Edinburgh, 1809. sp. $2.

PLAYFAIR: Outlines of Natural Philosophy. 3d ed. Edinburgh, 1819. 2 vols. in 1. cf. $3.

RUMFORD: Philosophical Papers. 8vo. London, 1802. sp. $1.75.

CHARLES DAVIES: Elements of Descriptive Geometry. 8vo. Philadelphia, 1826. bds. $1.25.

D'ALEMBERT: Elemens du Musique. 8vo. Lyon, 1762. sp. worn, $.37 1-2.

BRADLEY: Practical Geometry, Linear Perspective and Projection. 8vo. London, 1834. cloth, $2.

HACHETTE: Programmes d' un Cours de Physique. 8vo. Paris, 1809. paper, $1.25.

C. C. CLARKE: Readings in Natural Philosophy: or a popular display of the wonders of nature; exclusively selected from the Transactions of the Royal Society of London. 2d ed. 12mo. London, 1830. sp. $3.

P. NICHOLSON: Analytical and Arithmetical Essays. 8vo. London, 1821. bds. $2.

G. GREGORY: Lectures on Experimental Philosophy, Astronomy and Chemistry. 2d ed. 2 vols. 12mo. London, 1820. bds. $3.

VINCE: Principles of Hydrostatics. 5th ed. 8vo. Cambridge, 1820. paper, $1.25.

HASSLER: Elements of the Geometry of Planes and Solids, with 4 plates. 8vo. Richmond, 1828. bds. $1.25.

DUPIN: Mathematics practically applied to the useful and fine arts, by Birkbeck. 8vo. London, 1827. bds. $3.

FERGUSON: Lectures on select subjects in Mechanics, Hydrostatics, Pneumatics, Optics and Astronomy. 8vo. London, 1825. bds. $1.75.

RENWICK: Elements of Mechanics. 8vo. Philadelphia. 1832. sp. $3.75.

ARTHUR BROWNE: Short view of the First Principles of the Differential Calculus. 8vo. Cambridge, 1824. bds. $1.25.

Nautical Almanac and Astronomical Ephemeris for the year 1837, with an Appendix. 8vo. London, 1835. paper, $2.

Remarks by the Editor.

The account of the Coal formation of the Ohio and its confluent rivers, having occupied the greater portion of the present number, many other communications are necessarily postponed.

The amount of printed pages in this number is less than usual—but including the pages of Wood cuts, the size is larger and the expense *much greater* than common.

Our acknowledgments for books, pamphlets, &c., received, will be annexed to the January number.

ERRATA.

P. 22, bot. l. dele "Walhouding or" and insert "the."—p. 27, l. 15 fr. top, for "shells," read "shales."—p. 38, l. 8 fr. bot. for "Monongahela," read "Maxahala." —p. 40, l. 15 fr. bot. for "leaves," read "covers."—p. 50, l. 4 fr. top, for "Another," read "Descriptions."—p. 71, l. 6 fr. top. dele "or Walhouding."—p. 102 l. 10 fr. top, for "poles," read "polls."

Dr. Hildreth does not consider it as quite certain, although highly probable, that the rock which he has called Lias, as identical with that of England; the opinion, that they are geologically identical, is ably maintained by another gentleman, whose observations will appear in our next number.—Ed.

Vol. xxviii. p. 111, l. 6 fr. top, for "W. W.," read "F. H."—p. 118, l. 5 fr. top, for "10.63," read "1068 grs."—p. 378, l. 7, 10, 16, 27, and contents p. 7. l. 8 fr. top, for "Brown," read "Bronn."

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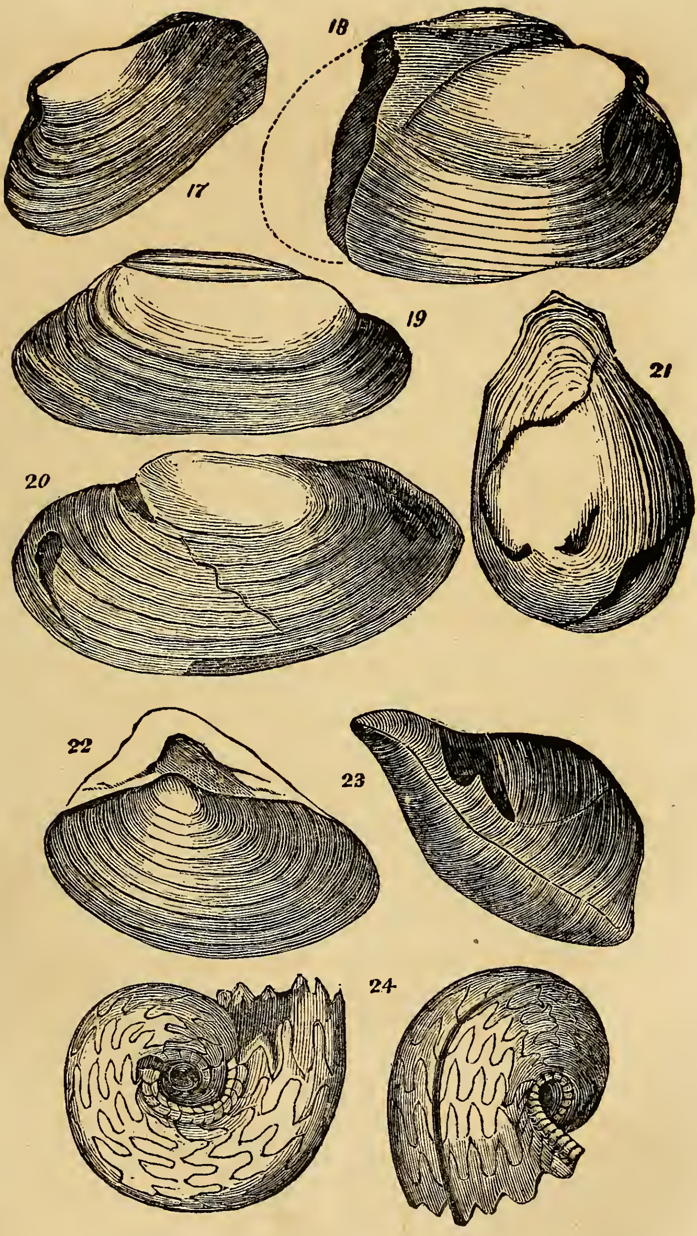

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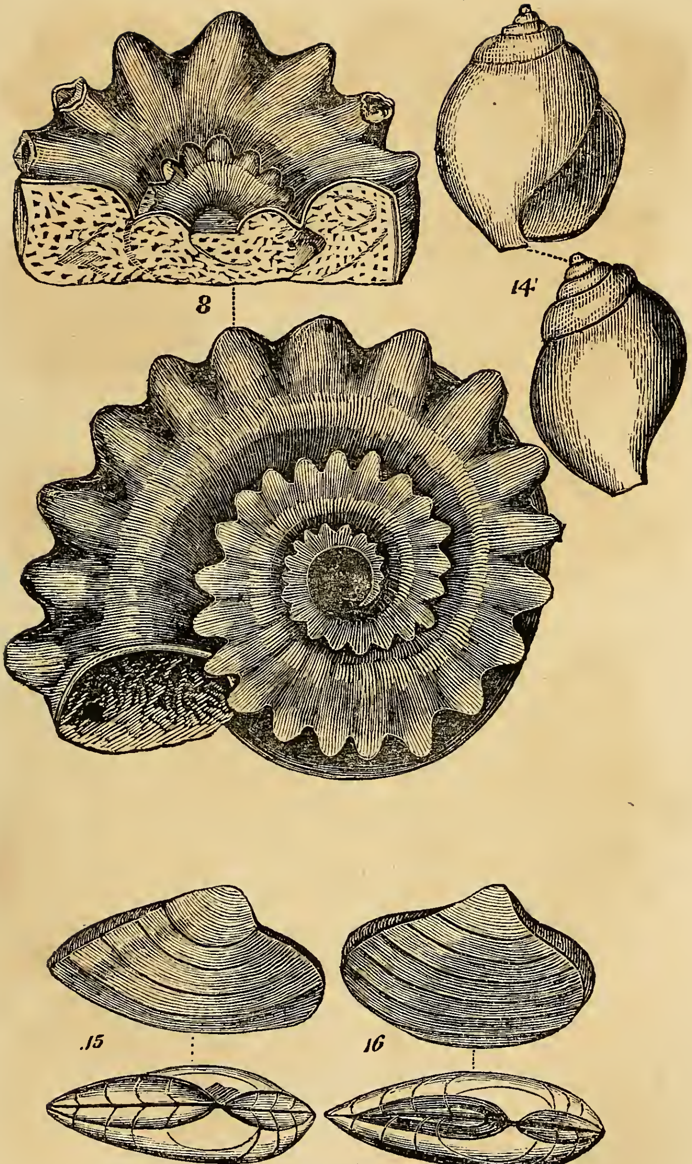

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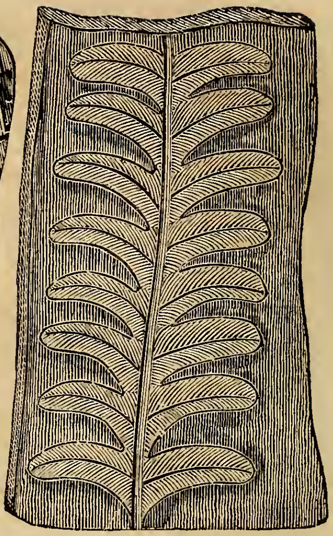

6

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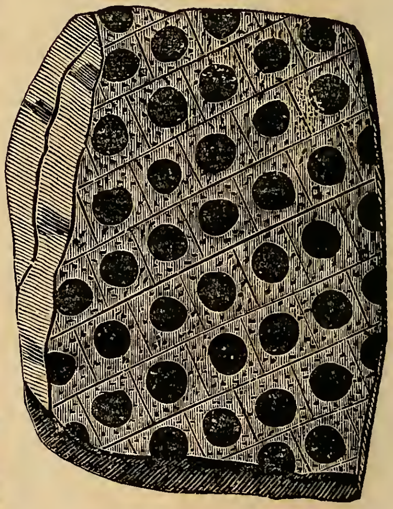
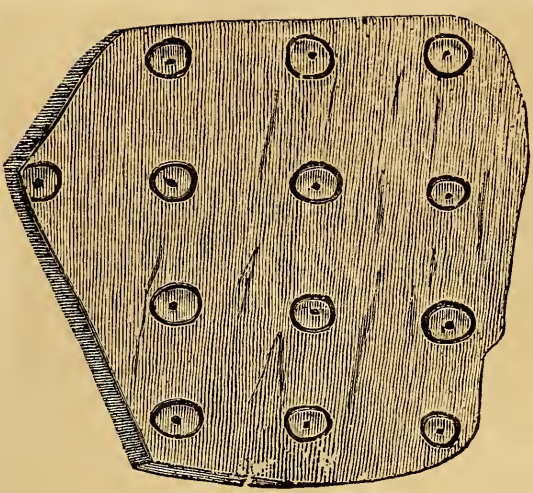


Nos. 5 and 9, one half size.—Nos. 6 and 8, natural size.

7



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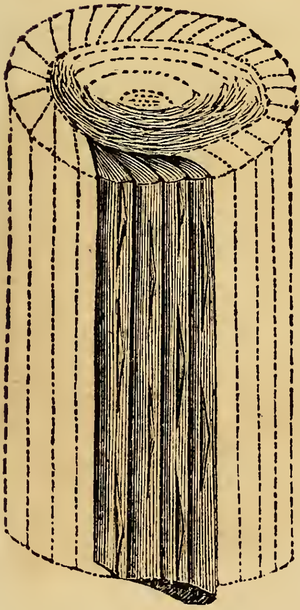

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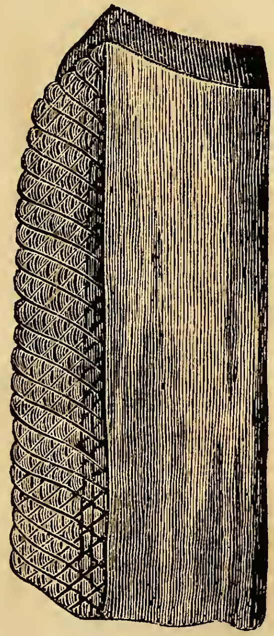
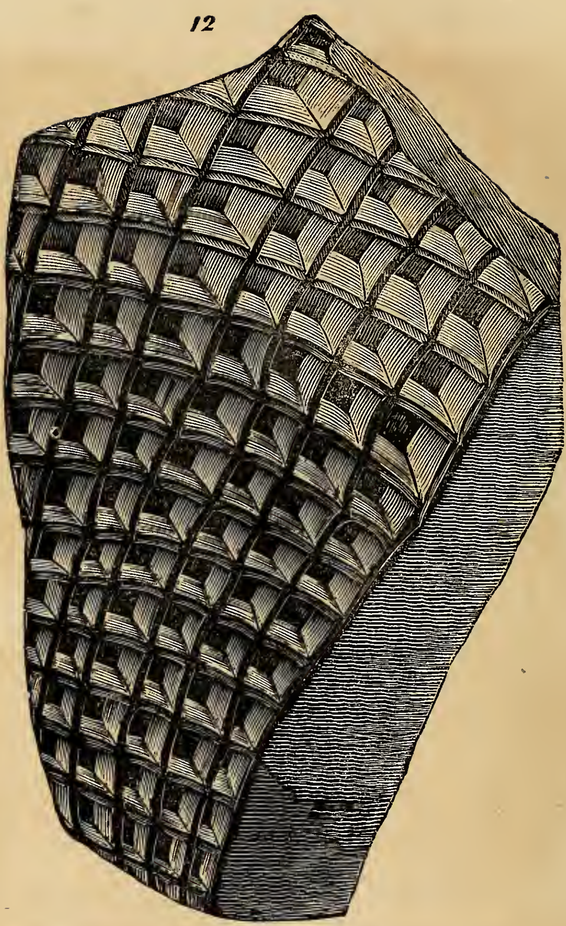


No. 7, natural size.—No. 15, one fourth size.—No. 11, one half size.

12



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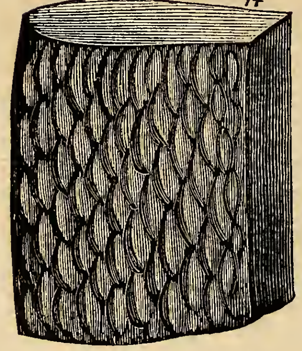

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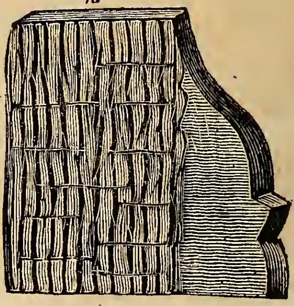
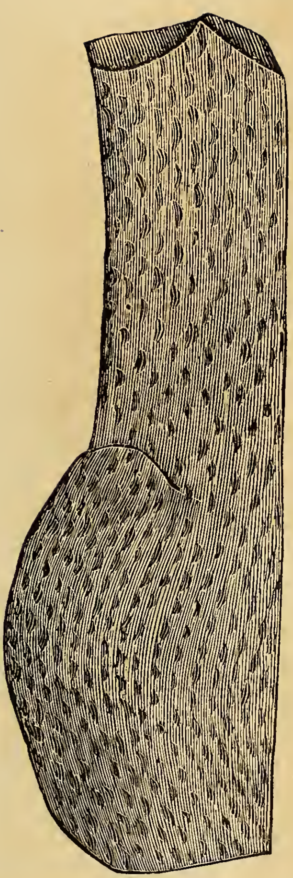


No. 12, from a drawing three fourths of the natural size, reduced one half.—No. 13, one sixth size.—No. 14, one fourth size.

16



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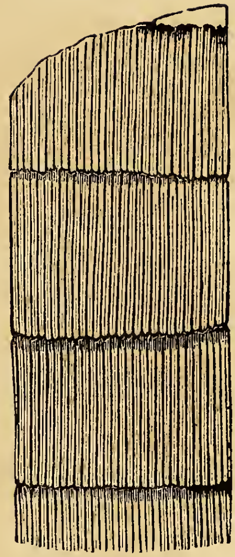

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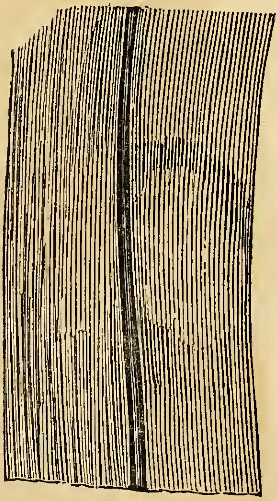

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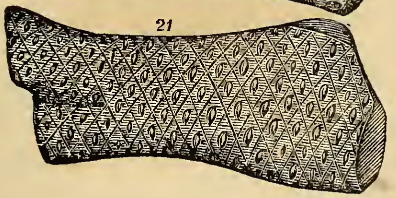

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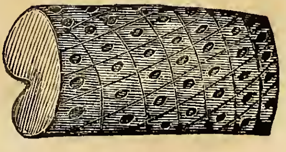
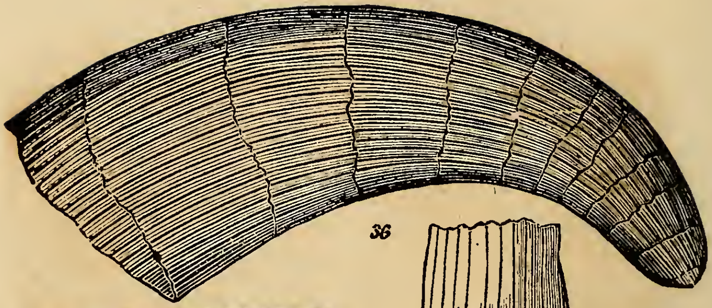


Nos. 16, 19 and 20, one fourth size.



36

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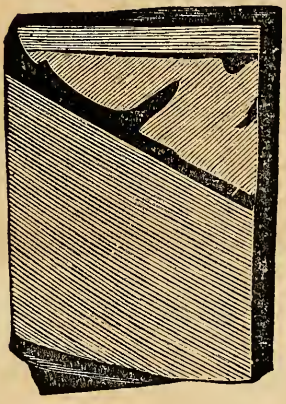
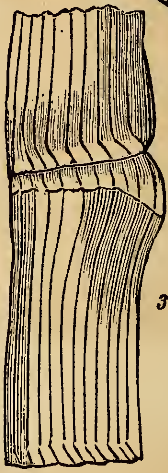
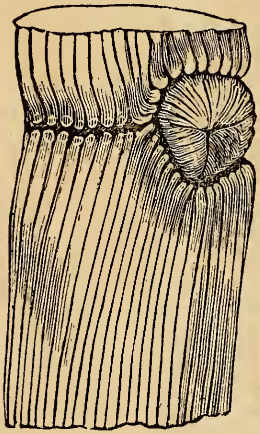




37

38



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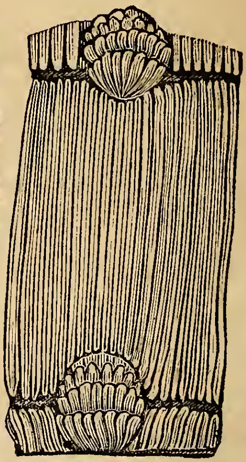
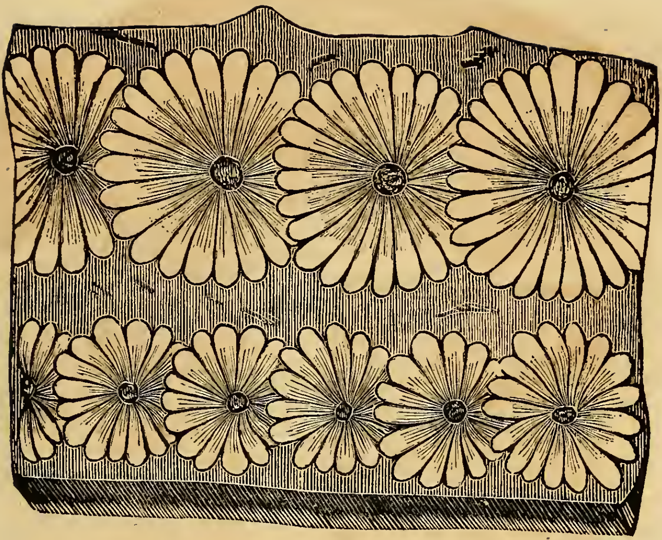


No. 36, two thirds size.

30



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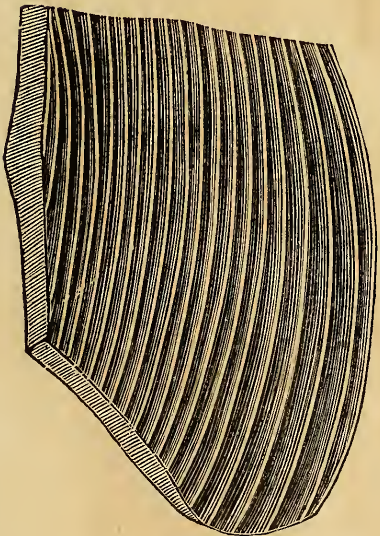

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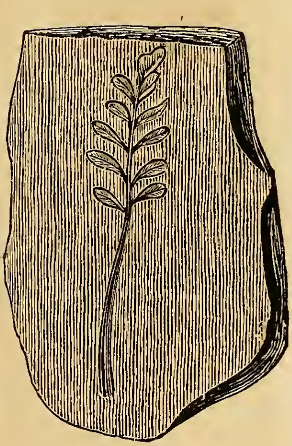
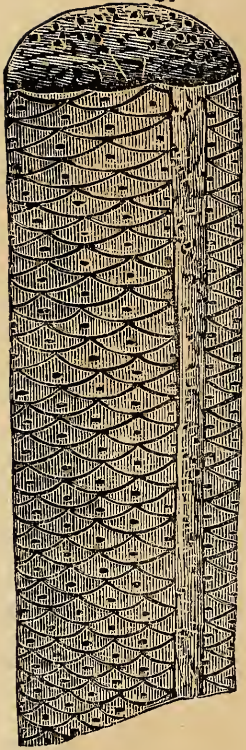


No. 30, natural size.—No. 32, one fourth size.—No. 33, one half size.

22



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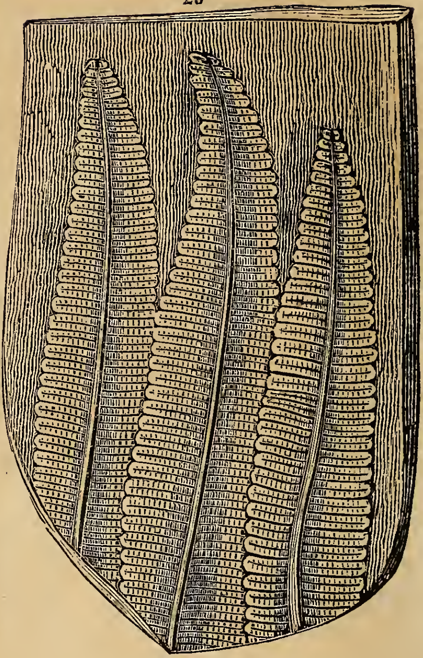

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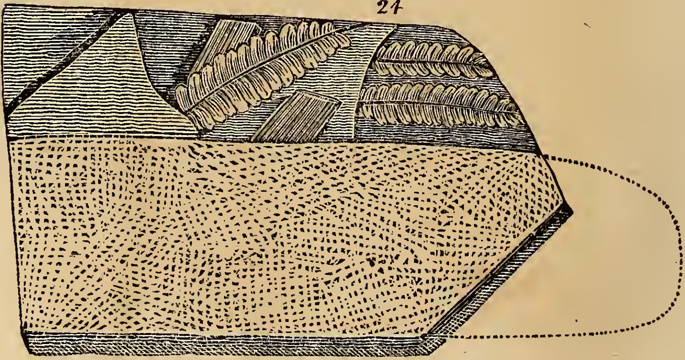
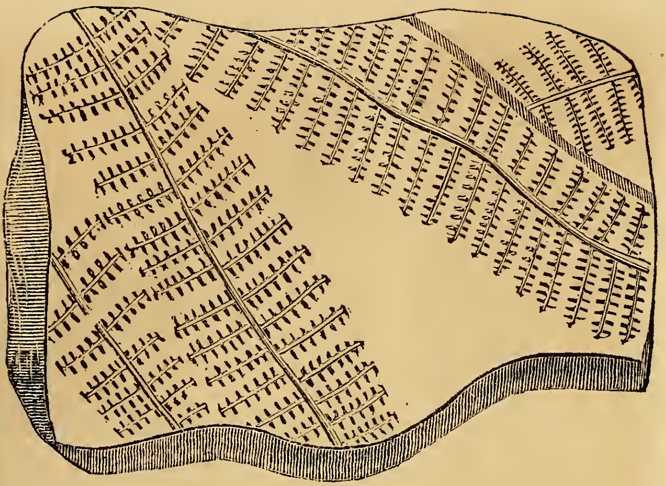


Nos. 23 and 24, one half size.

25



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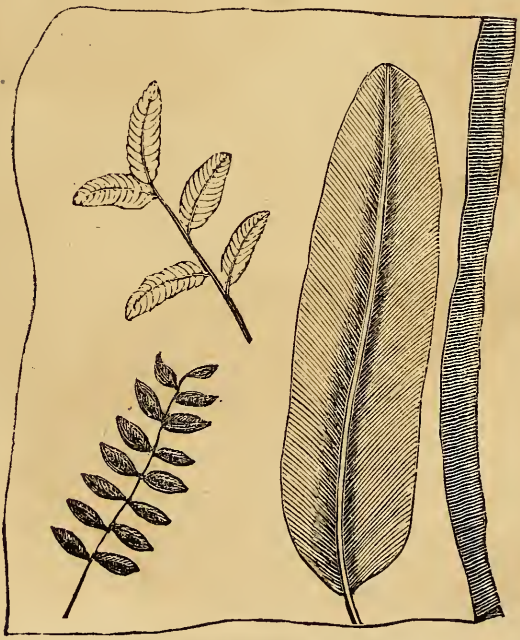

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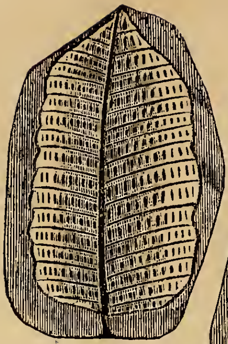
27



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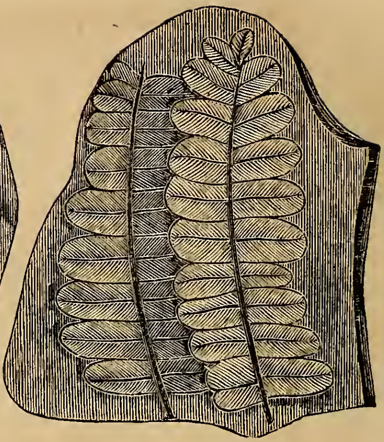

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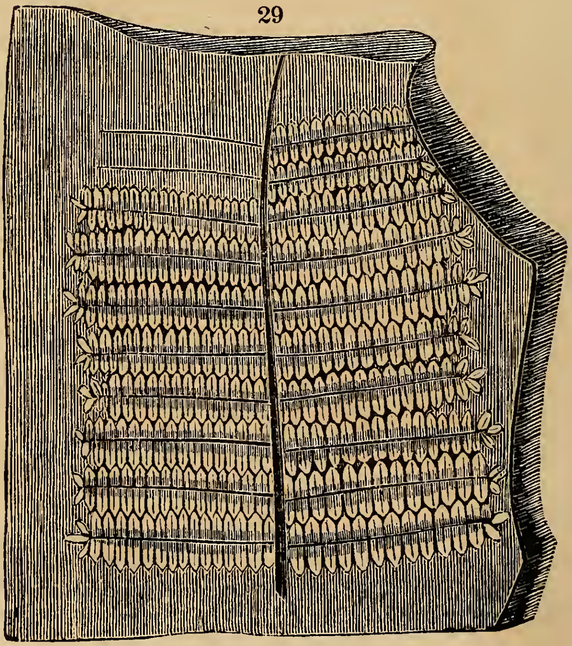
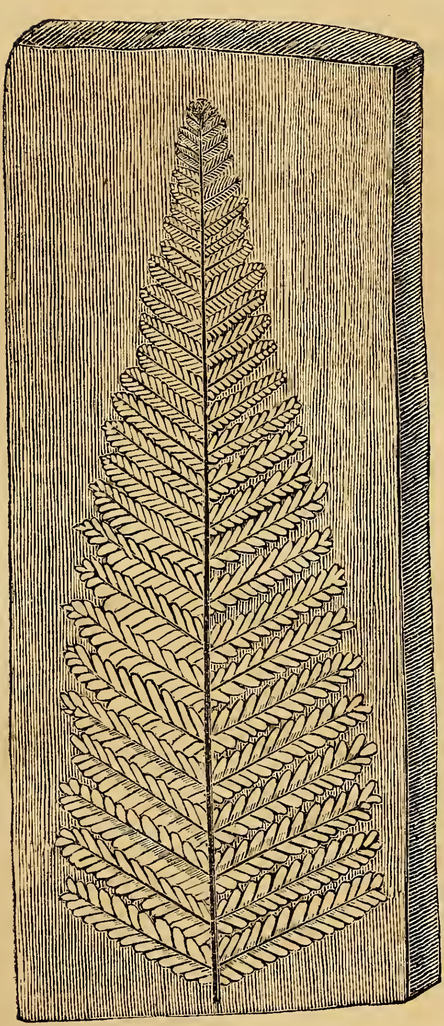
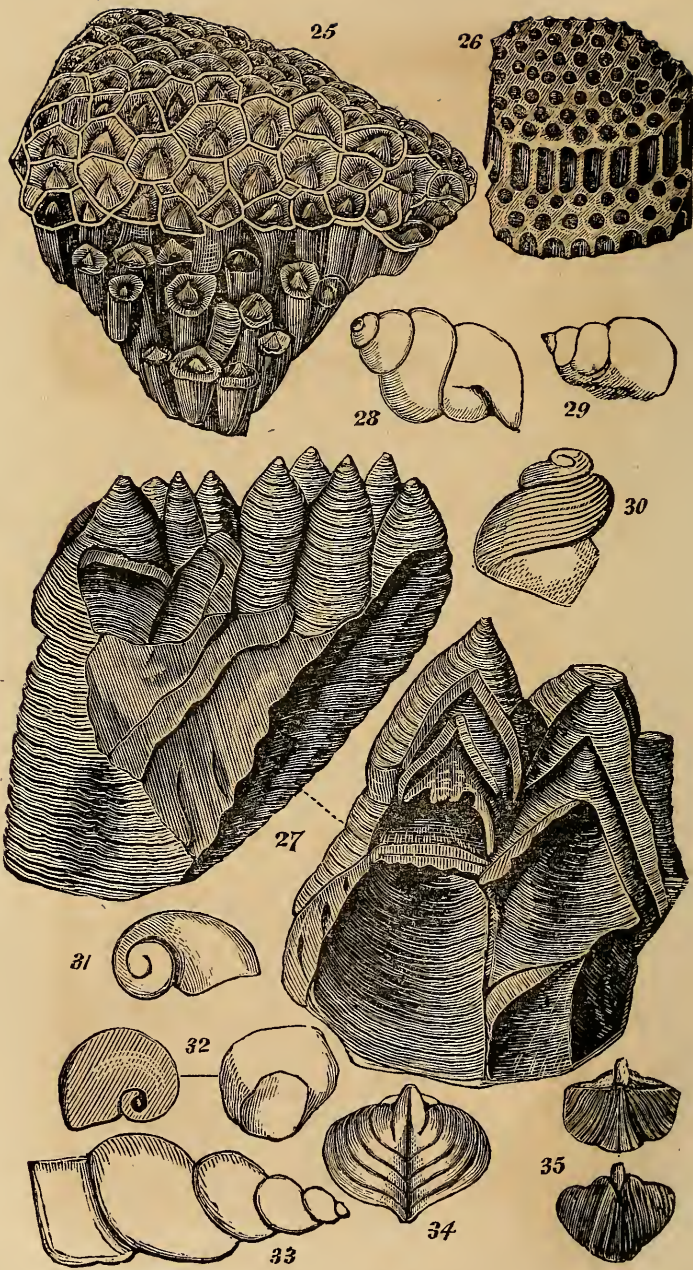


Nos. 27, 28 and 29, natural size.

31

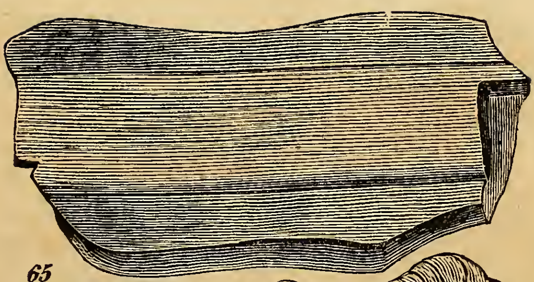


No. 31, one third size.



Nos. 25 and 26, one half size.

57



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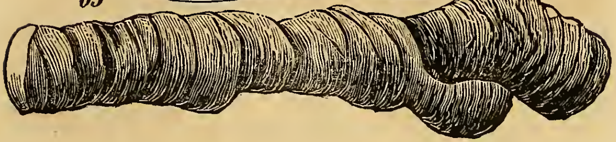

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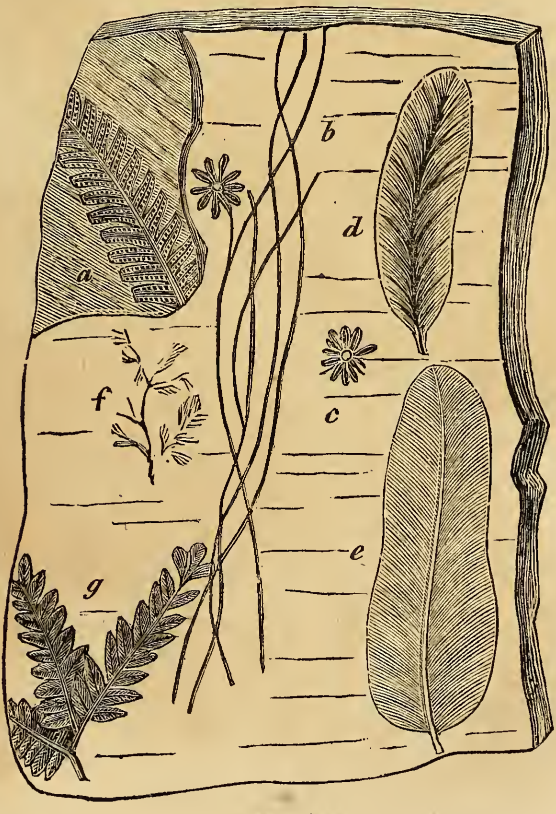
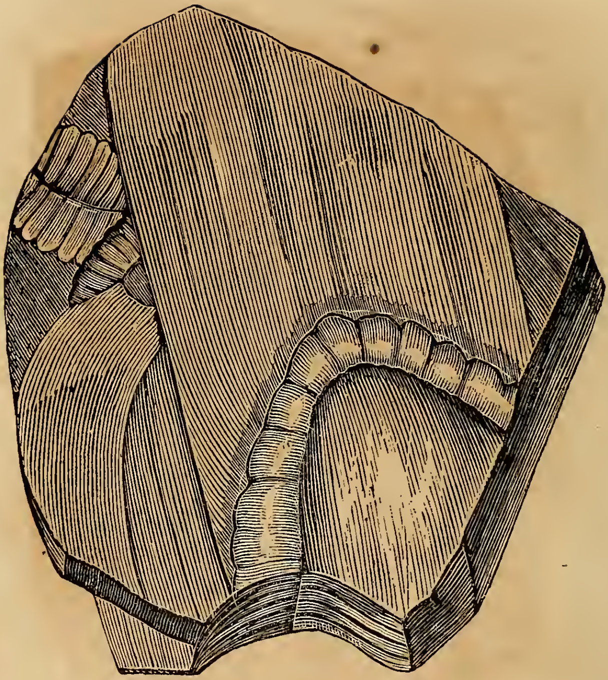


No. 57, one half size.

40



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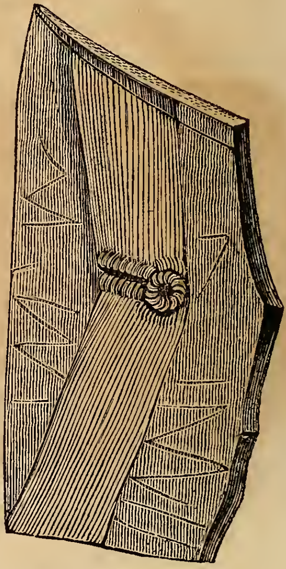
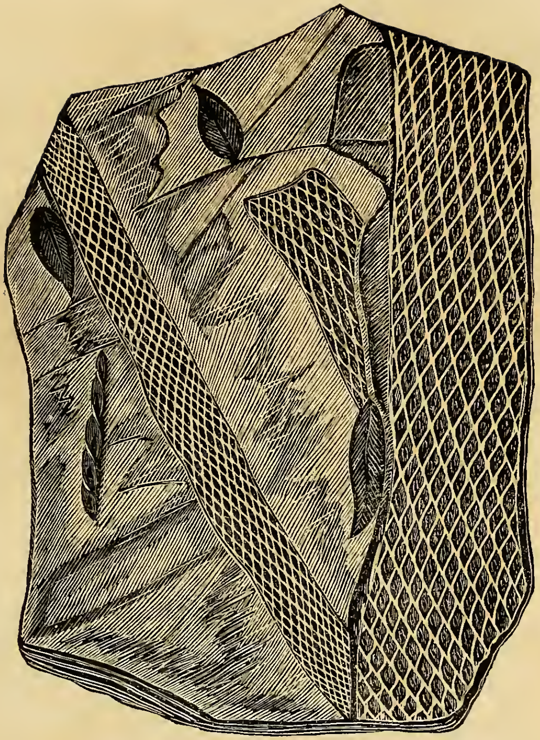


41

43



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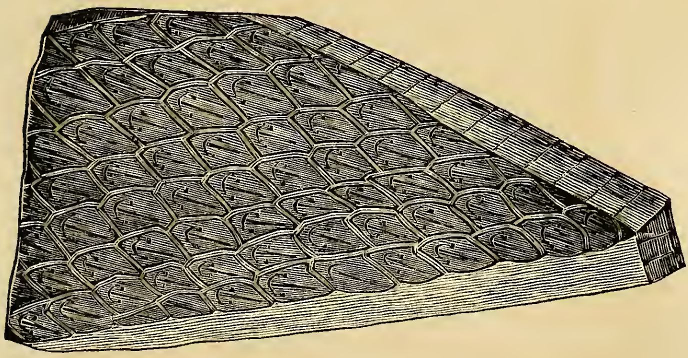
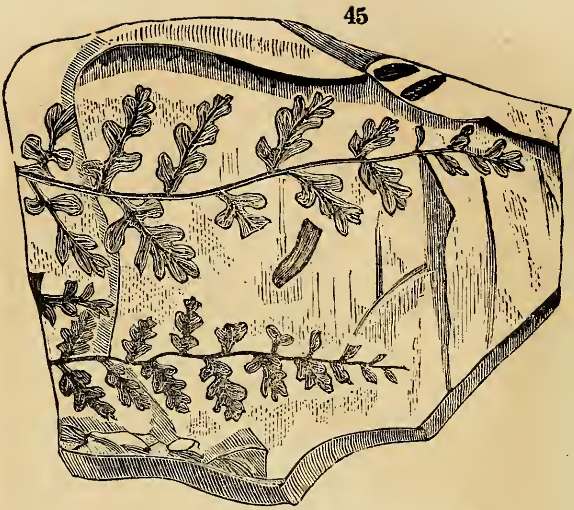
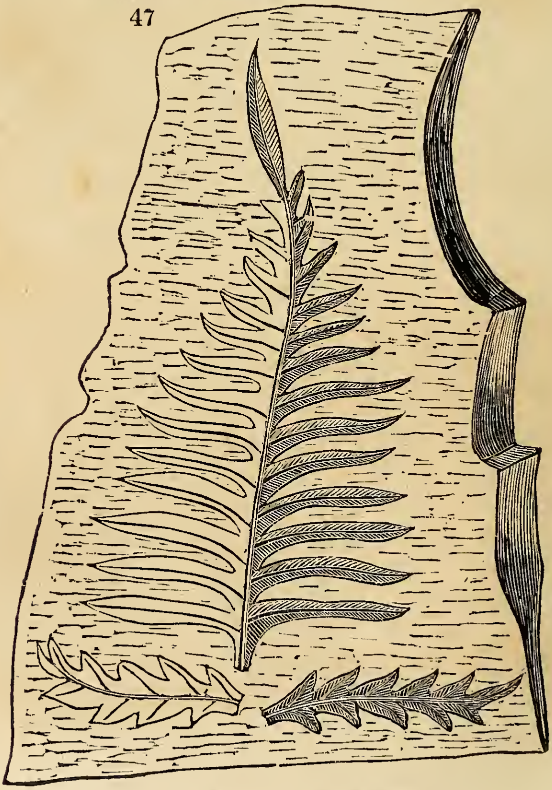


Nos. 43 and 44, one half size.

45

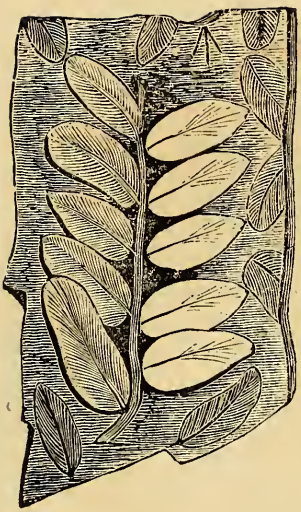


47



Nos. 45 and 47, one half size.

46



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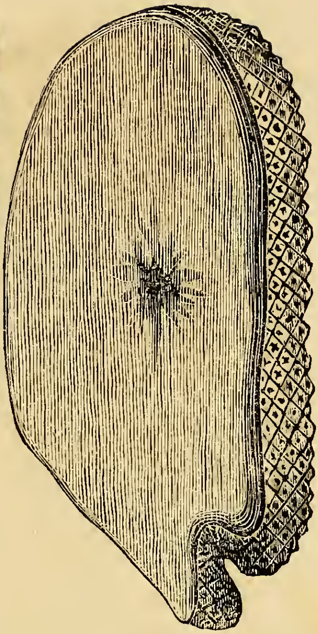
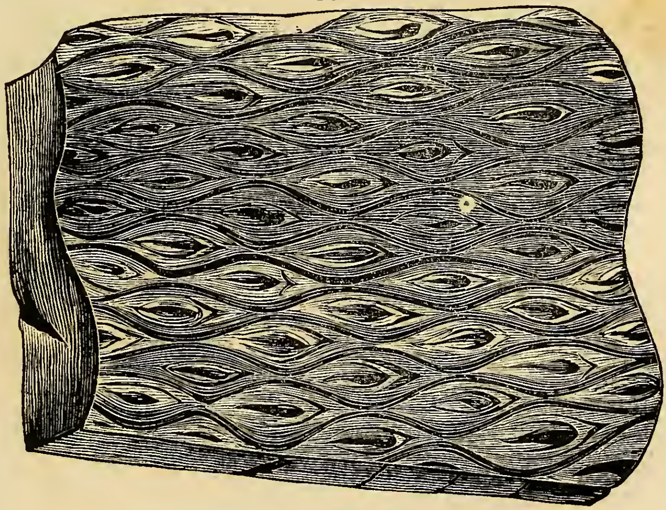


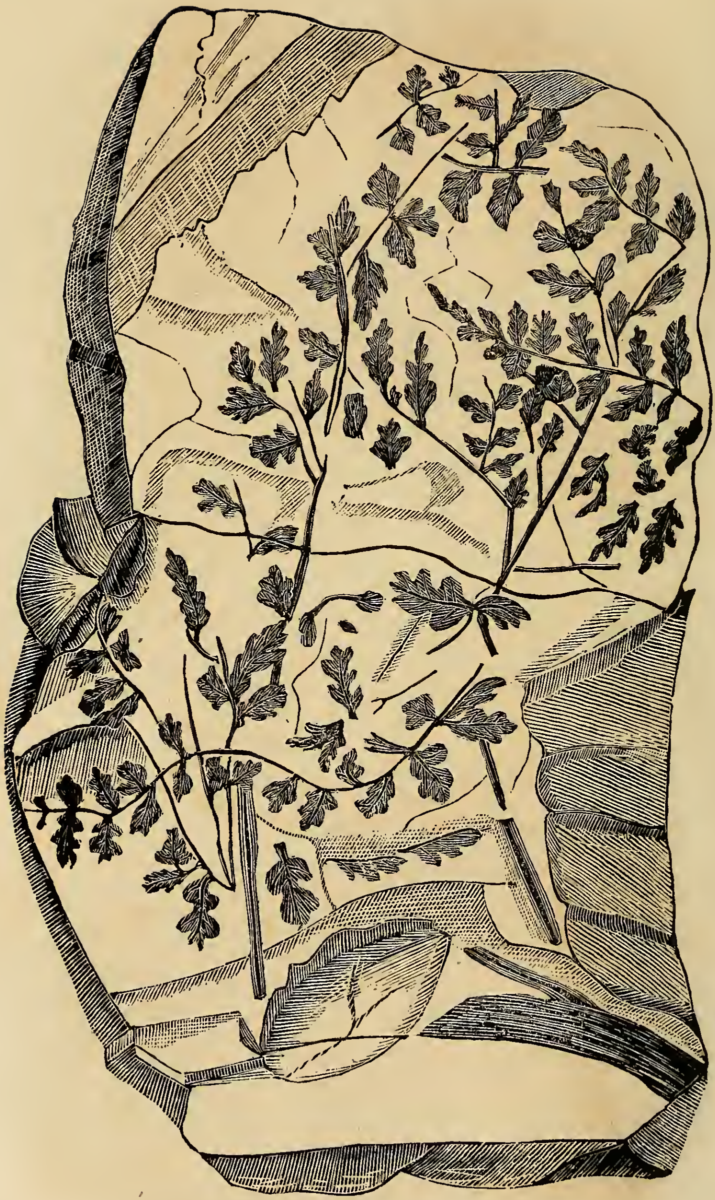
No. 51, section of a trunk three feet the longer diameter, and eighteen inches the shorter diameter.

50



Nos. 46 and 50, one half size.

48



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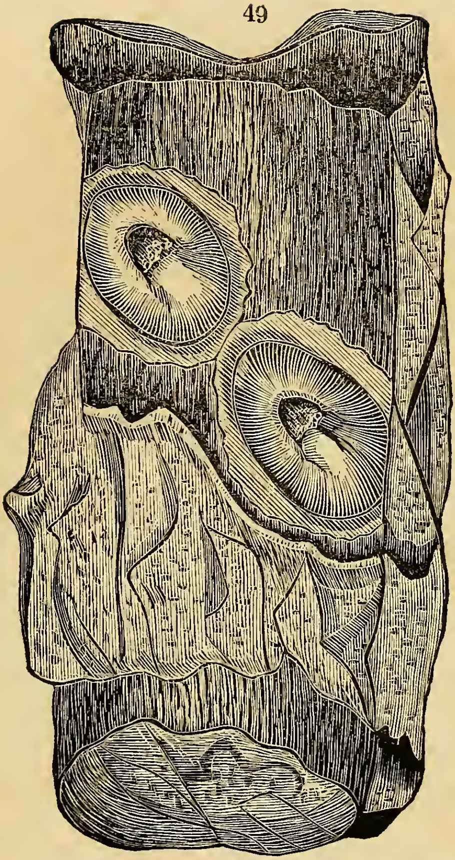
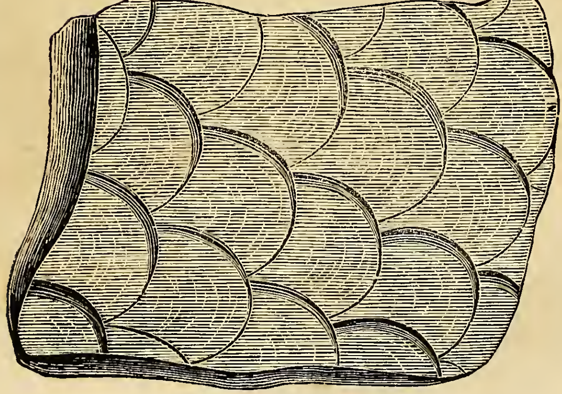
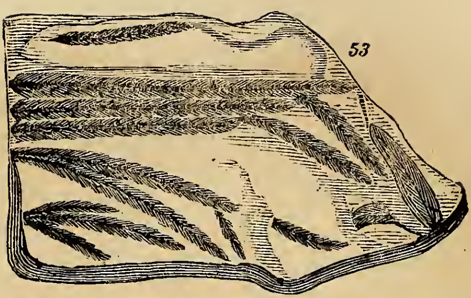


52



No. 52, one half size.

53



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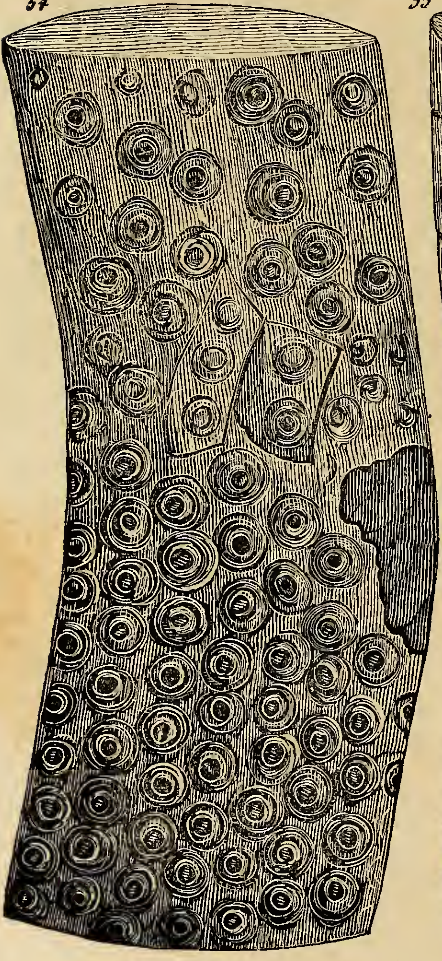

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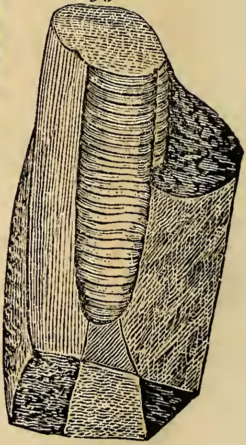
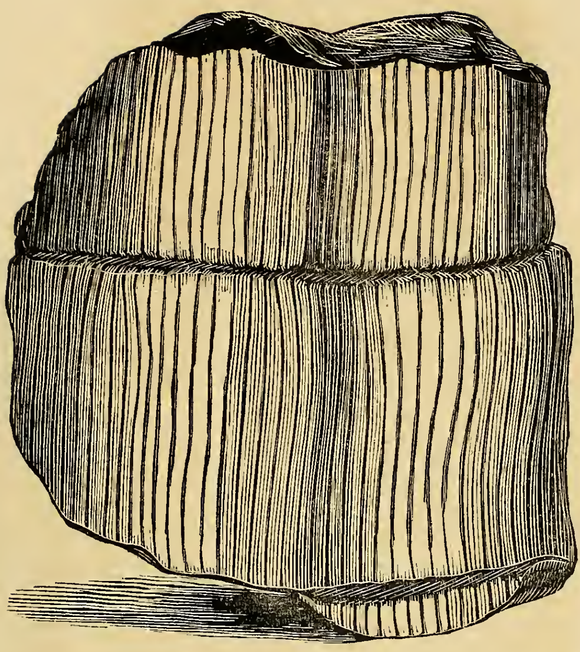
58



No. 54, one fourth size.—Nos. 55, 56 and 58, one half size.

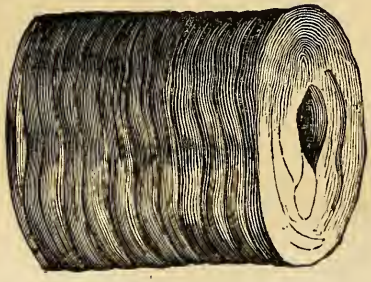
35



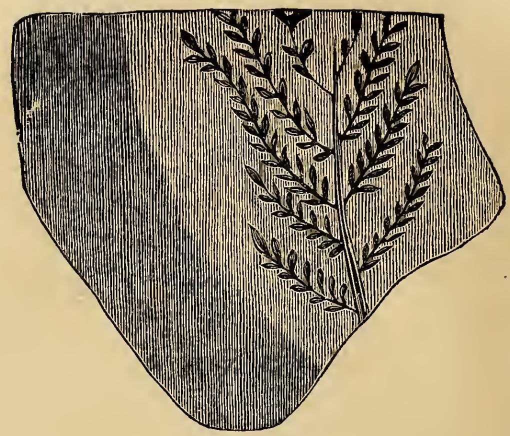
No. 35, natural size.—Cylindrical, compressed, divided by transverse depressions into joints, and impressed by numerous longitudinal striæ.

Diagram showing the flattening or compression of the above.

64



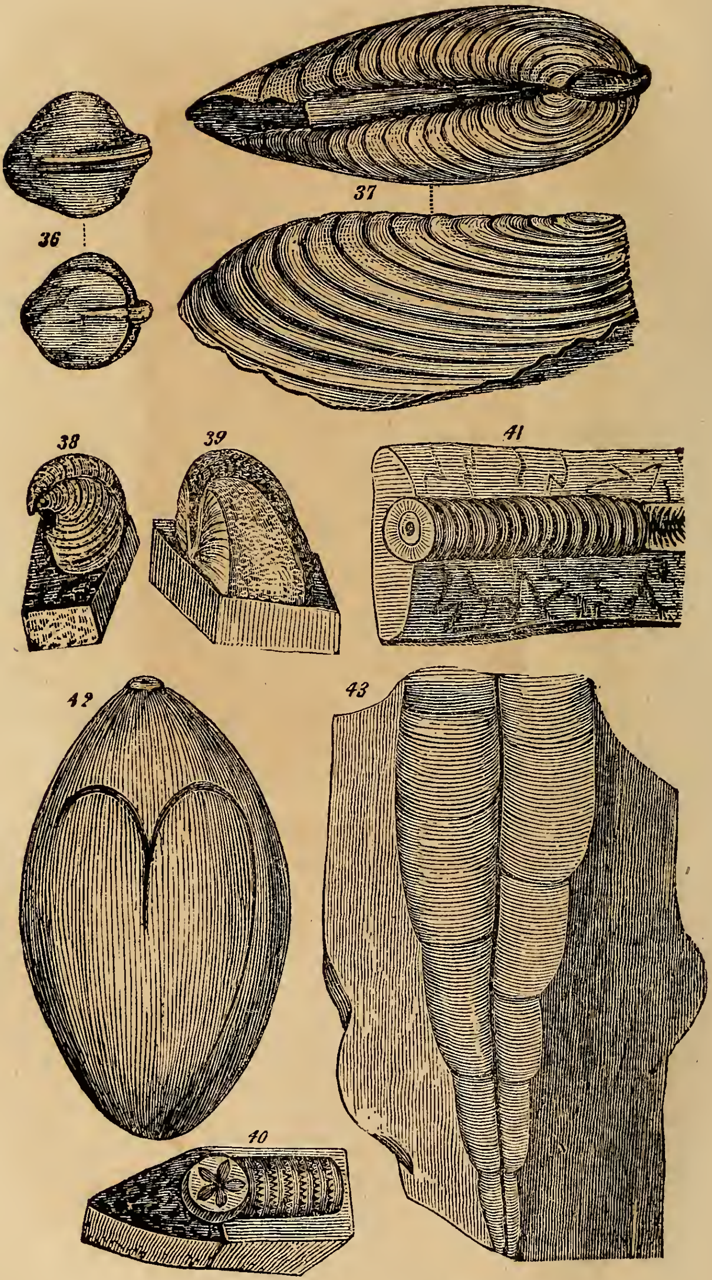
59



60

63

No. 63, one half size.

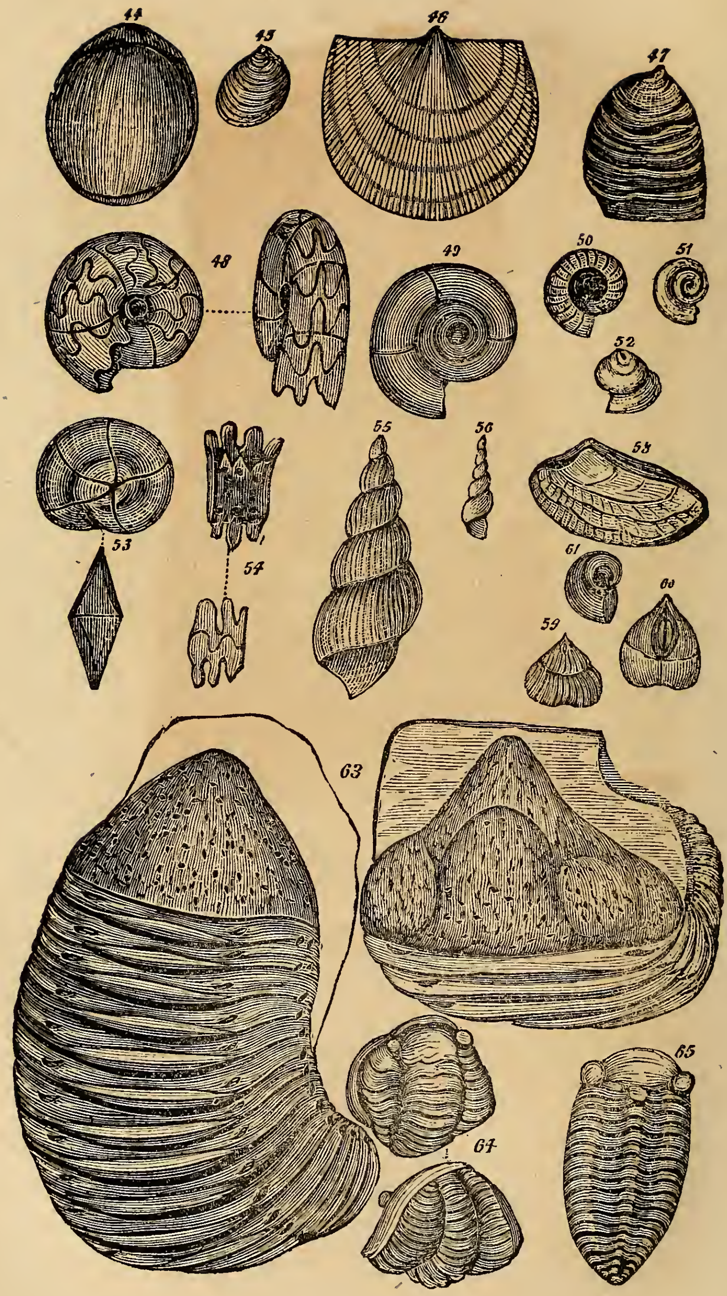


No. 42, one half size.—Spatangus.

64

No. 64, flattened, cylindrical cast, regularly pitted all around—the pits having small prominent points in the center.

Diagram showing the proportion of a transverse section of the above.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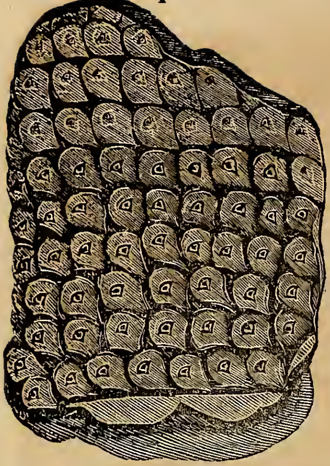
65

No. 65, conical, compressed, somewhat four sided—the two outer angles acute, the others very obtuse; impressed by striæ, which cross each other, have lozenge shaped eminences between them.

Diagram showing the proportion of a transverse section of the above.

1



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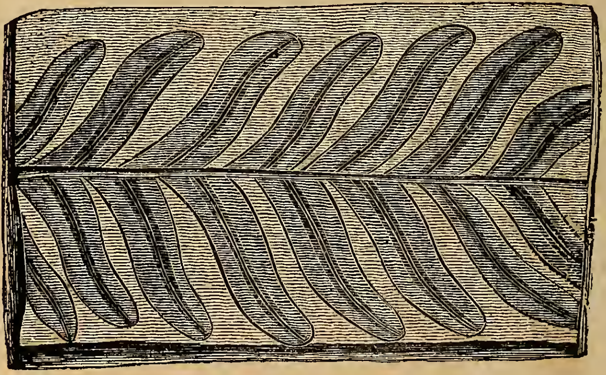
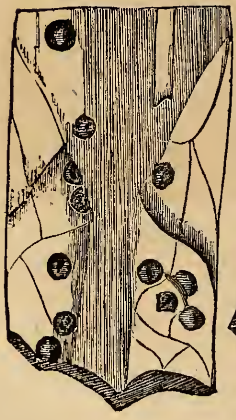
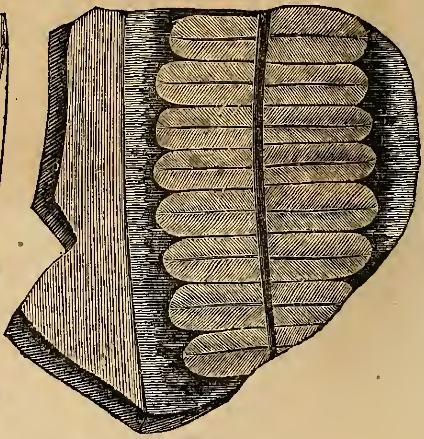


10



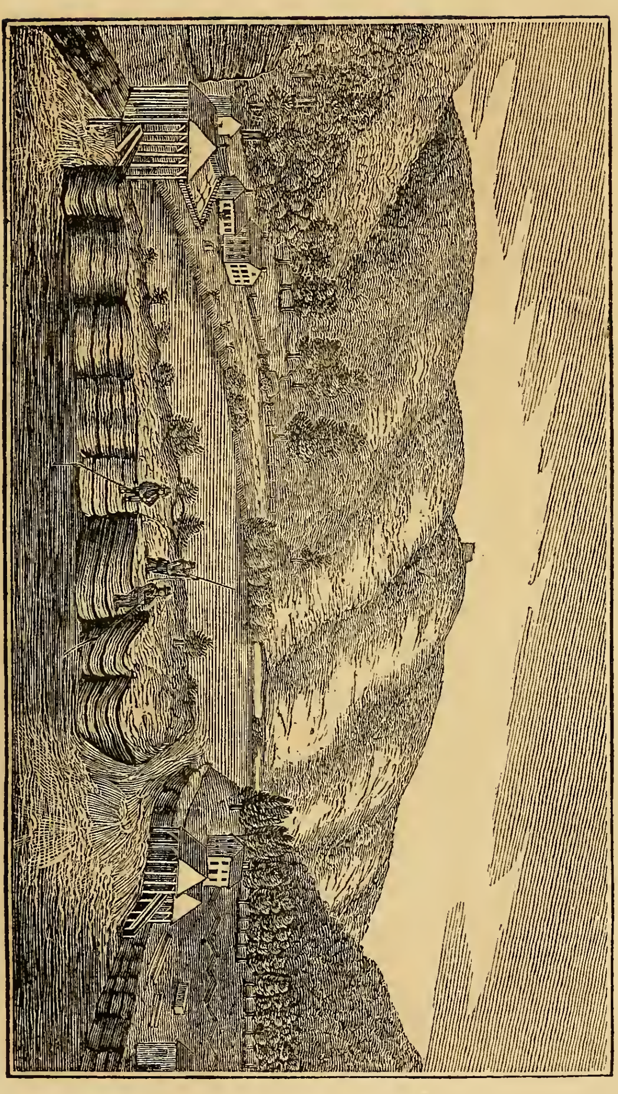
3



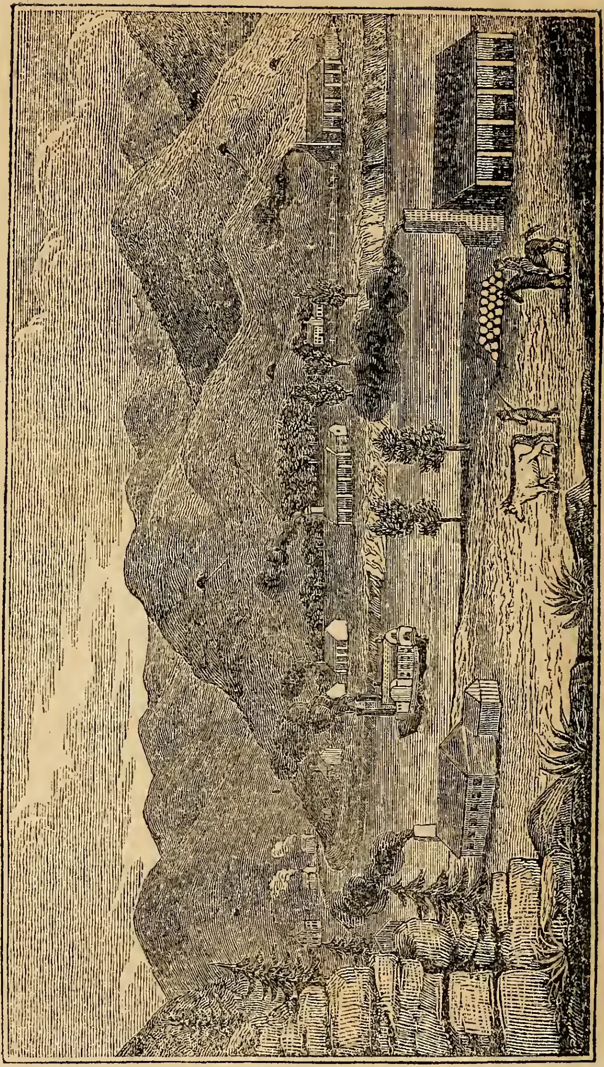
No. 4, natural size.

View of "Pomeroy's Coal Beds," at Carr's Run, Ohio.

View of "Marshall's Pillar,"—Cliffs of New River, Va.

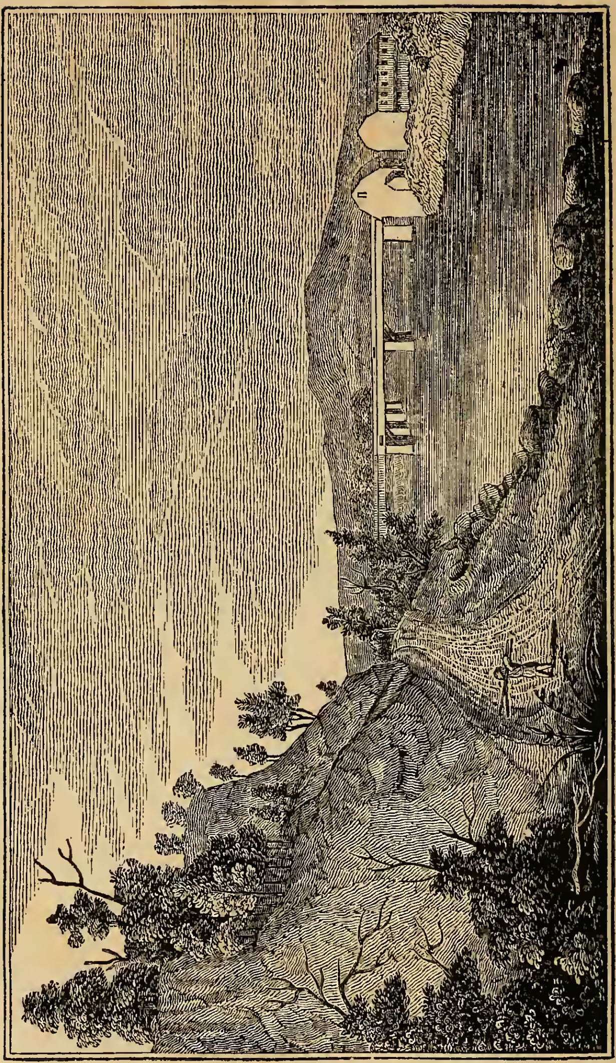


View of the "Falls of the Kenawha," Va.



View of the "Kenawha Salines."

View of "Putnam's Hill" from West Zanesville.



View of "Putnam's Hill" and the upper Bridge at Zanesville, on the Muskingum River.

Fig. 69. C. cryptocarpa, Meyer.
Fig. 70. C. petricosa, D.
Fig. 71. C. festiva, D.
Fig. 72. C. petasata, D.

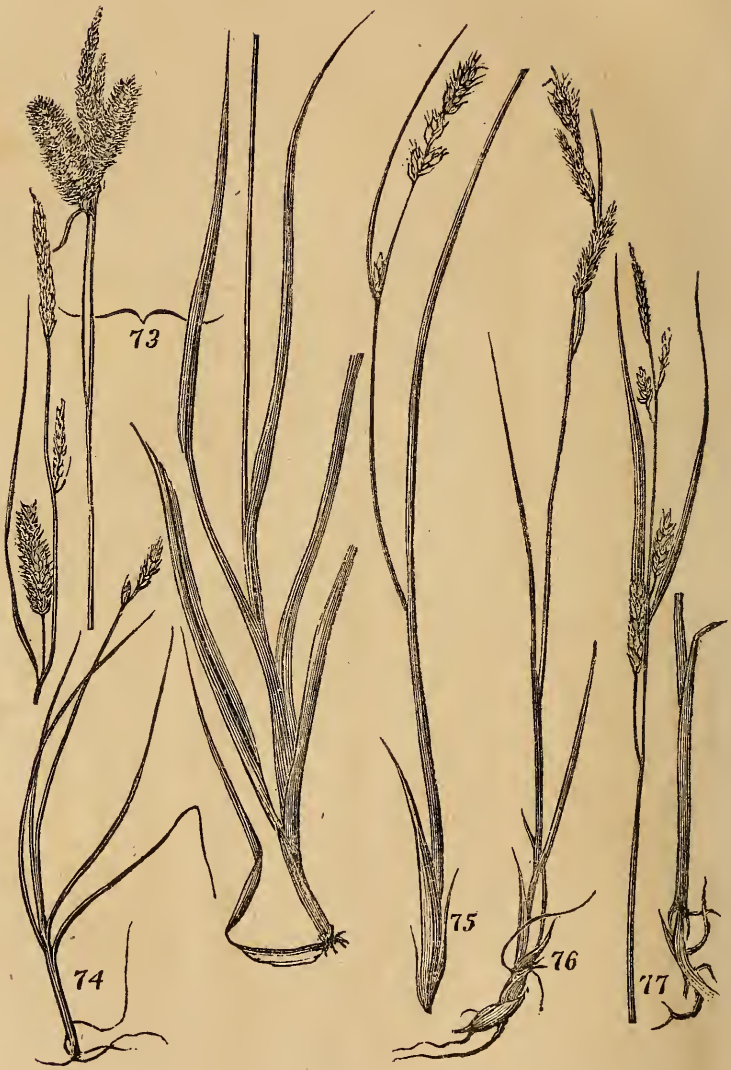


Fig. 73. C. membranacea, Hooker.
Fig. 74. C. marina, D.
Fig. 75. C. Hookerana, D.
Fig. 76. C. spectabilis, D.
Fig. 77. C. lanceata, D.

Fig. 78. C. fulvicoma, D.
Fig. 79. C. nigricans, Meyer.
Fig. 80. C. Redowskiana, Meyer.
Fig. 81. C. Backana, D.
Fig. 82. C. Drummondiana, D.

Fig. 83. C. podocarpa, R. Br.
Fig. 84 C. mutica, R. Br.
Fig. 85. Kobresia filiformis, Torrey.
Fig. 86. Kobresia globularis D.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*Remarks on the Geology of the Lakes and the Valley of the Mississippi, suggested by an excursion to the Niagara and Detroit Rivers, in July*, 1833; by John Bannister Gibson, Chief Justice of the Supreme Court of Pennsylvania.

It is known that the principal geological formations in Pennsylvania, so far as the series extends, occur in the order of superposition in which the same formations are arranged in Europe. We have, with their subordinates, granite, gneiss, mica slate, clay slate, graywacke including the old red sandstone, transition and mountain limestone, and the great coal formation which traverses the state from north-east to south-west, and which ought by analogy to lie immediately on the mountain limestone, instead of the stratum of rock salt* on which it is proved to lie by the borings on the Ohio and its tributaries. At Pittsburg, the salt is found under three distinct seams of coal, at an average depth of five hundred feet below the bed of the river.

In the north-western part of the state, in the western part of New York, in Upper Canada, Ohio, Michigan, and regions further west, two superior formations occur. The inferior of these, is the new red sandstone of the English geologists, and is scarcely distinguishable by its external character from the old, which has, in this country, been usually confounded with it, although admitted in Europe to be the undermost member of the carboniferous group, if not a ferruginous graywacke. The other, however, is here in place, resting on the basset edges of the coal strata which crop out along

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* The statement of the author is doubtless correct as a general fact; but, it may be added, that the salt of the West is found also above the coal, as well as below it. See Dr. S. P. Hildreth's memoir and sections in our last number. Salt does not occupy, invariably, the same position in Europe, for it is found both higher and lower than the new red sandstone.—*Ed.*

the north-western flank of the Alleghany mountains, from the Susquehannah in Pennsylvania to the Kenhawa in Virginia, a distance of three hundred miles. We are induced to remark as a curious anomaly in the geology of this mountain, one which is however unconnected with the subject of the present notice, that an anthracite formation, apparently the complement of the preceding, but dislocated by a gigantic shift, begins at the Delaware on the opposite flank of the chain, and, graduating into bituminous coal, terminates at the Susquehannah about seventy miles below the point on the same river at which it seems to be resumed; and that the stony anthracite of Rhode Island in the same range, seems to be an outlier of it still further to the north-east. This apparent continuity of formation through primitive, transition and secondary regions, seems to indicate a community of origin from substances whether of the mineral or the vegetable kingdom. The shale which wraps it, is marked with the same impressions throughout. But to return. This new red sandstone is attended by magnesian limestone, gypsum, and perhaps all its usual concomitants: certainly with rock salt, for the wells of the Canandaiga works are in it. Standing on Queenstown heights and looking to Lake Ontario along the shores of the Niagara, a Pennsylvanian is struck with its resemblance, in all but its flatness and want of greenstone trap, to the old red sandstone of the Conewaga hills. It is the predominant rock in many counties of New York, and subtends indefinitely to the west. It is by no means extravagant to suppose that it extends entirely across the valley of the Mississippi. It is the more reasonable to think so, as the floetz rocks throughout this vast expanse lie undisturbed, as they were deposited; and we perceive the outcrop of the same new red sandstone at each margin of them. It is described by Mr. James in the second volume (new series) of the Transactions of the American Philosophical Society, as constituting the valley of the Platte, of the Canadian and other tributaries of the Arkansaw, and as resting in highly inclined positions against the steep of the Rocky mountains, the stratum being broken off and upturned as if the granite had been pushed up through it. It evidently extends beneath the lakes a considerable distance to the north-west, as it forms the *Sault de St. Marie* between Huron and Superior.

Resting on this new red sandstone, and proceeding westward an indefinite distance, we find that calcareous formation which makes the cataract of the Niagara, of the Onondaga, and of the Genesee, and which marks the eastern margin of Lake Erie. At Queenstown Heights it rises abruptly from the sandstone to the thickness of seventy yards; and were the strata, as generally supposed, horizontal, would seem, at Buffalo, to occupy the space between the levels of the two lakes—a perpendicular distance of three hundred and thirty-four feet. These remarks, it is true, are not novel; but the attention of the scientific spectator seems to have been diverted from the geological character and relations of the rock, by the wonders of the scene. The surface rock has inadvertently been called a siliceous limestone—a word in such frequent use among us to denote the imbedding of quartz, that the rock properly so called, though found but at Fontainbleau and Nemours in France, might seem to be of common occurrence here. The principal rock at the falls is in fact a compact, argillaceous fetid limestone, of a drab or buff color, alternating with slabs of blue or bluish gray, and imbedding entrochi, lythophites, selenite, and a few shells. Silex and quartz are undoubtedly found in connexion with it, but deposited in its cavities and fissures, or in crystals on its surface. At Buffalo, flints are found in it; but, as they are found in the chalk cliffs, they enter not into its structure. Having a quality common to most secondary limestones, of hardening by exposure, it has the appearance of a transition rock at that place; but it works easily when taken from the quarry, affords a good building stone, and is that of which the fine column to the memory of General Brock is constructed. It corresponds, in all material respects, to the lias of the English geologists, and corroborates the German doctrine of universal formations.* No geologist has perhaps called it expressly by that name; but Doctor Mitchell in his observations on the geology of the United States, appended to his edition of Cuvier's theory of the Earth, in speaking of the '*layers*' of this calcareous mass, (as he justly but perhaps unconsciously denominated them, the word being changed to lias by a provincial corruption,) used a term precisely indicative of their specific character. The distinctive form of these layers is particularly perceptible in the succession of steps formed by their lateral edges in the steep immediately above the precipice. As in the English lias, the muschelkalk is wanting—at least at the cataract—the difference

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* It certainly proves, along with other facts of the like kind, that certain formations were very general, although it may well be doubted, whether there are any formations above the granite, which can be considered as strictly universal.—Ed.

in other respects, being that the limestone has changed place with the alum slate or lias clay which here rests immediately on the red marle of the sandstone. The shale is bituminous, and might possibly support a low degree of combustion. Its thickness is about thirty yards. Doctor Mitchell confounded it with the transition and primitive slates, fancying that he had traced it from beneath the granite of the Hudson through various windings to the foot of the cataract.

The coast of lake Erie, though really a dangerous one, is any thing in appearance but iron-bound. Down to the water's edge it is earthy, and without rocks, except at Point Albino on the British side; and the limestone, though forming the entire basin, rises above the surface of the water, for the first time, at the Bay of Sandusky, in a coarse granular form, imbedding numberless ammonites, orthoceratites, terebratulæ, and other shells. Is not this the muschelkalk or its equivalent? The shells are so thickly disseminated in it, that it is rare to find a piece of it as large as a cabinet specimen, without one or more of them. It is easily got out in blocks, works well, and at Detroit, is advantageously used as a building stone. Its place in the group is perhaps inferior to the compact limestone of the islands, remarkable for the profusion of its sulphate of strontian contained in druses. This drusy limestone is perhaps the uppermost rock in the valley of the Mississippi, for there is no trace of oolite, chalk, or any thing as recent. The extent of the formation westward is indefinite; but it probably reaches to the Missouri, which passes from the mouth of the Platte to the Mississippi, through extensive fields of horizontal and tabular limestone.

The retrocession of the cataract from Queenstown Heights, and the time supposed to have elapsed in accomplishing the present distance, are subjects of curious but unprofitable speculation, whose results must disappoint the expectation of those who think, by means of a comparison of the rate with the distance, to fix the date of the commencement of it. Professor Rogers ingeniously maintains in the late January number of this Journal, that the cataract had not its commencement at Queenstown Heights at all. The spectator who forms his judgment on the intrinsic evidence of the scene, will probably concur in the opinion generally received, that it in fact began at that place; but he will be satisfied that it affords no data to compute the duration of the recession with any thing like an approach to the truth. When we see the river working in the rock like an endless saw, it is difficult to think that it did not make the groove in which we find it. If this groove were originally but a valley of denudation, why are its sides perpendicular even at the brink, and why is the original inclination of its slope broken by a cataract now? In the opinion of Professor Rogers and many others, an inland sea, vastly more immense than the present fresh water lakes, sent a current along the course of the Niagara river, tearing up the exposed portion of the land, and imperfectly excavating the rough and unshapen trough below the falls. The traces of an overwhelming current are doubtless every where visible; and it is reasonable to suppose that, seeking the lowest part of the barrier, it would gradually narrow and confine its action at that point, at least sufficiently to mark out the course of the subsequently diminished stream. But we are unable to imagine how a wide spread torrent could have spent its entire action on a strip six hundred yards in breadth, giving to the sides of the gutter made by it, the character and appearance of perpendicular walls. No such walls are found in the water gaps of the Alleghany mountains. Granting that even a narrow diluvial current ran along the slope, till it reached the termination of the plain, what reason have we to think there was not, originally, an overfall there? It is a postulate of the argument, that the bottom of the trough at the close of the diluvial abrasion, descended gradually to the foot of the escarpment. Admitting it for the moment to have been so, it is not easy to see why a cataract should have been formed in it since. According to the same writer, the process of excavation now going on, will eventually reproduce an inclined trough, differing from the supposed diluvial one, but in its greater length and lesser inclination. It is more reasonable to conclude that the present one is altogether of postdiluvian origin, and that it has been formed by the present stream conducted to the point of embouchure at Queenstown, as it is now conducted to the cataract, by an excavation of the gravel which it retired into and deepened at the subsidence of the waters. But the eventual existence of an unbroken line of descent, can be admitted but on the very concessible ground of its corresponding to the dip of the strata; for while any portion of the lias remains to be worn away, an over fall will be a necessary consequence of its structure. It is reduced less by direct detrition than by the absorption and expansion of moisture from frost; a process of disintegration common to argillaceous rocks, and strikingly exhibited in the sandstone steps and lintels in Pittsburg, in which the exfoliation of each successive winter is distinctly marked. This exfoliation is greater in the shale below by reason of its softer consistence, than in the limestone above; consequently, until the bottom of the basin shall gain a point above the shale—if indeed it ever shall gain it—the incumbent limestone must continue to tumble in, as the supporting bed continues to be removed. But observation does not sustain the position that the portion of the shale visible at the cataract is thinner than the portion visible at the embouchure, though were the strata exactly horizontal, the inclination of the channel would indicate it. It indicates no more, however, than its own coincidence with their direction and dip; corroborative of which, is the evidence of the walls whose equality of height in their whole extent, exhibits a parallelism between the bottom of the trough and the surface of the plain. In fact, the plain itself, being without those steps that would otherwise be produced by the lateral edges of the broken layers, shews conclusively that it but conforms to the inclination of the surface rock. It is improbable that the water is very deep in any part of the trough, or that the excavation has been carried below the floor of the shale. The sea-green torrent at the brink of the cataract, is drawn out in its descent, into attenuated foam like rolls of cotton; and instead of plunging deep, as a solid column would do, into the sheet below, falls lightly on it in the form of spray. That it does so, is not only apparent to the eye, but proved by the comparative tranquility of the basin, which is such as to permit a ferry boat to pass within its verge—indeed to the foot of the rock which divides the chute. The writer of this notice crossed so near the spray as to became wet by it without feeling any unusual motion of the boat. Did a dense column rush against the bottom, or even penetrate to a considerable depth, the agitation of its rebound would be tremendous. The force of a falling stream is perhaps in a proportion inverse to the square of the distance. Hot water falling from a stopcock through the distance of a foot into the cold water of a bathing tub, is imperceptible to the finger at half an inch below the surface: falling through a distance of ten feet, it would be separated by the resistance of the air into thin drops. But the force even of a combined column must in any event be broken by the debris which lie at the foot of the fall—at least till they are swept away by it—and that they remain there, is another proof of the comparative feebleness of the descending tide. Loose rocks of the same size are unable to maintain themselves against a common flood tide on the bars of the Susquehannah: by the combined force of a column a hundred and sixty feet high—equal to the pressure of a hundred and forty two inches of quicksilver, or five atmospheres—they would be driven away like feathers. It is probable, therefore, that the bottom of the trough is the floor of the shale, and that it will continue to be so; for the portion of the latter which lies too deep for the action of frost, is sufficiently worn away by descending masses of drift-wood and ice, to keep the process of excavation perpetually going on as it has done heretofore.

But taking the fact of retrocession to be established in its greatest extent, yet the rate of it must have varied with the qualities of the rock and the temperature of the seasons; so that to get at a mean difference, would require a knowledge of the period already elapsed—the very problem to be solved. Even if there were no variation in these, the experience of half a century, during which the cataract has been an object of attention, has produced no data that can lead to any certain result as to the progress of it even in that period. The subject is essentially one of doubt; and the views of Professor Rogers in respect to this part of it, present difficulties that are not easily disposed of. His views, also, of the predicted catastrophe at the cutting of the barrier, as it is erroneously called, seem to be well founded; nor will the subsidence of the water be the less gradual though the channel be carried along the floor of the shale to the lowest depths of the lake.

That a wide spread current, although not, as imagined, fed from an inland sea, once swept over the entire region between the Alleghany and the Rocky Mountains, is established by plenary proof. An inland sea could not have brought to their present beds, the primitive or volcanic fragments with which the surface for more than a thousand miles in every direction, is overspread. At the cataract of Niagara, and within a few paces of the table rock, lies a mass of sienite such as occurs in the neighborhood of Philadelphia; and at the same spot are rolled pieces of common hornblende. From the museum there, the writer of this notice obtained a fine specimen of actynolite, broken, as he was assured, from a boulder in the immediate neighborhood. Along the whole line of coast thence to Detroit, he saw spheroidal masses of sienite washed up on the beach; and on the shore of lake St. Clair, he found the same masses with hornblende and granular quartz. Covered with a subsequent deposit of loam which gives to the valley of the Mississipi its surpassing fertility, the country between the lakes and the Ohio, is manifestly diluvial, consisting of flat beds of sand, clay, gravel and mud, without a single rock, in situ, but with innumerable boulders of sienite imbedded or lying on the surface, but more commonly huddled together in the gullies and water-courses. They dissappear only as the country becomes broken by the incipient undulations of the Alleghany Mountains. They vary in the proportions of their constituents from nearly pure hornblende to feldspar porphryry, the feldspar, frequently verging on flesh red. That they have been rounded in a long transport, only a few of the larger being angular, is sufficiently attested by their appearance; and that the tertiary, chalk, and oolite have been abraided by the tide that brought them, or else that it occurred at a period anterior to the deposits of these formations elswhere, is as plain as any geological truth can be. There are two things which indicate with a great degree of certainty, the quarter whence this current proceeded and the points to which it was distributed. These are the nature of of the debris scattered along its paths; and the paths themselves in their original state, or, as they now appear, deepened and contracted by the fresh water streams. The crystalline structure of these debris, consisting of granite, gneiss, hornblende, sienite, porphyry, agate, jasper, quartz and other promordial substances, proves incontestably, that they have come from a primitive region and not, as has been generally but gratuitously assumed, from the north, where primitive or volcanic rocks are not known to exist. In the lateral channels and fresh-water lakes, we behold the footsteps of the agent that brought them; and by these we are able to track him home. The present basins are but the remaining, as they were the deepest, parts of the ancient channels. Why have we these basins? Not as reservoirs for a present superflux of water; for that might as readily be disposed of by a trough of equal dimensions throughout the tract. In fact the entire product of the rains that fall in the nothwestern quarter of the continent, is passed by a succession of such troughs, the intermediate links in the chain of lakes. We have the basins not because we have an accumulation; but we have an accumulation because we have the basins. They evidently owe their excavation to some other power than that of the waters which now possess them; and to what other are they so likely to owe it as to that of the great denuding current of which we every where see such convincing proofs? To account for their origin at all, we must believe that they were scooped out by it, the abrasions of the lias being but partial in that quarter, and entire further on where the force of the current was increased by concentration in narrower channels. That being conceded or established, it would follow that the course of the ancient current is unerringly indicated by the course of the present lakes. Now running the eye over the map from the northwest angle of Pennsylvania to McKenzie's river, we perceive an uninterrupted series of lakes beginning with the one of which that river is the outlet, and proceeding by a direct line to the large terminating group at the point from which we started. The whole tract of country is studded with them as with a succession of pools left standing by a retired ocean. A current setting in the direction of this line, from the Pacific a little south of Bhering's Straights, would sweep over the primitive region at the northern extremity of the Rocky Mountains, and may well have supplied the fragments in question from that point. There is certainly no proof to assign them an origin elsewhere; nor can we otherwise account for their existence where we find them. The angular masses occasionally, though rarely, found even within the region of frost, have doubtless been borne on icebergs; but that they, as well as the spheroids came from that quarter, there is not a rational ground to dispute. It is evident from the greater degree of denudation to the northeast, that the main body of the current discharged itself into the gulf of St. Lawrence; but that diverging portions of it found their way into the gulf of Mexico, is equally evident. Such a division of it could not but be produced by its efforts to clear the obstruction presented to it by the Alleghany Mountains; to effect which it would necessarily pass round both ends of the chain. The proof of it however rests not merely on the configuration of the continent. A diluvium containing the same debris, is shown by Dr. Drake in the volume of transactions already quoted, to overlie the country on the right banks of the Ohio and Mississippi, as far down as Natchez where the pebbles are reduced to the size of gravel. At Cincinnati, they rest on a horizontal shell limestone described by him in his picture of that place, as 'a vast precipitate from a lake or sea of salt water'. This is evidently a continuation of the lias from the lakes, whose terminal edge in that direction, makes the falls of the Ohio at Louisville, and probably underlies the diluvium not only at the prairies, but throughout. Dr. Drake's known accuracy gives a peculiar value to every fact asserted by him.

But these two estuaries, though the principal, were not the only ones. The rolled pebbles found along the water courses leading to them, are found also along the shores of every river which flows through the passes of the Alleghany from the table land of the lakes. They are found on the Hudson, the Delaware, and the Susquehannah; and they are not found on any river which descends from either flank of that mountain. Portions of the great diluvial current must, therefore, have cleft it at the places occupied by those rivers. No feebler power could have cut their channels out. They could not themselves have done it. The disuniting force must have been applied at vastly higher levels than they could have attained by filling up the vallies; and the evaporation from the expanse of surfaces thus produced, would have nearly equalled the quantity of water returned to them in rain, so that there would have been but little comparatively to tumble over the ridges. But what power could there have been to sustain a mass of water at an elevation sufficient to cause an overfall at any point of the principal or dividing ridge, without which no fresh water stream could make its way through that barrier or produce the stupendous results observable in every member of the chain? An ocean beating against its side might perforate it; but it is infinitely more probable that the breaches were effected even before the mountains had raised their heads above the deep.

We have no district so rich in results and yet so imperfectly explored as the country of the upper lakes. There, will probably be discovered the records of those grand changes that have been made in the structure and condition of the continent to fit it for the reception of its ultimate and permanent inhabitants; and there, too, will probably be found the bones of the saurians and other relicta of the European lias, establishing, beyond contradiction, the contemporaneous deposition of that formation wherever it is found. The vertebrated land animals, beginning in the middle or perhaps lower tertiary, belong also to all the posterior periods, and in many cases, are subsequent even to the diluvium. With us, they lie in morasses, which rest upon it, and in postures indicative of a peaceful death and subsequent state of repose. At the Bigbone lick in Kentucky, the bones of the mastodon were commingled in the same layer with those of the bison of the present time. What seems decisive of the period of their existence, is that they are found only in river alluvions; and it is nearly certain that we owe their extinction to no catastrophe whatever.*

Remark by the Editor.—It will be perceived that the subsequent observations of Judge Gibson, have reference to a letter addressed to him by the Editor; the object of that letter will be apparent on reading the subjoined answer.

Carlisle, Penn. Aug. 19, 1835.

To Prof. Silliman.—*Dear Sir*—I feel strong in my position that the limestone described in my article, is consubstantial with the lias. This rock is described by Mr. Bakewell and Mr. De la Beche, if I mistake not, (for I have not the books at hand,) as a collection of limestone and shale, in layers resting on the new red sandstone, and constituting the undermost member of the oolitic group. That the rock at the cataract answers this description, except that it is the terminating member of the ascending series, will not, I think, be disputed. About the character of the red sandstone, there can be no more doubt than about the character of the coal measures, on which it visibly rests, and whose outcrop appears at the foot of the Alleghany mountain, distant forty or fifty miles. The sandstone, with the limestone it supports, exhibits a gentle but perceptible dip, whose direction conforms to the flank of the mountain. Its external appearance, as well as its geological character and accompaniments, is precisely that of the same rock in Europe.

Deposited on this red sandstone, we find an aggregation of limestone and shale, containing mollusca common to the lias, and disposed in *layers,* of which nothing can be more distinctively characteristic, than the lateral edges over which the water gambols, at the falls, with such wild and fantastic agility, before it makes its final leap. I presume this rock will not be considered *sui generis,* or an anomaly, so to speak, in the geological kingdom; and if not, to what inferior group is it to be referred? Not to the carboniferous; for the interposition of the red sandstone, is a bar to that. Not to the red sandstone itself; for that has no limestone but the zechstein, from which the limestone at the falls palpably differs. That its mineralogical character differs from the specimens of the English lias I have seen, I am free to admit; but how entirely incompetent a comparison of cabinet speci-

* Doubtless the author is aware that mastodons have been found in the tertiary in Europe, as well as in the diluvium, and we must wait to see whether the fact will prove to be the same in this country.—*Ed.*

mens is, to purposes of geological classification, I need not remark. The geology of a country must be studied in the open air. I found by comparing the limestone of the western part of Lake Erie, with a specimen of English lias, in the cabinet of Major Whiting at Detroit, that it differed less in its external character from the English, than from the same rock at the cataract. The English specimen, being of the sort used for purposes of lithography, was of a finer texture and brighter yellow, while the American, was of a drab or pale buff. Every one is familiar with the difference between the English lias, compact and earthy as it is, and the lias of Mount Jura and district of Vosges, which, if not crystalline, is at least granular, and resembles the limestone at the cataract in this respect; yet every one admits its title to the appellation.

No one yields a more ready deference than I do to the opinions of European geologists, especially the English, in matters within their personal cognizance. The science has not passed its maturity any where—here, it is still in its youth. But an implicit accordance with the views of foreign geologists, in matters about which they have not an equal opportunity to judge from personal observation, would be prejudicial to that freedom and boldness of enquiry, by which alone we shall be led to true conclusions, in respect to the natural history of our continent and thus contribute our proportion to the general stock of accurate knowledge; and this contribution must be made without waiting till it has received the stamp of foreign approbation. We may get our principles from abroad, but their application must be by persons on the spot. The Austrian armies were invariably beaten while their movements were directed, not by the general in the field, but by the cabinet at Vienna. Had Mr. Conybeare ridiculed the idea of our having the lias, after he had ascertained by personal examination that our formations from the granite to the new red sandstone inclusive, occur exactly as they do in England, and that the sandstone supports beds of limestone and shale in layers containing fossils, identical, as far as they have been examined, with those of the lias, I should have paid as much respect to his opinion as to that of any other eminent geologist. But to him America is, in a geological point of view, *terra incognita*. It is comparatively so even to ourselves. I should dispute the competency of any man to decide the present question, who had not, in person, investigated the country to which it belongs, although he had even seen the limestone at the cataract if he had seen no more.

You inform me that Dr. Hildreth, in his account of the coal formation, has described the lias. I had flattered myself with an expectation of being the first to perceive and point out its true character; and I shall still contend for that honor, notwithstanding Dr. Hildreth's mention of this rock, as my letter to the Geological Society of Pennsylvania, already in print, contains a description of it, with an assertion that it is identical with the foreign lias.

In regard to the diluvium, my remarks were not predicated of the diluvium in Europe, but of facts which actually exist here, and they were made in order to corroborate Prof. Rogers' confutation of the notion of Mr. Deholme, that the mastodons of America were extirpated by the flood which deposited the diluvium in the valley of the Mississippi and Ohio. It was unnecessary to speak of the period to which these animals may be thought to belong, or their place in the tertiary elsewhere. Perhaps small fragments of their bones may have been found in the strip of tertiary resting on the primitive rocks in Jersey near Sandy Hook. What relation the diluvium bears to it here, it is yet impossible to say; but my own opinion is that our diluvium is not contemporary with that of Europe. The lias seems to be the point of divergence at which the unity of deposition ceased, and the appearance of diluvium became as accidental and local as the ejection of the intrusive rocks. I have not room to state my reasons for this; but I will add, that in the valley of the Mississippi, the bones of the vertebrated animals there, lie, without exception, above the diluvium.

As you inform me that the existence of the lias has been positively denied—a fact of which I was not aware when I wrote my article—I should prefer to have appended to it, at least, the first paragraph of this letter accompanied, however, by any remarks, critical or explanatory, which you may deem proper.*

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* We have given the whole of Judge Gibson's letter that was necessary to sustain his opinion.—*Ed.*

Art. II.—*Fata Morgana at Gibraltar;* in a letter from an officer in the American Navy.

May 7th, 1835, 3 P. M., at sea, 20 miles E. from Gibraltar.

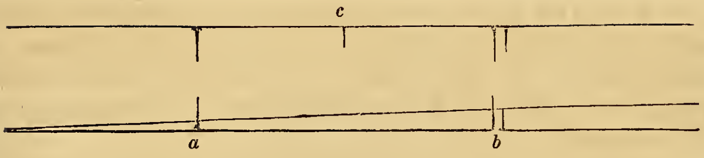
TO THE EDITOR.

Sir—I have just been witnessing an extraordinary phenomenon, so similar to the celebrated Fata Morgana, that I cannot help thinking that it must arise from the same cause, and is perhaps the same thing, though I always before understood that such apparitions were seen only in the straits of Messina. Yesterday, about 2 P. M. the officer of the deck sent for me to look at some spectacle ships, which he said he had been for some time observing over the straits of Gibraltar: I went up immediately, but was too late, being able to see nothing unusual, except that a brig just on the edge of a heavy fog that covered the straits, had her upper sails elevated by the refraction so as to give her an extraordinary height. The officers told me that a few minutes before, another vessel had appeared in the sky, inverted immediately over this one; and one of them described another phenomenon which he had observed during the forenoon, as follows—a vessel was in the straits, whose royal sails could only be seen above the thicker part of the fog: immediately above these, and in contact with them, was an inverted vessel, and directly above this was another one, upright; the two keels touching each other; so that he had two spectral vessels, one upright and one inverted, while directly under the latter was the original vessel, only partially seen. The day was pleasant and clear; the breeze was light in the bay of Gibraltar from the east, but in the straits it seemed to be more from the westward; the fog formed a stratum about two hundred feet thick, resting on the water, and with its upper edge horizontal and well defined. I have frequently noticed such fogs stretching from the foot of Apes' hill to the westward, but never before heard of such extraordinary refractions accompanying them.

We were then lying in Gibraltar Bay: this morning we weighed anchor, and at meridian were fifteen miles east from the southern end of the Rock, which, you know, goes by the name of Europa Point. Going on deck at this time, I was delighted to find the phenomenon once more exhibiting itself, and from this time until nearly 2 P. M., when it ceased, had ample time for observation. Its first appearance was to the eastward of us. A fog like that of yesterday commenced at Europa Point, and passing along the eastern side of the Rock, stretched along the coast of Spain, then curving across the Mediterranean about twenty miles east of us, returned westward along the African coast, and bending round the promontory of Ceuta, terminated at Apes' hill, so that we were completely surrounded, except a narrow opening in the direction of the straits. The phenomenon was observable in all this extent, but most striking over the water to the east of us, and at Ceuta and Europa Point. The atmosphere to a height of about two hundred or two hundred and fifty feet above the water, had an obscured and grey appearance, much like a fog, although I think it looked less dense and material than is the usual appearance of fogs. Near the upper edge it grew darker, and at length terminated in a well defined dark line, generally horizontal, but sometimes slightly undulating. Along this line, towards the African shore, we had frequently the appearance of islands, sometimes single, sometimes grouped, every two or three minutes changing their shapes. We were steering east. In front of us on either bow, and about eight miles distant, was a small lateen vessel carrying a press of sail: they were very distinct, their white sails glittering in the sun, and it was evident they had not reached the magic circle. A little to the right of the southernmost of these, however, a vessel, apparently of the same kind, was suspended from the upper line of the fog. It was of a dusky color, and not well defined, but I could only make out that it was a vessel with sails, and in an inverted position. Half way between it and the African coast was another vessel, a much larger one, for it reached half way down towards the horizon. It was also dark colored, but was better defined than the other, and had the tall tapering appearance of a brig, with bow or stern towards us. Both of these vessels were sometimes more distinct than at others, and also varied slightly in their size. While I was looking at them another appeared between them, of a white color, and very distinct, but in half a minute it began to fade away, and soon disappeared. To the southward of these vessels, along the upper line, were also numerous islands, sometimes grouped, sometimes single, and constantly changing their form and size. In twelve minutes after I had begun to notice these phenomena, the foggy appearance began to ascend above this dark line, and soon after another line of the same kind was formed an equal distance above it, but without any of the spectral vessels. These still kept their place on the first line; but three minutes after, the whole began to grow thin and air-like, and four minutes after this the sea before us was perfectly clear. I swept it carefully with the spy-glass to find the originals of the inverted ships, but they could not be seen. They must have been so far eastward of us as to be below the horizon.

In the mean time the little promontory of Ceuta, the Spanish coast, and the lower part of the Rock of Gibraltar, had been presenting a variety of curious shapes. The first of these slopes gently, on both sides from the water; but now it sometimes presented an iron bound shore, and for a while its eastern side looked much like the open mouth of a shark or crocodile. The real Europa Point could not be seen, but in its place we had its slopes and offsets inverted, and of a sandy or yellowish color. The sandy flats stretching northeastward from Gibraltar, were elevated into yellow perpendicular walls of great height; and further still to the eastward, there was apparently an irregular belt of water as smooth and bright as a mirror, though the sea all around us was agitated by a four knot breeze. This belt of smooth water was apparently mixed up with the land so as to form lakes and inlets, and here and there on each side their edge was dotted with white objects, whose character I could not make out: they were probably houses seen through the lower edge of the fog, and refracted also to the upper line. At one spot one of these white objects extended quite across the crystal belt, widening at each end so as to resemble a water spout. Several fishing boats were sailing along the coast, their fanciful lateen sails glittering bright in the sun. Suddenly the crystal belt stretched by them, and as suddenly we had their images attached in an inverted position to its upper line: this was the prettiest part of the whole exhibition, the spectre boats being as distinct as the originals, and standing out so clearly from the invisible back ground. I had scarcely time, however, to direct the attention of some friends to them, when they began to grow indistinct, and in three minute's time the phantoms could no longer be seen.

At 12 o'clock 30 minutes, the atmosphere began to clear up on both sides of us, and I was lamenting the loss of such an unusual and splendid exhibition, when, towards one o'clock I found it commencing in the straits of Gibraltar, which had heretofore been the only point of our horizon free from it. I noticed, with a watch in my hand, the different changes which the phenomenon underwent in this place, and the following is a copy of notes taken at the time.



The same appearance of fog, and of the same height, now stretched in a curved line quite across the straits, beginning at Apes' hill and ending at Europa point. At *a*, one third of the way across, was a merchant brig, with lower and top-gallant studding-sails set: it was steering eastward, and was about twenty-five miles distant from us:* over it was an inverted image of itself, the two tops approaching as near as in the above lines. At *b*, was a two-masted vessel, with its side toward us: its two sets of sails, and also its inverted image above, were very distinct to the naked eye; *a*, and its image were also clearly seen without the glass. This was the state of things at 1 h. 1 m. P. M.

At 1 h. 7 m. the image of *b*, very distinct, but the original is dim. *a*, as before.

At 1 h. 10 m. the image of *b*, easily seen, but the original has entirely disappeared. *a*, as before. With a glass I can now see an inverted vessel at *c*, but none below it.

At 1 h. 13 m. *b*, very distinct above, and the lower vessel again visible. *a* as before.

At 1 h. 18 m. At *b*, both the lower and upper vessels have disappeared; also the upper one at *a*; and *c* has grown very dim.

At 1 h. 21 m. the inverted vessel above *a*, has not reappeared, but considerably on its right are three inverted vessels, (probably *c*, the image of *b*, and a new image); they are thin and airy-like, but very distinct, and their outline is very well defined; only the images are seen.

At 1 h. 23 m. the inverted vessel over *a*, has reappeared, and can be seen with the naked eye. The fog is beginning to grow very thin, and its upper line is becoming indistinct, but the four inverted ships are as distinct as before.

At 1 h. 27 m. the inverted vessel over *a*, has again disappeared: the other three remain as before.

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* I give you the opinion of an old quarter-master as respects the distance, having more confidence in his judgment than my own.

At 1 h. 29 m. the fog has disappeared; the atmosphere resting on the straits being as transparent as any other: still the three inverted ships on the right continue, but they seem now to be suspended in the clear air: they are rather dim. The one over *a*, has not reappeared.

At 1 h. 31 m. those three are still seen, but are quite in the clear sky: the extremities of the fog at Ceuta and the Europa point still continue: at the latter it is thin, at the former place it is still thick and grey.

At 1 h. 34 m. the three inverted ships still visible, but very dim.

At 1 h. 38 m. they have disappeared, and nothing is now left but the brig at *a*. What has become of the two-masted vessel which at one o'clock I saw at *b*? It has not had time to get behind the land, and its masts were then high above the horizon: was this vessel beyond the horizon, and was it thus elevated by refraction? At all events, of the three inverted vessels which four minutes since we saw elevated two hundred feet or more in the sky, the originals cannot now be seen. The horizon is perfectly clear, and I have got the quarter-master to search it carefully with a good glass, but neither of us can see any thing but the brig at *b*.

I ought perhaps to add a few words about the weather and winds. On the 12th ult. it commenced blowing from the east, and on the 18th increased to a gale, in which all our squadron except the schooner, broke from one or both their anchors: it lasted ten days, and then became moderate. About the first of this month the wind changed, and for four days we had strong westerly winds: the last two days have been very pleasant, with moderate breezes from the west and south-west; thermometer at the Rock from 68° to 72°. To-day at 1 o'clock 13 minutes P. M. the breeze changed suddenly from west to east north east, at which point it still continues. I have since ascertained that the Fata Morgana were seen over the straits also during the forenoon. The mountains in Spain, and also some high ridges in Africa just south of the straits, are covered with snow. The hot winds from the desert crossing these latter, probably become surcharged with vapor, which settles down in the basin between Cape de Gatt and the straits, and thus forms the radius for the reflection which we have just been witnessing. This will account for at least a part of the phenomena.

An officer has just informed me that four years ago, when lying in the Brandywine at Algesiras, he saw the same phenomenon around the bay. It lasted about half an hour, and during this time the ships rigging, and the clothing of the persons on deck, were covered with fine cob-webs: the wind was then blowing from the southward. He tells me that he has seen the same while lying in Hampton Roads, Virginia, at a time when the wind had suddenly changed from the N. W. to the N. Eastward.

You will recollect the incident in the early history of New Haven, when the colony were expecting a vessel with provisions from Massachusetts Bay: the phenomena of to-day seem to afford an explanation. Very respectfully, &c.

Art. III.—*Visit to the Quicksilver Mines of Idria;* in a letter from an officer in the American Navy.

You know I travelled through Germany as a pedestrian—a mode of travelling which I would recommend to others through that interesting country. You must imagine me then on the second day of my journey, from Trieste to Vienna, in a region thickly settled and well cultivated, and with a mixture of hill and dale sufficient to make it highly picturesque. An old countryman with whom I stopped to converse about noon, informed me that by taking a cross-cut over the country, I should make my road to Idria much shorter than by following the high way, and as I am fond of by-ways I received his information with pleasure, and soon after struck into a wagon track, to point out which to me, he kindly left his work. The wagon track, after leading me through some retired villages, dwindled into a foot-path, and even this soon after disappeared and left me alone among the hills: but a lover of nature is never solitary, and particularly with such varied and beautiful scenery as almost every step opened to view. I am strongly tempted to describe some parts of it, and also the simple and hospitable manners of the people—but this would not be exactly suited to a Journal of Science. The country towards evening, became a constant succession of steep rounded eminences, generally of considerable height, and just before sunset, reaching the summit of one of the highest, I had just under my feet the pretty little town of Idria. It is situated at the bottom of a deep valley or green, the houses were white, and as the streets have to follow the windings of the green ravines, it has a simple and very pleasing appearance. Near the center, is a conical hill with a church on its summit, from which a line of a dozen little chapels, along the side of the eminence, showed the course of the Via dolorosa—sometimes an appendage to papal churches. A stream of water about forty yards in width, dashing along the bottom of the valley, and several of the excellent German roads, running zig-zag up the steep ascents completed the view. At the entrance of the village my pass-ports were examined, and the officer having ascertained that I wished to examine the mines said he would send a person to accompany me. Accordingly, a sergeant soon after called at the public house where I lodged, to say that the mining operations were carried on day and night, and that I could enter at any time: I had noticed from the hills a dark crowd of men in front of a large building, and those, he told me, were the evening gang about commencing the descent. I appointed 6 o'clock in the morning, and on waking, found him waiting for me. At the building alluded to, which is on one side of the village, and covers the entrance to the mines, we changed our dresses, and the keeper unlocking an iron gate we found ourselves in a horizontal gallery three or four hundred yards in length, running directly into the hill at the foot of which the edifice is erected. Here we came to a small chapel with a light burning before the picture of the virgin, and turning short to the left commenced the descent. It has nothing difficult, being effected the whole way by means of stairs in pretty good order: indeed, the mines have nothing corresponding to the ideas of terror which we are apt to connect with such places, except the atmosphere, which, throughout the mine, must be strongly impregnated with mercurial vapor, and is constantly producing salivation among the workmen. Having descended by seven hundred and twenty seven steps, reaching to a depth of one hundred and twenty five fathoms, we arrived at the region where chiefly the cinnabar is procured. The mining operations are carried on principally in galleries, the friable nature of the ground or rock seldom admitting of larger chambers. The cinnabar is in strata of from two to six inches in thickness, and of a variety of colors from dark to light red, the quicksilver sometimes being mixed with it, sometimes occuring in the intervening strata of earth or stone. Sometimes the cinnabar is of a brilliant red, and once I found it in small crystals, but such specimens are rare: generally it is of a dull red color, and the stone is so brittle that nothing more than a pick-axe is required. The strata affording the quicksilver appeared to have no particular direction, and occupy about one third or one half of the entire mass of rock. Proceeding a short distance, however, we came to galleries where the cinnabar is less common and the quicksilver is the chief object of search. It occurs here sometimes imbedded in a friable rock, sometimes in a kind of earth, in appearance and hardness resembling talcose slate, but principally in the former. Generally, it is in particles too minute for the naked eye, but often when the rock is broken, small globules present themselves, varying from a size just large enough to be seen up to that of a common pin's head. These globules are not distributed at random through the mass, but the substance in which they occur forms strata usually about one inch or two in thickness.

Descending still lower, we soon came to the richest part of the mine. Here the *gangue* consists almost entirely of talcose earth mentioned above, and the globules are so large that when it is broken, they fall out and roll to the bottom of the gallery. The laborers here are relieved every four hours, being unable from the state of the atmosphere, to work longer than this at one time. In the other parts of the mine they work eight hours. There are three hundred and sixty altogether employed in the mines, divided into three companies, and working, each, eight hours out of the twenty four: their pay is only from 15 to 17 kreutzers (12 to 13½ cents) a day, the usual pay of day-laborers throughout Germany. I found several of them suffering from the effects of the mercury.

Having loaded myself and the guide with specimens, I returned by the same way to the upper mine and proceeded next to examine the washing rooms, which are situated a few hundred yards from the mines. The *gangue* containing the metal is carried to this house, and if it is of the earthy kind, it is broken up and thrown upon large seives, by means of which the loose or native quicksilver (called here yung frau or virgin quicksilver) is separated from the earth: the latter is then cast into shallow boxes open at the ends and a little inclined, and a gentle stream of water being made to pass over it, a rake is used, and the earthy matter is carried off. There are seven of these boxes in succession, and by the time the residuum reaches the last of them, it resembles a heavy gray powder, and is sufficiently pure to be carried to the vapor furnace. The stony fragments require only a slight washing to cleanse them from the outward earthy impurities.

The furnace is half a mile lower down the valley and at the extreme end of the village. It consists of a circular walled building about forty feet diameter by sixty in height, on each side of which is a continuous range of chambers ten or twelve feet square, and nearly as many in height: by means of small square openings in the partition walls, the air is allowed to pass from the center building to the remotest. Each has also a door communicating with the external air. These buildings are all of stone and are plastered within. The *gangue*, after being prepared in the washing house as already described, is removed to this edifice and placed in earthen pans four inches deep and fifteen in diameter, which are piled up so as to fill the center building. The doors of the chambers are then carefully walled up; and a strong fire having been lighted under the center building, the quicksilver rises in the form of vapor, and passing into the small chambers, is there condensed by the cold atmosphere around them. Some of the gangue you will observe, is brought here in the form of the native rock: I understood them to say that the expansive power of the vapor, together with the heat of the fire, was sufficient to cause the rock to disintegrate and thus allow the escape of the quicksilver. When this process is over, the door ways of the chambers are once more opened, and the quicksilver, which is found chiefly adhering in drops to the sides and ceiling, is scraped off, and running into a hollow in the floor, is taken thence to the cleaning and bottling room. It appears to act on the mortar of the chambers, for I found the latter flaky, and the crevices all filled with small globules.

The cleaning process is very simple, a piece of canvass being merely spread over a funnel and the quicksilver being made to pass through this, comes out sufficiently pure. That intended for home consumption is then tied up in sheepskins, while that for exportation is put in iron bottles large enough to contain sixty eight pounds. The furnace is kept in operation only during the winter months, and then the vapor which escapes from it is a serious annoyance to the town: they have a blast three times every fortnight.

The price of quicksilver at the mines is 112 florins for one hundred German pounds, or about 44 cents for an American pound. The quantity annually procured is about one hundred and sixty four tons: formerly it was greater, and brought a better price, their market, which is chiefly in China, having been injured by competition from the quicksilver mines near Almeria, in Spain.

Art. IV.—*The Traun Stein Rock;* in a letter from an officer in the American Navy.

The Danube! wishing to see it to better advantage than in its divided state at Vienna, I determined that we should be companions for a day or two and so set out for a walk along its banks, as far up as Lintz, the capital of Upper Austria. The country in the whole distance was in a high state of cultivation, and the river itself and its shores, resembled very much the Susquehanna, where we crossed it a few years ago, just below the valley of Wyoming. There is this exception, that the shores of the Danube are dotted with villages, castles, palaces, and now and then with a large monastery; and as the buildings are uniformly white, the views are more varied, but perhaps not more pleasing. On the 28th August I breakfasted at the little city of Ens, romantically situated on the top of a high ridge, and commanding a very superb view: from this place the road led through rich meadow lands for ten or twelve miles; when ascending another eminence and passing through a pine forest, it brought me to a point of view that arrested my steps and produced an impression that will not soon be effaced. I cannot stop to describe the views further than to say, that Lintz was in the distance, just at my feet the village of Ebbelsburg and the Traun river, with large boats shooting like arrows down its swift waters; and far off on the left, a range of broken mountains with a high and curious looking rock standing nearly isolated on the plain. A genteelly dressed man who was ascending the hill, was polite enough to describe the various objects of local interest: at the village just below, a battle, he said, had been fought with the troops under Massena—the signs at two of the public houses still continuing as they then were, riddled by the French bullets:—and in answer to my question respecting the isolated rock, he said that it was called the Traun stein, (Traun rock) and that, as I was going to the Gmunden lake, my road would bring me in front of it, where I should see on its edge a very remarkable likeness to the profile of Louis XVI.

I visited Lintz, where is the commencement of a rail road sixty eight miles long, the only one I saw in Germany: it was made two years since and is an unprofitable concern, bringing only 2 per cent; but they are commencing one to the Gmunden lake, which is expected to be more profitable. I turned from Lintz to the left, nearly at right angles to my former course, and at ten the next morning

began to come in front of the rock, which was now to the south of me and about ten miles distant. It appeared to be about half a mile in length and fourteen or fifteen hundred feet in height, and was now partly blended with a range of mountains running near it to the east and west. Its outline was broken, but although I examined carefully each side of it I could see nothing of the profile spoken of—when, happening to raise my eyes to the upper edge, I actually started and drew a long breath, and it was some minutes before I recovered from my astonishment. The day was bright, the sun being on the side, gave to the mountains the coloring of India ink, and against the clear sky was the profile of a man, as perfect almost as if Canova had cut it there. Whether I should have recognized the resemblance to Louis XVI, without being led to expect it, I cannot say; but I think I should, for, as he is shown on his coins, which I have often studied, the similarity is very striking. I am almost afraid to trust myself to speak of it, for I fear I may appear rather like an enthusiast than a sober narrator of facts. And yet I cannot attribute its powerful effect on me to any expectation I had been led to entertain of something wonderful: for my road during the afternoon led through a forest in its direction, and often while engaged in other musings and not thinking at all of it, I caught sight of it suddenly between the trees—the feeling was always that of wonder, mingled at least with awe, to a degree that became almost oppresive. It was not a simple profile, but the features had an expression corresponding to the melancholy fate of that monarch: the forehead was wrinkled, the mouth slightly opened, and the appearance was that of a person in a disturbed and painful slumber. In the large double chin, the beaked Roman nose, and the slightly receding forehead, there was a striking resemblance to Louis: a cap appeared to cover the head, and what was singular enough, just back of this a flat mountain covered with snow to represent a pillar, on which the head appeared to recline. To complete the picture, the range of mountains to the east was, from the position of the sun, blended in some measure with the rock and assisted to form the bust, while still further on, particles of snow at intervals, gave them the appearance of a counterpane. I am almost afraid to say, after this, that a slight protuberance over the breast resembled the doubling of the bed clothes at that place.

The French troops in their invasion of Austria, marched along the road from which I had the first view of this remarkable rock, and in the village of Lambach just in front of it, had some severe skirmishing. The landlord, at the inn where I stopped to dine, resided there at the time. From Lambach my road turned southward towards the Traun Rock, and the profile continued uninjured until towards evening, when on my nearer approach it gradually disappeared.

The annexed copy of a sketch taken from the spot where I first got sight of it, will shew you the general character of the profile. I was not skilful enough with the pencil to come nearer than a resemblance, but the sketch is as honest an one as I could make it.

Art. V.—*The Salt Mountains of Ischil;* in a letter from an officer in the American Navy.

My object in turning out from the direct road to Salzburg, was to visit the Gmunden Lake and the salt mountains of Ischil, which I was told I should find on its southern shore. The road after leaving Lambach, led by the Traun river, by which the lake discharges itself into the Danube, and down which the salt is conveyed in large flat-bottomed boats. It is an extremely turbulent and rapid stream, and at one spot, where is a high picturesque fall, a wood-shoot has been constructed, down which the boats glide with frightful rapidity.

At the head of the lake is the village of Gmunden, where is a depot for salt, and a large manufactory of casks, both belonging to the government. I found here two German students, also pedestrians, with whom I kept company on to Salzburg. We hired a boat to convey us to the other end of the lake. It was rowed by two men and a girl, there being scarcely any kind of manual labor from which the females of the lower class in Germany are exempted. The lake is romantically situated, having on the eastern side a range of mountains rising boldly from the water, and on the other a champaigne country highly cultivated, and sprinkled with *kerrschaufts** and farm houses. Among the former was the Traun stein, which rises abruptly from the lake about two miles from its outlet. It was a bright morning; every object looked cheerful, and my companions when out on the lake commenced a song about freiheit and Faderland, to an air that I had often heard among the Germans of my own father-land, Pennsylvania. Suddenly the boat stopped, and the father of the crew rising up, sprinkled us with water, and with the usual ceremony of baptism gave us each the name of one of the surrounding mountains.

We landed at Ebens-see, a small village at the southern end of the lake, and in reply to our inquiries, they informed us that the salt was manufactured at this place, but that the salt mines were several miles in the interior. I had supposed that the salt was dug in a solid state from the mountain, and was therefore surprised when they took us to a large building, in which was a sheet-iron pan about sixty feet in diameter and two in depth, with a brisk fire kept up beneath. Water was flowing into it from two huge cocks, and workmen were employed shoveling salt out from the bottom on to a draining-board, from which it was afterwards removed to small cone-shaped vessels, with holes at the bottom for further draining. In these it was suffered to remain until it became solid, when it was turned out, and the moist end of the cone being cut off, it was ready for transportation. Each lump contained about thirty-three pounds.

From Ebens-see we followed the windings of a deep valley for nine miles, when we arrived at Ischil, a pretty little village, frequented by valetudinarians for the benefit of its salt-baths. These are in a new and very handsome edifice, with a Grecian colonade in front, and an inscription, *In sale et sole omnia existunt.* The salt moun-

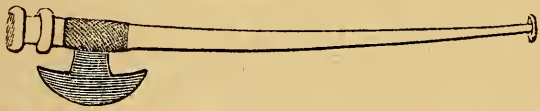
* The residences of the titled proprietors.

tains are about three miles to the southward of Ischil. They form part of a high and broken range extending eastward and westward, and in the exterior are not to be distinguished from other parts of the range, the vegetation on every part being equally luxuriant. About half way to the summit, we arrived at the residence of the superintendant, and having here obtained permission to enter the mines, were conducted to a house a few hundred yards below, and provided with suitable dresses. Here is one of the entrances, of which there are twelve in all: they informed us that salt is found in any part of the mountain where they take the trouble of digging for it. Our course after entering was along a narrow horizontal gallery, openings occurring at intervals, along which we heard the dashing of water: at our feet were also wooden pipes for water, with branches running off into the various lateral galleries. Having proceeded a quarter of a mile, we came to a halt just where some bare logs rose in a slanting direction, from a cavity whose depth we could not ascertain. A guide straddled this log, and directing me to do the same, and hold on by him, he raised his feet, and away we went, sliding, or rather darting down on the smooth log, and, except the glimmering light from our lantern, enveloped in total darkness. The guide kept himself upright, and holding fast to him, I presently found myself deposited in safety on a heap of soft earth, and turned to enjoy the equal astonishment and fright of my companions. We were now at the bottom of a chamber of irregular shape, but averaging about one hundred and fifty feet in diameter, and from four to ten feet in height; the ceiling in some parts being supported by blocks of sulphate of lime, piled up in the form of rude columns. The gangue of the salt, if the word may be used, is composed chiefly of a clayey earth, mixed up with irregular blocks of sulphate of lime: the salt is mingled with these, usually in strata of from six inches to two feet in thickness, forming, however, every variety, shape and direction. It was generally of a reddish color, and though mixed with impurities, very strong. The strata were very distinct on the ceiling of the chamber, which looked not unlike marbled paper, the salt itself presenting a great variety of colors, and its gangue scarcely a smaller number. The surface of the salt presented to us was rough and honeycombed.

We now for the first time learnt the mining process, which certainly is very simple and sufficiently economical. In the first place, a small chamber is formed by the pick-axe and shovel, and arrangements having been made by means of pipes for conducting water to and from it, the outlet is stopped up, and the chamber is filled with fresh water, of which the mountain streams furnish them with abundance. In a few weeks the water in the chamber is saturated with salt; it is then let out, and conducted by aqueducts to Ebens-see, a distance of twelve miles, where, as I have already described, the water is evaporated artificially, and the salt is shipped for the storehouse at Gmunden. When the chamber has become sufficiently dry, the workmen descend into it, clear it from the stones and dirt which have been loosened by the water and fallen from the ceiling, and the chamber is then ready for another flooding. The large chamber we were in, as the guides informed us, requires one month for the process of filling, fifteen days more for completing the saturation: it holds eighty thousand German Emers, is filled four times a year, and has been in use thirty years: one hundred lbs. of water furnish twenty-six and three-fourth lbs. of salt. There are thirty-four chambers in all, in which two hundred men are employed, working night and day, six hours at a time. They work four days in a week, and get forty-eight cents per week. When the chambers are approaching so as to threaten a breach from one into the other, the further encroachment of the water in that direction is prevented by a compound formed by the clay and pulverized rock, which is beaten against the wall so as to form an effectual barrier. At intervals, in the descent of the mountain, are three reservoirs, into which the water is successively discharged, I believe for the purpose of breaking the violence of the descent.

There is a chain of six or seven very beautiful lakes in this neighborhood, two of which we visited after leaving Ischil, and on the 29th August stopped for a short rest at Salzburg. Our consul at Vienna had described in glowing terms the beautiful scenery at Berchtsgaden, a short day's journey to the south of Salzburg, and as it had also a salt mountain, I determined to pay it a visit. There are also salt mines at Hallein, south from Salzburg, which I did not examine; but which I was informed are worked, and are about as productive as those of Ischil.

Berchtsgaden is now comprehended in the kingdom of Bavaria. The royal family were there on a visit at this time: they had just been inspecting the mines, and I found many parts of the interior ornamented in a fanciful manner; the richest crystals of the salt and gypsum having been collected and disposed so as to form grottoes, devices, &c.: some of the former were large and perfectly transparent, but a deep red or brown is the prevailing color. This mine appeared to me to be richer than that of Ischil. In some parts the salt forms regular solid strata several feet in thickness, and so free from foreign matter as to be fit for use without any purifying process. In these places it is mined by the aid of gunpowder, and the guides, after placing us in secure places, allowed us to witness two or three explosions. Generally, however, the mine differs very little from that of Ischil. We entered by a horizontal gallery, a quarter of a mile in length, and then came to branching galleries, along which pipes were conducted for filling the chambers with water, or emptying them. One hundred and ninety men are employed, and the yearly product, I was told, is eight thousand one hundred and thirty-four tons.



Annexed is a drawing of Montezuma's battle-axe. This axe was preserved by the Spanish conquerors, and during the time of Charles V. was deposited in a collection of curiosities at the royal palace of Ambras near Inspruck. On the invasion by Bonaparte they were all removed to Vienna, where they now form what is called the *Ambras samlung*, and are worthy of particular attention. The axe is of basalt, of a green color, with white spots, and bears a resemblance to many which I have seen in Ohio and the adjacent parts. The handle is of hard wood, and about three feet in length: at the thicker end is a socket, into which the stone was let, and was then secured in its place with twine. I saw also in the royal library, a specimen of the Mexican picture, but these manuscripts I propose to notice in a future communication.

Art. VI.—*Remarks on the Topography, Scenery, Geology, &c., of the vicinity of the Cape of Good Hope;* in a letter to the editor from Rev. George Champion, a Missionary in Southern Africa—dated Cape Town, Cape of Good Hope, May 18, 1835.

TO PROF. SILLIMAN.

Dear Sir,—As a very small tribute of regard for the instructions once given me,* I send you these specimens of African mineralogy. I regret that I could not send you larger specimens, but in my walks and rides I have been so situated that I could not carry them. I regret too that I have not more time to devote to this interesting study, being, as you know, directly engaged in other, and to me more engrossing subjects.

Being detained here by unforeseen circumstances from our field, three of us early took an opportunity of ascending Table Mountain. The ascent is gradual from the town for at least two miles. The ascent of the rest of the three thousand five hundred and eighty-two feet, is at an angle of about fifty degrees. As you approach it, the perpendicular walls, perfectly level at the summit, and stretching along for a distance of two miles, to compare great things with small, somewhat like the Palisades upon the Hudson, rise up before you like the battlements of some huge fortress. At first, you think it impossible to climb it; but on proceeding, you enter a ravine, which leads you at once behind one of the projecting cliffs of the mountain: the town is out of sight, walls of rock rise up on either side to the clouds, and before you is, to appearance, an almost perpendicular path, some parts of which are to be climbed upon the hands and knees, while at the end of it the walls of rock seem to converge to a width just sufficient for one or two to pass at once. We reached that spot in two and a half hours, having enjoyed the advantage of the cool of the morning.

And then what a scene! in a northerly direction lay Cape Town, with a population of twenty-five thousand, appearing as if seen through a magnifying glass in a museum; its church steeples; its blocks of white-washed, flat-roofed houses, contained within the squares of streets, all intersecting each other at right angles; its parade ground, fringed with a triple row of firs; its park of oaks, a mile long; and the numerous verdant spots in the suburbs, with the villas of gentlemen—all giving an air of coolness to the town. The harbor seemed like a neatly defined basin, containing twenty or thirty

* Mr. Champion was educated in Yale College.

pleasure boats. We saw a French man-of-war firing a salute, but as the wind was against us, we heard no report. All around us was awfully still: we saw not, nor heard a living thing. At the entrance of the harbor lay Robber's Island, the Botany Bay of the Colony. To the east and north, were high ranges of mountains, which, were it not for three or four passes or kloofs, would entirely exclude the district of the Cape from any communication with the rest of Africa. Immediately to our left, stood the Lion's Head, a bare conical mass of rocks, over two thousand feet in height, and once probably joined, even at its summit, with Table Mountain. Stretching to the northward of this is the Lion's Rump, another high eminence, which defends the harbor from the winds of the Atlantic. To our right, and joining Table Mountain, was the Devil's Mountain, frightful by its chasms, and almost as high as Table Mountain itself. To the south, stretched along the rugged mountains of the Cape Peninsular, even to the Cape of Good Hope. In this direction the Table land of Table Mountain gradually slopes, and at its foot lies the beautiful village of Wynberg, embosomed among firs and oaks, and adorned with silver trees.

We found it quite chilly on the summit. The Table-cloth we noticed coming on the mountains south of us, in connexion with the south-east wind just breezing up. It always accompanies this wind. The account given by Barrow in his Travels in South Africa, in order to explain this phenomenon, seems to be very rational, only (if I may be allowed to express an opinion) he multiplies words too much respecting it. The same causes which produce fogs or clouds upon the tops of high mountains in the vicinity of the sea, when a strong wind is blowing upon the shore, are doubtless in operation here, but especially in reference to Table Mountain, because of its *height* and *peculiar situation.* The mountains are so situated to the south and east of Table Mountain, that a south-easter coming from off the ocean through False Bay, would be directed somewhat as through the mouth of a tunnel immediately up the inclined plane of Table Mountain. Owing to the diminished temperature of the atmosphere upon the mountain's top, it is surcharged with vapor by the warmer air from the ocean, and the fog is produced. The wind blowing strongly in the above direction, forces it over in immense volumes, rolling down the perpendicular sides of the mountain, threatening at times to deluge the town beneath; but as soon as it arrives at a point where the temperature is equal to what it was on the other side, before it assumed the shape of mist, it vanishes, and is seen no more. This point is higher upon this side than on the other. The Lion's Head and Devil's Hill flanking the Table on the right and left, and thus partially surrounding the town, confine the heated air, so that it naturally rises higher to find its equilibrium. At times, the Table-cloth is superbly beautiful, stretching along the whole length of the linear summit a fine sheet of white mist, and very much resembling its namesake.

But I had designed to speak of the stones, rather than the clouds. As the fog was coming on, and we were aware of danger in such a case, our time to look around was limited. Persons have been there suddenly enveloped in the fog and lost, perhaps by being blown over the summit, (for the wind is very strong,) or unable to find their way in the thick fog to the *poort*, or gateway leading down, have died of hunger, and been devoured by the wild beasts.

No. 1.* The summit of the mountain is of sandstone. [The sandstone is entirely quartz; the cement the same, and apparently a chemical deposition, with some traces of crystallization.]

2. Pebbles were scattered here and there in great abundance, that once doubtless had been imbedded in the rocks now much worn by the ravages of time. In very many cases, the rocks appeared as if worn by the action of water, much like those upon the sea shore. Often the rock was very brittle, so that by the pressure of the foot it could be ground into fine sand. All the rocks were filled with pebbles oval and round, and on a much larger scale than in these small specimens. Some of the skeletons of the matrix thus deprived of the pebbles, appeared singularly: one I recollect had much the shape of the skull of an antelope. [From the shore of Table Bay. Rounded and flattened fragments of quartz and primary slaty rocks, and red sandstone; there are also fragments of chrysolite, apparently portions of crystals—the color is greenish yellow, or pale sea-green—lustre vitreous—scratch window glass, but are scratched by quartz.]

3. In descending the mountain, we saw, as far as we could judge, nothing but differently colored sandstone, such as No. 3. for at least two-thirds the distance. Pieces of iron ore were scattered along our path. The strata we observed were perfectly horizontal. On the south side the mountain descends by terraces. [These sandstones are quartzose, and colored red, more or less by iron, which

* The remarks enclosed in brackets are by the editor.

however does not always pervade the entire piece, which is sometimes white or grey in part, and red in part.]

4. These fragments of granite, containing black tourmalines, are to be seen in large quantities between the Lion's Head and Table Mountain. Very large fragments are often imbedded, in the sandstone, presenting a very chequered appearance.

5. Rocks in the vicinity, a dark slate and slaty clay.

6. Rocks from the top of a range of mountains, (sandstone like Table Mountain,) forty or fifty miles east of Cape Town. [These rocks have much of the character of grauwacke; pebbles and fragments of quartz are imbedded in an exceedingly firm siliceous cement, through the whole of which small angular fragments are dispersed.]

7. Granite from the mountain, called Paarl Berg, pretty well described in Barrow. On the top of it are two immense blocks of granite, supposed to be the largest in the world. One of them is at least a mile in circumference, and five or six hundred feet high. As you approach them you feel a sensation of awe, somewhat as if drawing near a mighty mausoleum of the dead. [This granite consists of white feldspar, grey quartz and black mica; the feldspar is partially decomposed, and in some portions pulverulent.]

8. Is a specimen of the seams of harder rock, with which they are intersected. The Paarl Berg is a mountain eight or ten miles long, and perhaps one thousand three hundred feet high. I have seen no granite any where like that of the Paarl Berg. The mountains in the vicinity are certainly all of sandstone. The rock, called the Diamond, appears as if it had been broken by an earthquake. [This is a granitic compound, but without mica; very small granular quartz is intimately blended with a feldspar, which is almost compact.]

9. Blue asbestos, given me by some friends at Tullagh, eighty or ninety miles north-east from this, said to be from a place called Roggeveld, (Rye field,) an elevated country still on beyond, and above them. As you are aware, the country ascends by successive terraces, till you reach the vast plateau or Karroo of the Orange River, called the Great Karroo—Roggeveld Karroo is an intermediate one between this, and the Great Karroo. [This is very beautiful asbestos; the color is sky blue, and the fibres are as fine as the most delicate silk: it is in regular veins, which evidently ran crosswise between walls of rock, exhibiting smooth joining surfaces,

but none of the rock remains: it may probably have been slate or serpentine. Specimens perfectly similar were sent out to America some years ago by the Rev. John Campbell, English missionary in Africa. The veins appear firm, but they are easily slivered by a knife, and then the fibrous structure appears delicate as that of the asclepias syriaca, or milk weed. There is also marked with the same No. (9.) a superb piece of prehnite, of a deep emerald green, and the surface crystallized in the usual form. It will be remembered that Col. Prehn, after whom this mineral is called, first obtained it at the Cape of Good Hope, but we cannot say whether it was from the same locality with this specimen.]

10. Stones given me by a Hottentot from the Roggeveld. The large one, as large originally as the two hands when extended; she was very reluctant to give it up, saying that it was "her book." The other she brought to me as a present, saying, "it was gold." The former are said to be abundant in the Karroo. [The specimen taken by the Hottentot for gold, is simply fine grained mica slate, with bright spangles of yellow mica, often taken for gold by people better informed on other subjects than Hottentots. The piece which the Hottentot woman called her book, greatly resembles Basanite or touch stone. It is gashed or cut, apparently by art, in innumerable directions, and on all sides, except where it appears to have been broken off from the larger mass.]

11 and 12. Specimens from different strata I met with in ascending the mountain near Tullagh, which led into the above named river Karroo, and from the top of which the land extends off an almost level plain to the north and east. [This appears to be a rock of granular quartz.]

13. Translucent pebbles, siliceous, stalactitic, &c., from the Great Orange River, six or seven hundred miles from this. This river stretches almost across South Africa, and may be compared to the string, while the ocean boundary will represent the wood part of the Bushman's bow. [These are very beautiful fragments of chalcedony and agate, evidently rounded by friction in water; the colors are delicate shades of grey, blue and white. It is probable that the place whence they came abounds in similar things, and might afford fine subjects for the lapidary. It is not unlikely that these things indicate a region of trap rocks, in which they were formed, and from which they were detached.]

14. Specimen of the flinty fragments often found in the roads over the plains, very injurious to the unshod hoofs of the bullocks. [This is a fragment of milk quartz, verging in its appearance towards common opal.]

Among the rest is a shell, or collection of shells, from the sea-shore near by. There are beds of shells deposited with the soil upon the side of the Lion's Head, at least one thousand feet above the sea, but I have not had time to climb it and obtain some for you.

Last of all, but I cannot think it least, I send you one of the pears from George Schmit's pear-tree, from the mission station, Genadendal. This good Moravian was the first missionary ever sent by Protestants to the heathen in Africa. About one hundred years ago he came out, settled at Genadendal, eighty miles from this, and planted his pear-tree. For a long time this was his church and school room. It has been very fruitful, a fit emblem of the cause he thus first began in this country, the cause of missions. It was originally a very wide-spreading tree. The last year it bore twenty-five bushels of fine large pears; but it is withering, and will ere long die. Schmit went home to remove some difficulties under which his mission labored, was most cruelly hindered from returning by the government, and at last was found dead in his closet, at the hour he had appointed to pray for the Hottentots. Genadendal is a most interesting station. It has a population of twelve or fourteen hundred Hottentots, and six or seven hundred are members of the church. (There is an interesting history of it by Montgomery. It has been published in one of the numbers of the African Repository.)

As to our mission, we hope soon to be proceeding on our way. The Caffre war which has disturbed the country, is drawing to a close. We wait to know our course of duty; wide fields are every where opened and opening, and through this section there are not known any obstacles towards penetrating even to the interior of Africa. This, the cause of religion and humanity demands.

P. S.—*May* 19.—I have this afternoon taken a walk to the granite rocks which come in sight between the Lion's Head and Table Mountain.

15. I should think this mass was nearly one third the thickness of all the others put together which are above it, perhaps eight hundred feet. Table Mountain seems to be built upon it. [This is a coarse

grained granite, with large crystals of feldspar and tourmaline; it is much weathered and partially decomposed.]

16, is a piece of the rock next above it. [This is a fine granular quartz, tinged yellow by iron.]

17, is a stone often found among the débris of No. 15; in many places the loose rocks have been washed entirely away, except leaving heaps of these dark stones. [This is also a fine granular quartz.]

18, is from a peculiar kind of earth I have several times seen here; once doubtless much harder and firmer, as it is now in some places. The stratum I saw to-day, was three feet wide and descending perpendicularly into the soil, directly over the granite before named. It was as long as I chose to travel it. [This is a ferruginous earthy mass, not unlike ochre, but more siliceous.]

I send you also a twig or branch from the silver tree, the only tree, (and this but a bush,) growing on the sides of Table Mountain. Also some of the heaths and low bushes from thence; the Hottentot fig, bearing a fruit which, when ripe, supplies the Hottentot with food; a twig from the African fir, &c. I am sorry that the time of flowers has not yet come. G. C.

[There are among specimens labeled, "given me by my friends at Tullagh," beautiful crystals of quartz, some of which are transparent, iridescent and splendid as those of Lake George, in the state of New-York; there are also pieces of hornstone and jasper, and of amygdaloidal trap. Among the pieces not labeled, are pebbles of quartz, granite, slate, &c.]

[There is also a rich iron ore, apparently a variety of hæmatite, but resembling bog iron. We must not omit to mention a fine fragment of calcareous spar, of the Iceland crystal variety, nor an elegant group of modern serpulas, in which hundreds of the contorted calcareous tubes are united, and their interior, where it is exposed, presents a high degree of lustre, which is almost pearly.]

[The soil from the suburbs of Cape Town, is little else than quartz, tinged yellow by iron; it appears to be the result of the decomposition of quartz rock or sandstone, and presents sufficient evidence, that it must be sterile unless ameliorated by the addition of argillaceous or calcareous ingredients, or of organic matter.]

[The fruit of the venerable pear-tree, arrived in safety, dried rather than decomposed; its juices had stained the paper wrapper, and insects had found a lodgement in it, but there was no unpleasant odor, and its taste was rather agreeable, like that of dried fruit.]

Art. VII.—*Physical Observations, made on board the U. S. ship Erie, during her passage from New York to Rio Janeiro, in* 1834, *and communicated to the Navy Department, by* D. J. Browne.

Date.	Latitude.	Longitude.	Face of the sky.	Class of clouds.	Direction of the wind.	Temperature of the atmosphere.	Sun's force.	Surface temperature of the ocean.	Evaporating state of the atmosphere.	Hygrometrical state of the atmosphere.	Barometrical state of the atmosphere.	Intensity of the light of the sun.	Color of the sky near the zenith.	Color of the sky near the horizon.	Color of the ocean.
Aug.	° ′ N.	° ′ W				° F.	° F	° F.	° F.	° S.	IN.	° L.	° S.	° S.	° S.
21	40 27	73.58	Fair	4,	N. easterly	68	4	70	7	78	29.91	73	11	3	32
22	39.34	72.52	Fair	5,	variable	72	2	69	6	80	29.95	84	12	4	33
23	38.33	70.27	Fair		westerly	75	2	75	6	80.5	30.00	74	12	4	34
24	37.46	68	Fair	1, 5,	W. N. W.	80	3	81	10	62	30.04	81	14	4	44
25	38.17	65.31	Rainy	6,	S. E.	75		76.5	3	93.5	29.98	63			
26	38.33	64.18	Fair‡	1, 4, 5, 6	variable	77	2	77	5	86.5	29 97	84	18	4	44
27	37.59	62.29	Fair	1, 3, 5,	S. westerly	78	4	76.5	7.5	75.5	30.05	88	15	5	45
28	37.46	59.28	Fair	1, 4,	S. westerly	80	2	77	5.5	84.5	30.14	88	28	8	47
29	37.33	55.47	Fair	1, 4,	southerly	79	3.5	78	5	86	30.32	89	23	4	48
30	38. 1	53.28	Fair	1, 5,	southerly	79	2.5	77.5	4.5	88.5	30.40	80	30	5	49
31	38.11	51.52	Fair	1, 4, 5,	southerly	79	3	78	8	73	30.35	82	24	5	49
Sept.															
1	37.34	49.20	Fair	1, 3, 4,	S. westerly	78	1	77.5	4	90	30.30	89	24	5	49
2	36.10	46.19	clo'dy‡	1, 3, 4, 6	S. W.	79		77	3.5	92	30.30	66			
3	35. 3	44.43	Fair	3, 4, 5,	E. N. E.	78	4	77.5	7.5	76	30.26	86	23	6	48
4	34.29	41.42	Fair‡	1, 2, 5, 6	W.	79	1	76.5	4.5	88	30.02	75	17	clo'dy	48
5	33.46	38.25	clo'dy‡	1, 3, 4,	N. W.	78		76	4	90.5	29.98	70			
6	33.50	36.53	Fair	1, 3, 4, 5	variable	78.5	2	76.5	7	78	30.17	84	20	6	50
7	33.32	33.30	Fair	1, 2, 5,	S. S. W.	77.5	3	76	7	78.5	30.37	98	18	8	48
8	33.27	31.27	Fair	4,	S. S. W.	78	3.5	76	6.5	80	30.36	86	29	clo'dy	49
9	33.22	29.29	Fair	4, 5,	N. westerly	76	4	75	5	86.5	30.16	77	27	8	47
10	32.53	27. 3	Fair	1, 4, 5,	N. easterly	76	3	75	6.5	80	30.12	85	30	9	48
11	32.20	26. 1	Fair	1, 4, 5,	variable	75	2	76	4	90	30.17	80	26	9	46
12	31.57	23.37	Rainy	6,	N. N. W.	78		74.5	5	86.5	30.08	63			
13	31.52	20.35	Fair	5,	N. N. E.	73.5	2.5	73	7	78	30.00	75	22	8	43
14	32.38	17 41	Fair	4, 5,	W. S. W.	75.5	2.5	72	6.5	80	30.00	83	19	9	45
19*	31. 3	17.58	Fair	4,	S. easterly	77	1.5	7	8.5	70.5	30.25	89	23	8	45
20	28.58	19 7	Fair	1, 3, 4,	S. S. E.	76	2	73.5	9	68	30.19	89	hazy	clo'dy	
21	26.20	20	Fair	4,	N. easterly	76	2.5	74.5	7	78	30.22	85	26	8	46
22	23.53	21.32	clo'dy	4,	E. N. E.	76		75	6	82.5	30.21	82			
23	21.33	23.11	Fair	1, 4, 5,	N. easterly	77	3	75	9	67.5	30.16	87	27	8	46
24	19.26	24.42	Fair	1, 3, 4,	N. easterly	77	1.5	77	6.5	80	30.14	71	hazy	clo'dy	
25	17. 2	25. 6	Fair	4,	variable	81	4	78	9	67.5	30.10	85	17	7	46
26	15.52	23.22	Fair	3, 4,	N. E.	78.5	0.5	78.5	4	89.5	30.08	85	18	4	40
29†	13.59	24.21	Fair	1, 4, 5,	easterly	83.5	3.5	81	7	77.5	30.08	95	18	14	40
30	12. 5	26. 8	Fair	1, 4, 5,	S. S. E.	80	2	80 5	6	82.5	30.03	80	hazy	clo'dy	
Oct.															
1	11.50	25.23	Fair	3, 4,	variable	83.5	1	81.5	6.5	80	30.13	98	hazy	clo'dy	
2	10 56	25.19	Fair	4, 5,	E.	82.5	4.5	81	10	62.5	30.08	77	22	5	47
3	8.36	25.53	Fair‡	1, 2, 4, 5	N. easterly	82.5	2.5	81.5	8	73	30.03	98	18	6	46
4	7.56	55.58	Fair	1, 3, 4,	N. easterly	82.5	1	82	5.5	85	30.04	82	hazy	clo'dy	
5	7.23	25.42	Fair	1, 4, 5,	variable	82.5	2	83	4	90.5	30.04	100	27	5	48
6	6.47	25.21	clo'dy‡	4, 6,	S. westerly	79		81	2.5	95	30.09	65			
7	5.36	25.30	Fair	1, 4, 5,	southerly	80	1	80	4	90	30.06	87	hazy	clo'dy	
8	4.43	26.19	Fair	1, 4, 5,	southerly	79.5	1.5	80.5	5	86	30.05	89	hazy	clo'dy	
9	2.47	27.41	Fair	1, 4,	S. easterly	81	1	79.5	6	82	30.09	100	29	10	44
10	0.36	28.36	Fair	4,	S. easterly	78	2	77.5	6.5	84	30.12	100	30	12	turbid
11	1.6 S.	30.24	Fair	4,	S. E.	78	1	77	6	82.5	30.12	100	30	12	turbid
12	3.19	30.33	Fair	4, 5,	S. easterly	79	1	76.5	6	82	20.12	100	37	12	48
13	5.59	31.34	Fair	4,	S. E.	79	1	78	5.5	85	30.13	100	29	14	48
14	8.58	32.35	Fair	4,	S. E.	78	3	78	7	77.5	30.15	100	18	7	39
15	12. 3	33. 8	Fair	4,	S. easterly	77.5	4.5	78	8	73	30.15	100	33	12	44
16	14 35	34. 4	Fair	4,	S. easterly	77	4	77	8.5	70.5	30.15	100	26	14	48
17	16.42	35	Fair	1, 4,	E. S. E.	77.5	4.5	77	8.5	70	30.15	100	29	14	46
18	18.19	36. 9	Fair	1, 4, 6,	N. E.	79	6	76.5	8	71	30.15	100	26	13	45
19	19.53	37.24	Fair	1, 2, 4,	E. N. E.	78.5	2.5	77	5.5	85	30.16	100	hazy	clo'dy	
20	22.22	40	Fair	1, 3, 4,	N. N. W.	76	3.5	73	7.5	75	29.15	91	30	14	44
21	22.17	40.42	Fair	1, 3, 4,	variable	68.5	0.5	69.5	6	81.5	30.08	85	hazy	clo'dy	
22	22.49	41. 5	clo'dy‡	4, 6, 7,	variable	73		70.5	4	91	29.98	65			
23	23. 8	41.57	clo'dy‡	1, 4, 6, 7	S. westerly	69		67.5	2	96	30 05	64			
24	23.13	41.53	clo'dy‡	1, 4, 5, 6	variable	68		68.5	4.5	89	30.01	62			
25	23. 6	42.50	Fair	1, 4,	variable	68	1	68	6	82.5	30.10	94	hazy	clo'dy	

* Abode at Madeira four days. † Abode at Port Praya, Cape de Verds, two days.

‡ This mark indicates that it was rainy some portion of the day.

∴ Time of Observation at Noon.

Remarks.

Latitude and Longitude.—The latitudes and longitudes given in the foregoing table, were generally deduced from celestial observations.

Face of the Sky.—The face of the sky was considered *fair*, except when it was totally obscured by clouds.

Classification of Clouds.—The classification of clouds was arranged in the order of their ordinary elevation, after the manner of Howard and Forster, viz:

Class 1st. Cirrus, or *Curl-cloud.*
" 2d. Cirro-cumulus, or *Sonder-cloud.*
" 3d. Cirro-stratus, or *Wane-cloud.*
" 4th. Cumulo-stratus, or *Twain-cloud.*
" 5th. Cumulus, or *Stacken-cloud.*
" 6th. Nimbus, or *Rain-cloud.*
" 7th. Stratus, or *Fall-cloud.*

Direction of the Wind.—The direction of the wind was noted after the predominant course which it blew during the day; otherwise it was regarded *variable.*

Temperature of the Atmosphere.—In ascertaining the temperature of the atmosphere, the thermometer was constantly observed at the windward side of the ship, in the shade, and there exposed two minutes at each observation, in the open air, free from all possible humidity and reverberation of heat arising from the body of the vessel.

Sun's Force.—The power of the rays of the sun also, was attempted to be measured by means of the thermometer; first, by determining the temperature of the air in the shade as above described, and then by exposing the instrument a short time to the rays of the sun. The increment of temperature arising therefrom, was considered as the sun's force.

Temperature of the Ocean.—As sea water is in general, a very bad conductor of heat, it was deemed sufficient to expose the thermometer about a minute at each observation in a bucket of water just taken from the surface of the ocean in order to ascertain its temperature.

Several experiments, were made in the course of the voyage, by means of a valved thermometrical sounding lead, on the temperature of the ocean at different depths, the most important of which, were the two following: The first, was made in the morning of the 24th of August, in the Gulf Stream, in latitude 37° 46′ N., and longitude 68° 05′ W., in order to determine whether its waters were in motion at any considerable depth. In sending down the instrument to the depth of one hundred fathoms, it indicated a temperature of 80° F., while the water at the surface was 82°, and the atmosphere in the shade 78°, a conclusive evidence that its waters were in motion at that depth. The second was made in the evening of the 10th of October, near the equator, in longitude 28° 36′ W., where the instrument gave a temperature of 64° at the depth of one hundred and seventy fathoms, while the surface temperature, and that of the air in the shade were each 78°. In the latter experiment, the water brought up in the valved instrument, was highly charged with gas, which, when exposed to the atmosphere, made its escape by a slight effervescence.

Evaporating State of the Atmosphere.—This was imperfectly determined by noting the descent of the mercury in the thermometer, after plunging it into water, and then exposing it a short time to the rays of the sun in the open air. Then the number of degrees that the mercury descended below the temperature of the air in the sun, was noted, and was considered as an index to the approximate dryness or humidity of the atmosphere.

Hygroscopical State of the Atmosphere.—This was determined by an accurate hygrometer, constructed after that of M. de Saussure, and was placed under the break of the poop of the ship for observation during the passage.

Barometrical State of the Atmosphere.—The instrument used for this purpose, was a common marine barometer, suspended in the large cabin of the ship, which was kept well ventilated during the time of observation.

Intensity of the Light of the Sun.—This was determined by a good photometer, constructed after that of Professor Leslie, which was exposed to the light, on the poop of the ship, about one minute at each observation. The instrument when taken directly from the dark, invariably stood at 4°, and when exposed to the light of the full moon, it stood at 10°.

Color of the Sky.—The instrument employed for this purpose, was a cyanometer, graduated after that of M. de Saussure. The observations were always made near the horizon, and about the zenith, except when the sun was in the latter situation, then the zenith observations were taken about 15° from the sun.

Color of the Ocean.—The color of the ocean was also attempted to be measured with the cyanometer, although its color is commonly regarded as green. The mode of using the instrument on this occasion, was, first, by directing the eye on a small space of open sea, on which the sun shone, not far distant from the ship, and then to compare its color with a corresponding shade on the instrument. Then the number of degrees corresponding thereto, was noted, as given in the foregoing table.

On the 10th and 11th of October, in the regions of the equator, the ocean assumed a turbid or milky appearance, which is generally considered by navigators, as an indication of shoals; but this could not be the case in the present instance, for, in sounding to the depth of one hundred and seventy fathoms, no bottom was obtained.

Geology of Monte Video.

The face of the country in the vicinity of Monte Video, is beautifully undulating in moderate hills and valleys, and exhibits but few rocks, except on the shores, where they are only of a few feet in elevation. The soil is generally composed of deep beds of clay, in which are often found nodules of calcareous marl. In the immediate vicinity of the city, the rocks consist of micaceous schist and quartzose sandstone. The latter, containing small particles of mica; sometimes passing into beds of a more compact nature, and at other times, traversed by veins of quartz. At the northward of the city, the rocks are almost entirely composed of this, while Rat Island consists of greenish sandstone, containing small spangles of auriferous pyrites. At the southeast part of the city, there are large beds of talcose schist, which are traversed by veins of quartz, containing small masses of talc.

El Cerro de Monte Video, or the Mount, is elevated about four hundred feet above the level of the river, and is generally covered with soil and herbage. Its base consists of a coarse quartz sandstone, apparently passing into a bed of argillaceous schist, which presents itself in an out cropping, near the summit of the hill. The argillaceous schist, is arranged in nearly a vertical position, but not in regular stratification. At about one hundred feet above the river, there is a bed of marine shells of recent formation, and resembling those found at present on the neighboring shores.

Art. VIII.—*On the Deutarseniuret of Nickel, from Riechelsdorf in Hessia*; by James C. Booth.

Forwarded for insertion in this Journal from Berlin, Prussia, April 26th, 1835.

In the xxv vol. of "Poggendorf's Annalen," p. 491, is a description of an arseniuret of nickel, from "Schneeberg" in Saxony, which is a higher arseniuret than that commonly found and known under the name of "kupfernickel." According to the analysis of Hoffmann, it consists of

Nickel, - -	28.14
Arsenic, - -	71.30
Bismuth, - -	2.19
Copper, - -	0.50
Sulphur, - -	0.14
	102.27

The proportion, by weight, in which arsenic and nickel stand to each other is equivalent to 2 atoms of the former and 1 atom of the latter, and its chemical formula would consequently be $Ni\ As^2$.

A similar combination has lately been found in the cobalt mines in Riechelsdorf in Hessia, differing only by containing a small quantity of cobalt, which is not found in that from Schneeberg. This arsenuiret of nickel is generally found massive and mingled with sulphate of baryta, which forms the gangue of the cobalt ore at this place. It is fine grained, and where it meets the heavy spar, is generally crystallized. The spar may be readily removed with a knife and the crystals, thus exposed to view, present the form of hexäeder with flattened (?) edges and corners, that is, they are combinations of hexäeder, dodecäeder and octäeder; the same as the "speiskobalt," with which this mineral has a similar composition and is consequently isomorphous. The crystals are $\frac{1}{8}$—$\frac{1}{10}$ of an inch in size and have smooth and lustrous surfaces. The mineral is likewise found with a columnar structure, the columns being $\frac{1}{2}$—3 inches long, parallel and either straight or curved. Where the columns enter into the spar, they generally terminate in the above-mentioned crystals, and this columnar structure in a mineral, which belongs to the regular system, is remarkable.

The color of this arseniuret is tin white, with a shade of blue gray, and is somewhat darker than that from Schneeberg.

Before the blow-pipe, in a tube, as well as upon charcoal, it indicates the presence of large quantities of arsenic, and fuses to a brittle metallic bead. If the bead be roasted and fused with borax, it gives a blue glass. By breaking the glass, and fusing the metallic bead contained in it with phosphoric salt, the action of nickel may be observed, viz. a reddish brown transparent glass in the exterior, and a brown opake glass in the interior flame. If an insufficient quantity of borax was employed, the phosphoric salt gives indeed a blue glass and it is therefore necessary to repeat the operation with borax.

The purest pieces of the mineral were set apart for analysis, and 0.8028 grammes, powdered and ignited with ten times its weight of a mixture of equal parts of saltpeter and carbonate of soda, in a platinum crucible. The fused mass was treated with water and filtered; the remainder on the filter was dried and the filter itself burned, then dissolved in hydrochloric acid and heated with sulphuric acid. The sulphate of baryta, which was thus precipitated, resulted from the heavy spar, with which the mineral was so penetrated, that it could scarcely be detected by the eye. The weight of the precipitate was 0.0611 grammes and therefore that of the pure mineral 0.7417 grammes.

To the solution, from which the baryta was precipitated, muriate of ammonia was added in considerable quantity, and then ammonia in small excess, by which oxide of iron was thrown down, and its weight determined to be 0.0348 grm.

Nickel and cobalt were then separated according to the method of Laugier, as that of Philips failed after repeated trials. The oxide of nickel, thus obtained, weighed 0.1954 grm., a part of which reduced with hydrogen, gave for the whole quantity of metallic nickel 0.1538. The oxalate of cobalt ignited for a moment gave 0.025 for the metal. The arsenic was determined in this analysis by loss, since in another, in which the mineral was dissolved in nitric acid and precipitated by sulphuretted hydrogen, the quantity of arsenic was found to correspond.

According to the above analysis, the arseniuret of nickel from Riechelsdorf consists of

	in 0.7417 grammes,	or, in 100 parts,
Nickel, - -	0.1538 - -	20.74
Cobalt, - -	0.0250 - -	3.37
Iron, - -	0.0241 - -	3.25
Arsenic, - -	0.5388 - -	72.64
	0.7417	100.00

By calculating the quantity of metallic arsenic, which the metals require in order to consider them as bin-arseniurets, it will be found that

20.74	nickel takes up	52.84	arsenic, as	$Ni\ As^2$
3.37	cobalt " "	8.58	"	$Co\ As^2$
3.25	iron " "	9.01	"	$Fe\ As^2$.
		70.43		

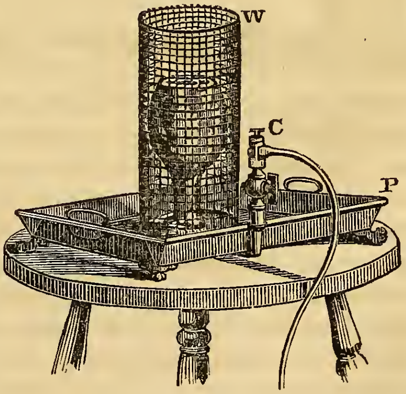
The quantity of arsenic thus determined, differs from that actually obtained by something more than 2 per cent; but as this is evidently too large, since it contains the loss unavoidable by analysis, we may conclude that the chemical formula for the mineral is

$$\left.\begin{matrix} Ni \\ Co \\ Fe \end{matrix}\right\} As^2.$$

Or if the small quantities of cobalt and iron be considered as accidental, $Ni\ As^2$

ART. IX.—*Explosive Reaction of Hydrogen with Chlorine, under the Influence of the Solar Rays;* by R. HARE, M. D. Prof. of Chem. in the Univ. of Penn.

A flask is half filled with chlorine over the pneumatic cistern, in the usual way, and then transferred to the pan P, so as to have its orifice exactly over that of the orifice of a pipe which, at the other end, communicates with the cock C, to which is annexed a flexible pipe extending to a self-regulating reservoir of hydrogen.



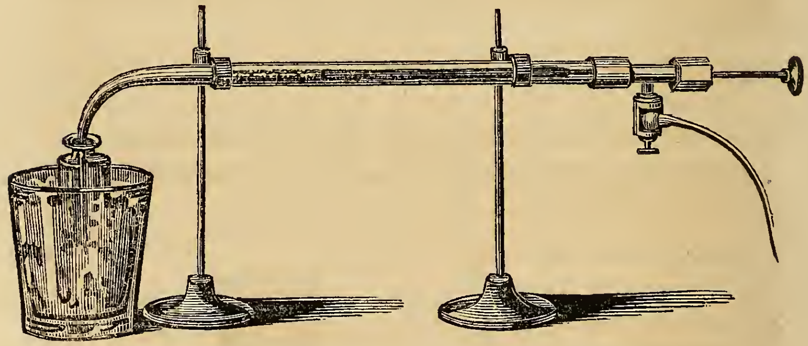
The flask is surrounded by a wire gauze, and just before the explosion is desired, hydrogen from the reservoir is allowed to occupy that portion of the cavity which was previously unoccupied by the chlorine. It should be understood that the pan, during this operation, retains a sufficient stratum of water to cover the mouth of the flask, and that this is occupied with the same liquid in part until it is displaced by the hydrogen.

The preliminary arrangements being made, a mirror must be placed in a situation to receive the solar rays directly, and reflect them upon the flask. The result is an explosion, from the effects of which the spectators are protected by the wire gauze.

It must be obvious that this experiment can only succeed, when the sun is unobscured.

It should be understood that the condensation arises altogether from the absorption of the gas by the water.

Art. X.—*Apparatus for the Evolution of Cyanhydric or Prussic Acid;* by R. Hare, M. D. Prof. of Chem in the Univ. of Penn.



Let a tube, three-fourths of an inch in bore, and about two feet in length, be bent at right angles, at about six inches distance from one end. Let the shorter portion be drawn out into a tapering form, with a bore not exceeding a tenth of an inch in diameter. Upon the larger orifice let a brass band be cemented, in which a female screw has been cut, so that a stuffing box furnished with a corresponding male screw, may be easily fastened air-tight to the band, or removed when desirable. Through the stuffing box an iron rod passes, flattened like an oar at the end, which is within the tube when the stuffing box is in its place. There must likewise be a lateral aperture in the band communicating with the cavity of the tube, and furnished with a gallows screw. The main body of the tube is to be situated nearly level, yet a little inclined towards the curvature, so that the tapering extremity may descend nearly perpendicularly into a tall narrow phial surrounded by a freezing mixture. The horizontal portion of the tube near the bend should likewise be refrigerated. The apparatus being thus arranged, introduce a sufficient quantity of the bicyanide of mercury into the tube, and close it by inserting the stuffing box with its rod. In the next place, by means of the gallows screw, make a communication between the cavity of the tube, and a self-regulating reservoir of sulphydric acid. This gas must be allowed to pass into the tube very slowly, and meanwhile, by means of the rod, the bicyanide is to be stirred. Before long a portion of the cyanhydric acid will be seen in the narrow part of the tube. This serves to regulate the admission of the sulphydric acid, since, when the quantity passing into the tube is inadequate, the liquid will rise in the tube; when too great, it will be expelled from it. By these means, after a little while, all the bicyanide will be decomposed, and a corresponding quantity of acid collected in the refrigerated phial.

Art. XI.—*Caricography;* by Prof. C. Dewey.

Appendix, continued from Vol. xxviii, p. 276.

No. 145. C. *cryptocarpa*, Meyer.*
Tab. W. fig. 69.

Spicis distinctis; staminiferis superioribus subternis et partim sessilibus; pistilliferis distigmaticis subternis cylindraceis pedunculatis et interdum superne staminiferis; fructibus obovatis utrinque convexis brevissime rostratis ore integris, squama oblongis longo-lanceolatis duplo vel triplo minoribus.

Culm two feet high, large, stiff, erect, very scabrous above, triquetrous, with long and large leaves; bracts long, leafy, with scarcely any sheaths; staminate spikes 3—4, upper ones sessile, with oblong obtuse and brown scales; stigmas two; pistillate spikes about three, long, cylindric, often staminate above; fruit obovate, convex on both sides, smooth, with a very short beak and entire mouth;

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* C. A. Meyer, M. D. in the "Memoirs of the Imperial Academy of Sciences, Vol. I. N. S. 1830." St. Petersburgh. Dr. Meyer described and figured *twelve* species as *new* and found in Russian America. Several of these have been found also in other northern regions of America.

pistillate scales, oblong-lanceolate, obtusish, black, three or four times longer than the fruit; bracts, leaves, and culm very rough.

Found on Columbia River.

No. 146. C. *petricosa*, D.
Tab. W. fig. 70.

Spicis subquaternis oblongis tristigmaticis, terminali androgyna superne staminifera, inferioribus exsertè pedunculatis; fructibus lanceolatis lævibus acutis ore apertis, squama ovato-oblonga obtusiuscula brevioribus.

Culm ten inches high, triquetrous, smooth, leafy towards the base, upper leaves long as the culm; bracts leafy and sheathing; spikes four, exsertly pedunculate, oblong, subremote; fruit lanceolate, smooth, with an open mouth; stigmas three, and upper spike staminate above; pistillate scale ovate, oblong, rather obtuse and longer than the fruit, reddish-brown on the edge and whitish on the keel.

Found on the summit of the Rocky Mountains.

No. 147. C. *festiva*, D.
Tab. W. fig. 71.

Spicis distigmaticis androgynis, superne pistilliferis subsenis ovatis in capitulum densi aggregatis; fructibus ovatis oblongis rostratis in apice serrulatis bifidis convexo-planis, squama ovata acutiuscula longioribus.

Culm six to ten inches high, scabrous, triquetrous, striate, erect, stiff, leafy; lower leaves shorter, upper ones longer than the culm, flat, striate, rough on the edge; spikelets about six, androgynous, staminate below, ovate, aggregated into a close head, without bracts; stigmas two; fruit ovate, sub-oblong, compressed, convex above, nearly flat below, acuminate, rostrate, split at the mouth and scabrous on the edge; pistillate scale ovate; acutish, tawny, shorter than the fruit; color of plant light green.

Found by Dr. Richardson at Bear Lake and on the Rocky Mountains.

No. 148. C. *petasata*, D.
Tab. W. fig. 72.

Spicis distigmaticis androgynis, inferne staminiferis subquaternis ovato-oblongis cylindraceis subsessilibus approximatis; fructibus lato-lanceolatis utrinque acutis rostratis vel acuminatis ore bifidis subalatis, squama lato-ovata subobtusa longioribus.

Culm four to eight inches high, erect, slightly scabrous, triquetrous, striate; leaves shorter below, upper one about as long as the culm; spikes androgynous staminate below, oblong-cylindric, about four, short pedunculate, approximate, brownish; fruit broad lanceolate, acute at each end, acuminate or rostrate, compressed, bifid, and slightly winged, convex above; scale ovate, obtusish, tawny, broad, shorter than the fruit.

Found on the Rocky Mountains.

No. 149. C. *membranacea*, Hooker.*
Tab. X. fig. 73.

Spicis distinctis, staminiferis sub-binis oblongis cylindraceis cum squamis e laciniis membranaceis; pistilliferis tristigmaticis cylindraceis subbinis, suprema superne staminifera sessile, infima sæpe pedunculata, omnibus dense fructiferis et nigris; fructibus ovatis subtriquetris ventricosis brevi-rostratis ore bilobis, squama ovata obtusa longioribus.

Culm about a foot high, erect triquetrous, scabrous above, leafy towards the base; leaves nearly long as the culm, shorter below; staminate spikes 1—3, oblong, cylindric, sessile, with oblong and obtuse and black scales but white and *membranaceous* on the edge; stigmas three; pistillate spikes 1—3, commonly two, upper sessile and staminate above, lower pedunculate or sometimes sessile also, densely flowered, oblong and cylindric and black, with a leafy bract; fruit ovate, ventricose, sub-triquetrous, short-rostrate, orifice two-lobed, black; pistillate scale ovate, obtuse, black, shorter than the fruit.

This is a beautiful species. Found at sea coast, Arctic regions, at Bear Lake, and on the Rocky Mountains, and Kotzbue's Sound. It is a distinct species, the scales and covering of seed being singularly membranaceous.—*Hooker.*

No. 150. C. *marina*, D.
Tab. X. fig. 74.

Spiculis androgynis distigmaticis inferne staminiferis subternis approximatis sessilibus, infima bracteata; glumis omnibus fuscis ovato-obtusis; fructibus ovatis sub-lanceolatis acutiusculis plano-convexis, squama paulo longioribus.

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* In Appendix to Parry's second Voyage, and Hooker and Arnott's Botany of Capt. Beechy's Voyage.

Culm four to six inches high, triquetrous, striate, slightly scabrous above, longer than the leaves which are flat and sheathed towards the base; spikelets androgynous, staminate below and stigmas two; approximate in threes, sessile, lowest bracteate; staminate scale ovate and obtuse; fruit ovate, sub-lanceolate, acutish, convex above and flat below, a little longer than the ovate and obtuse scale, spike tawny, and plant light green.

Found at the sea coast of Arctic regions, by Dr. Richardson.

No. 151. C. *Hookerana*, D.
Tab. X. fig. 75.

Spica composita; spiculis androgynis distigmaticis superne staminiferis inferne subremotis ovatis sessilibus multis bracteatis; fructibus ovato-lanceolatis scabro-rostratis subdivergentibus convexo-planis bidentatis, squama ovata lanceolata cuspidata paulo brevioribus.

Culm twelve to eighteen inches high, triquetrous, scabrous above, rather slender, longer than the leaves which are shorter too below and sheathing towards the base; spikelets many with two stigmas and staminate above, ovate, sessile, bracteate, often aggregated at the apex and remotish below; fruit ovate and lanceolate, rostrate, scabrous on the edge, somewhat diverging in maturity; pistillate scale ovate, lanceolato-cuspidate, tawny, green on keel, white on edge, and a little longer than the fruit; color of the plant light green.

Found at Carlton House by Dr. Richardson.

No. 152. C. *spectabilis*, D.
Tab. X. fig. 76.

Spicis distinctis, staminifera solitaria oblonga cylindracea, pistilliferis subbinis *tristigmaticis* ovato-cylindraceis exserte pedunculatis subremotis erectis, infima longo-pedunculata folio-bracteata; fructibus ovatis obtusis nervosis ore bilobis brevissimè rostratis, squama oblongo-lanceolata mucronata paulo brevioribus.

Culm eight to twelve inches high, erect, smooth, striate; leaves sheathing, flat and smooth, upper ones about equalling the culm; bracts long and leafy; staminate spike single, erect, cylindric and oblong, with oblong obtusish scales; stigmas three; pistillate spikes 2—3, ovate, cylindric, erect, remotish, pedunculate, and the lowest long-pedunculate, sheaths short; fruit ovate, obtuse, nerved, scarcely rostrate, orifice two-lobed; pistillate scale oblong, lanceolate, short mucronate, all reddish brown, and a little longer than the fruit.

Found in the Arctic regions.

No. 153. C. *lanceata*, D.
Tab. X. fig. 77.

Spicis distinctis, staminifera solitaria vel ternis cylindracea erecta, pistilliferis subbinis *tristigmaticis* cylindraceis erectis sub-approximatis pedunculatis sub-laxifloris bracteatis; fructibus ovatis obtusis plano-convexis vix rostratis lævibus, squama lato-ovata lanceolata brevioribus.

Culm about a foot high, erect, leafy, triquetrous, sub-scabrous; upper leaves long as the culm, lower ones shorter, and all sheathing towards the base; bracts leafy; stigmas three; staminate spikes 1—3, erect, cylindric, with obtuse and oblong brown scales; pistillate spikes about two, cylindric, rather loose-flowered, not very remote, pedunculate, with short sheaths; fruit ovate, obtuse, scarcely rostrate, orifice entire, flat below and convex above, smooth; pistillate scale broad ovate, long-lanceolate, surpassing the fruit, dark brown, green on the keel; color of plant light green.

Found at Cumberland River by Dr. Richardson. The fruit and scale remove it far from C. *Grayana*, which it much resembles in several particulars.

No. 154. C. *fulvicoma*, D.
Tab. Y. fig. 78.

Spiculis androgynis distigmaticis superne staminiferis conferto-aggregatis subquinis parvis; fructibus ovatis obtusis compressis lævibus, squama lato-ovata obtusa paulo longioribus.

Culm four inches high, erect, large, smooth, striate; leaves radical, flat, grassy, striate, surpassing the culm; spike compound, oblong, stigmas two; spikelets several, staminate above, sessile, closely set together, with lower scale broad-ovate and lanceolate like a bract; fruit ovate, obtuse, compressed, smooth; scale broad-ovate, obtuse, tawny, membranaceous on the edges, and a little shorter than the fruit. Whole plant is yellowish, short, thick, singular in form, with the root tapering and perpendicular, and all the parts very large in proportion to the height of the plant.

Found by Dr. Richardson on the sea coast of Arctic America.

No. 155. C. *nigricans*, Meyer.
Tab. Y. fig. 79.

Spica unica superne staminifera *tristigmatica* densa, squamis oblongis obtusis; fructibus densis sub-divergentibus ovatis sub-triquetris acutis rostratis, squamam oblongam obtusam æquantibus.

Culm four to six inches high, slender, erect, stiff, smooth, longer than the sub-bristle-form leaves, which are sheathed at the base; spike one, staminate above; stigmas three; fruit ovate, triquetrous acute or sub-rostrate, somewhat diverging, smooth; scales all oblong, obtuse, tawny white on the edge, and mostly shorter than the fruit; color of plant a pale green, and of spike, a dirty brown.

Found by Dr. Richardson on the Rocky Mountains. It is nearly related to C. *spicata*, Schk. Tab. D. fig. 15, if it is not indeed the same plant which inhabits the Pyrennees.

No. 156. C. *Redowskiana*, Meyer.
Tab. Y. fig. 80.

Spica unica dioica oblonga; fructibus lineari-oblongis utrinque attenuatis lævibus ore bilobo hyalinis, squamam obtusam ovatam in margine scariosam sub-duplo longioribus; culmo lævi, foliis triquetro-setaceis.

Culm five to eight inches high, triquetrous, very slender, erect, sulcate, glabrous, leafy towards the base; leaves setose, triquetrous, glabrous, nearly equalling the culm; stigmas two, scales with a broad white scarious margin; fruit smooth, glabrous, nerved, and with an obtuse two-lobed orifice.

Found in Kamtschatka by Dr. Redowski, and on the Rocky Mountains by Dr. Richardson.

No. 157. C. *Backana*, D.
Tab. Y. fig. 81.

Spica unica superne staminifera; fructibus tristigmaticis ovato-globosis sub-conico-rostratis fuscis paucis ore scarioso lævissimis, squama ovata acuta membranacea paulo longioribus.

Culm four to six inches, triquetrous, sub-erect, nearly smooth, leafy towards the base; leaves flat, linear-lanceolate, shorter than the culm, and lower ones the shortest; spike single, with oblong and obtusish white scales above, and about four pistillate flowers below with three stigmas; fruit ovate, spherical and tapering into a conic beak, very smooth and dark brown, with an orifice lacerated or scarious.

This is a beautiful species; and was found by Dr. Richardson in British America, near Carlton House.

No. 158. C. *Drummondiana*, D.
— *attenuata?* R. Br.
Tab. Y. fig. 82.

Spica unica cylindracea superne denseque staminifera, sæpe sola staminifera, tristigmatica; fructibus obovatis subtriquetris infra planis nervosis lævibus brevi-rostratis alternis et paucifloris ore occluso, squamam ovatam obtusam subæquantibus.

Culm about four inches high, triquetrous, sub-scabrous, striate, erect and stiff, leafy towards the base; leaves flat, linear-lanceolate, nerved, grassy, long as the culm, deep green; spike ½—1 inch long, dark brown, densely flowered above, with a few alternate fruit at the base, sometimes the spikes are wholly staminate, with oblong and obtuse scales white and membranous on the edges; fruit obovate, three sided, flat below, with a short beak, projecting a little beyond the scale in maturity; pistillate scale ovate, obtuse or rather obtuse, often white on the edge and dark brown on the back.

Found at Fort Norman in British America, and on the Rocky Mountains.—*Dr. Richardson.*

The figure shows one wholly staminate spike, and one which is pistillate below.

Note.—Of the following species more full descriptions and figures are here given and taken from the plants themselves.

C. *podocarpa*, R. Br.
Tab. Z. fig. 83.
Vol. XI. p. 162 of this Journal.

Spicis distinctis, staminifera solitaria ovata, pistilliferis tristigmaticis binis oblongo-ovatis sub-laxifloris pendulis bracteatis; fructibus ellipticis compressis brevissimè rostratis integris lævibus sub-pedicellatis, squama ovata obtusa vel emarginata cristata paulo longioribus.

Culm ten to sixteen inches high, triquetrous, smooth, slender, lax, leafy towards the base, lower leaves shorter; staminate spike single, lax, with oblong obtuse and dark brown scales; stigmas three; fruit elliptic, compressed, scarcely rostrate, entire, smooth, slightly pedicellate; scale oblong, obtuse or emarginate and cuspidate, the point projecting beyond the fruit, while the scale is a little shorter than the fruit.

The specimen from which the figure is taken was found near Fort Vancouver, British America, May, 1826.

C. *mutica*, R. Br.
Tab. Z. fig. 84.
Vol. XI, p. 310 of this Journal.

Spica staminifera solitaria erecta, squamis obtusis; spicis fructiferis *distigmaticis* ternis distantibus erectis sparsifloris sub-exserte pedunculatis; fructibus ovalibus obtusis subcompressis lævibus, squama ovata oblonga brevi-mucronata paulo longioribus.

Culm four to ten inches high, slender, sub-erect, leafy towards the base and dark brown; leaves flat, and about as long as the culm; staminate spike single; stigmas two; pistillate spikes two or three, sub-distant, erect, pedunculate, often much projecting from the sheath, sparsely flowered; fruit oval, obtuse, flattish, smooth, and often a little longer than the oblong and ovate and short mucronate scale; spikes dark brown, and plant light green.

Found in Arctic regions by Dr. Richardson. It seems to be a distinct species, and belongs in the section with C. *aurea*.

Since the Carices in Vol. XXVII, p. 241, were published, the article of Dr. Meyer, in the *Memoirs of the Imperial Academy at St. Petersburgh*, for 1830, has been received by the Lyceum at New York. One of the new species, Vol. XXVII, p. 238, C. *Carltoniana*, D. had already been published by Dr. Meyer as *new*, and the name given by him must be adopted. C. *Carltoniana*, D. is C. *stylosa*, Meyer.

Figures of the following species accompany this paper.

C. *cryptocarpa*,	Meyer.	Tab.	W.	fig.	69.
— *petricosa*,	D.	"	"	"	70.
— *festiva*,	D.	"	"	"	71.
— *petasata*,	D.	"	"	"	72.
— *membranacea*,	Hooker,	"	X.	"	73.
— *marina*,	D.	"	"	"	74.
— *Hookerana*,	D.	"	"	"	75.
— *spectabilis*,	D.	"	"	"	76.
— *lanceata*,	D.	"	"	"	77.
— *fulvicoma*,	D.	"	Y.	"	78.
— *nigricans*,	Meyer,	"	"	"	79.
— *Redowskiana*,	Meyer,	"	"	"	80.
— *Backana*,	D.	"	"	"	81.
— *Drummondiana*,	D.	"	"	"	82.
— *padocarpa*,	R. Br.	"	Z.	"	83.
— *mutica*,	R. Br.	"	"	"	84.

By some botanists, *Kobresia* is considered different from Carex, while by others the several species are united under the latter. The two genera have been thus united by Sprengel in the sixteenth edition of the *Systema Vegetabilium* of Linnè, Vol. III, 1826. There seems to be reason for separating them, and the more so, as *two new species* have been found in the Arctic regions of America among the species of Carex. These two species are here described.

1. Kobresia *filiformis*, Torrey.
Tab. Z. fig. 85.

Spica unica simplici tereti superne staminifera; squamis lanceolatis hyalinis fructum tristigmaticum ovatum rostratum lævem laxum superantibus; culmo nudo subscabro, foliis radicalibus setaceo-filiformibus longis.

Culm a foot high, stiff, erect, with linear and bristle-form leaves rising from the base and often equalling the culm; spike simple, sparsely flowered, and few flowered at the base; stigmas three; staminate scale oblong lanceolate; fruit ovate, lanceolate, smooth, with a lanceolate and transparent or membranaceous scale.

Found on the Rocky Mountains.

2. K. *globularis*, D.
Tab. *Z*. fig. 86.

Spica unica simplici, supernè staminifera attenuata densifloraque, inferne rariflora; fructibus tristigmaticis sub-globosis alternis ore obliquis subrostratis, squama ovata obtusa hyalina paulo longioribus.

Culm near a foot high, erect, stiff, slender, smooth with radical filiform leaves a little shorter than the culm; spike one, an inch long, staminate above and densely flowered and attenuated; staminate scales oblong and obovate, obtuse, and hyaline; fruit sub-globose, smooth, alternate, few and rare, subrostrate, oblique at the mouth, nearly inclosed in the two scales, which are ovate and obtuse, shorter than the fruit, white and silvery hyaline.

Found at Carlton House by Dr. Richardson. It is a beautiful species: the silvery scales give the spikes a woolly appearance at a little distance, although they are not in the least vellose.

Figures of these two species accompany this paper.

Kobresia *filiformis*, Torrey. Tab. *Z*. fig. 85.
globularis, D. " " " 86.

Art. XII.—*On Water Spouts;* by Lieut. H. W. Ogden, of the U. S. Navy.

TO PROFESSOR SILLIMAN.

Dear Sir,—At the suggestion of several of my friends, with whom I have lately conversed on the subject of that singular, and as yet unexplained phenomenon the water-spout, I take the liberty of sending, for your consideration, a short account of the appearance of several of them, which once surrounded our ship at the same time, giving us from their proximity, a better opportunity of observing them than is generally had.

In May 1820, while on our passage from Havana to Norfolk, in the U. S. sloop of war John Adams, we had reached the latitude of Cape Fear, and near the inner edge of the gulf stream, when the wind died away, the weather became very warm, and the atmosphere close and oppressive. The crew were lounging listlessly about the deck, dreading the dull monotony of a continued calm, when one of the seamen called out that there was a water spout on the larboard bow.

The officers immediately rushed up from below, and I among the number, but we had scarcely reached the deck before a second and a third were seen, and within half an hour, there were seven around us varying in their distance from the ship from two hundred yards to two miles.

The atmosphere was filled with low ashy colored clouds, some of which were darker underneath than others, and from these the water spouts were generally formed, each one from a separate cloud. In some instances, they were perfectly formed before we observed them, but in others, we could see a small portion of the cloud, at first extend downwards in the shape of an inverted cone, and then continue to descend, not very rapidly, until it reached the water. In other instances, however, we observed that this conical appearance of a portion of the cloud, did not always result in the perfect formation of a water spout. Several times we saw the cone project,—continue for a short time stationary,—then rise again slowly and disappear in the clouds. This would in some cases occur two or three times to the same cloud, but eventually a larger and darker cone would descend, and result in forming the visible spout as above mentioned.

We saw so many of these failures, that the eye very soon became accustomed to that degree of density in the cone which would ensure its descent, and even the sailors became practical philosophers for the time, correctly predicting when a spout would be formed, and when it would fail.

While intently watching these various operations, we observed that the nearest water spout, then about two hundred yards on our starboard quarter, was moving slowly towards the ship with a light air from the eastward. The captain immediately ordered the topsails to be clued down, the hatches to be covered with tarpaulins and battened, the crew to be sent under deck, and directed some of the marines to be in readiness with loaded muskets, to try what effect might be produced by the concussion of firing, as it is the general belief that water spouts may be broken by this means. As soon as it was near enough, the marines were ordered to fire, and although many of the balls must have passed directly through it, neither the perforation nor concussion had the slightest effect on it. The marines were ordered to load and fire again, and in the mean time I was directed to cast loose one of the thirty two pounders. I did so, and took aim directly at the base of the spout, then within sixty yards, and fired. The captain, and others who were watching the effect to be produced, said they distinctly saw the ball strike the spout at its base, dashing the water on each side, but still it remained as perfect as before. I was ordered to load and fire again, and to elevate the gun so as to strike the tube as high as possible, but just as I was in the act of pulling the lock string, the captain looked aloft, and observing the head of the spout directly over the main truck, called out to me to hold on, not wishing to try further experiments while it was in such dangerous proximity to the ship. For some minutes I had been too much occupied with the gun to notice particularly the position and progress of the water spout, but now, on looking up, I saw the dense black cloud from which it was formed, hanging immediately over us, at a height, as nearly as I could judge, of between three and four hundred feet, and the upper part of the spout directly over the mast heads. When at a distance of two hundred yards, the tube of the spout seemed to fall perpendicularly from the cloud to which it was attached, but as it approached, the cloud alone moved steadily on, while the lower part of the tube, as though it found something repulsive in the ship, diverged slowly to the south west, and passed the stern at a distance of about sixty yards.

This, however, was no doubt caused by a difference in the current of air above and below, and I observed that some of the others, more distant from the ship, would occasionally vary from a perpendicular line and then resume it.

While the spout was thus moving slowly by us, we had a good opportunity of observing it attentively, and, as we were well convinced that it was not to be broken or dispersed by the concussion of firing, the gun was secured.

Around the base of the spout for several feet, the sea was considerably agitated, and a few feet above, a gyratory motion was very distinct, tending upward, and accompanied by a whizzing noise, something like that made by a small quantity of steam escaping through a valve which is not very tight.

The tube of the spout was apparently four or five feet in diameter, and its surface well defined. Its color was light and misty, but we observed that they all looked darker at a distance than when close to us. Its shape was somewhat like a trumpet—the small end downwards, and spreading out suddenly as it united with the cloud. At a height of between twenty and thirty feet from the water, a number of sea-birds were flying around it, evidently in quest of food. They were in rapid motion, flitting and crossing each other's paths at every moment, darting in towards the tube, wheeling away, and then as hastily returning. In the mean time, the cloud above, which had rapidly grown denser and larger, began to exhibit corruscations of electricity. The spout which had passed off to a distance of about three hundred yards, after having been visible more than twenty minutes, became smaller at its lower part, and then gradually rose until entirely lost in the cloud, part of which still hung over us. Soon after this, several severe flashes of lightning struck near to the ship, and the rain began to fall in large and very cold drops. Some of the sailors who believed that the water was taken up in a body to the clouds, tasted the rain as it fell on the deck, and were very much astonished to find it perfectly fresh. A light breeze now sprang up, bearing the cloud off to the Westward, which as it passed on, assumed the appearance of a heavy squall, and from its accelerated motion, it was evidently carried on by a strong wind.

In another instance on board the same ship, we were one day sailing with a light breeze from the Westward, all sail set, and the weather mild and pleasant. Light fleecy clouds were occasionally passing over the ship, but unattended by any increase of wind. I was officer of the deck at the time, and my attention was attracted to one of the clouds, which was somewhat lower than the others, but it also passed over without the slightest change in the strength of the breeze. It very soon however began to grow darker, and in a few moments I observed the formation of an inverted cone on its lower edge, and a slight agitation of the sea directly under it. The cone continued gradually to descend until it joined with the agitated point beneath, thus rendering the whole length of the spout visible. It was at this time about a cable's length on the lee quarter. The cloud continued to increase until as large as those which produce the ordinary squalls met with at sea, and soon after the spout disappeared, the lightning began to flash, and the rain to fall so heavily, as to entirely obscure a brig about eight miles to leeward of us. In a few minutes the cloud passed over her, and when she reappeared, we saw that she had furled her light sails, and clued down her topsails, evidently having experienced a heavy squall.

I have here given you the principal facts, as well as I remember them, but I very much regret that so favorable an opportunity of witnessing these singular phenomena, was not enjoyed by one whose scientific knowledge would have enabled him to arrive at some correct conclusion on the subject. Writers who have already given their attention to it, differ very widely indeed in their theories. Dr. Franklin, Dr. Richardson, Dr. Stuart, M. de la Pryme, and others contend that the water ascends to the cloud. Dr. Lindsay, treats this opinion with great severity, and exercises both his wit and his genius to prove that the water descends in all instances, and that a water spout and a whirlwind, are entirely different. Dr. Perkins of Boston, holds to the same belief, and had a long correspondence with Dr. Franklin on the subject; but it ended by each adhering to his own opinion. Mr. C. Colden of New York, differs again from all these, and (in a letter to Dr. Franklin, I think,) asserts from his own observation, that what is called a water spout, "is a violent stream of wind, rushing from the upper regions," &c. Indeed, all these gentlemen seem to have derived their different opinions from facts within their own observation, which go directly to prove their various theories, from which we can only infer that water spouts are very different in their appearance and operation at different times. At the short distance of sixty yards, I could see no evidence of a column of water rising within the tube to a height of thirty two feet, as mentioned by Dr. Stuart. Had this been the case, the spout must have had a much darker appearance thus far, than from thence upward, which was not the case, but it was, on the contrary more dense at the upper part where it united with the cloud. But even admitting that the water may rise within the tube to a height of thirty two or thirty three feet, equal to the weight of the atmosphere, by what means is so dense a body carried upward several hundred feet higher, and there so diffused as to form a cloud? We believe that clouds are formed of vapor, which when it becomes more dense than the surrounding atmosphere, form into drops and descend in rain. How then can a body of water which is already heavier than the atmosphere be supported within it after spreading from the upper part of the spout? It seems to me that it would, as a matter of course, fall again the moment it left the impelling influence which carried it upward. On the other hand, Dr. Lindsay contends that the water *descends* in a body, and describes a spout as seen by himself, near the banks of Newfoundland, where he says the sea was so agitated by the violence of the falling water, that their ship felt its influence, and was considerably tossed by it at a distance of half a mile. This was very different from any case that ever came within my observation. In the course of my sea service, I have seen perhaps as many as twelve water spouts, but never observed any agitation of the sea caused by them, that would give a ship the slightest motion, even within sixty yards. I am confident that a boat might have approached within a ship's length of the one I have described as being nearest to us, without the least danger.

As to the theory of Mr. Colden, that the phenomenon usually called a water spout, is nothing more than a stream of wind, rapidly descending, I can only say that nothing in any of the spouts seen by me, ever gave me the slightest reason for such a belief. From the variety of accounts given of water spouts, it would seem almost impossible to establish any general theory on the subject. Dr. Stuart and Mr. Mercer say, they distinctly saw the water carried up into the air. Dr. Lindsay and several persons quoted by Dr. Perkins, plainly saw it descend; while Mr. Colden at a distance of only forty yards from a spout, positively asserts that there was no water at all, but a stream of wind descending with violence from the clouds.

For my part, I could not see that any of these principles were applicable to the spouts which I saw. The nearest, remaining within sixty yards of our ship for at least fifteen minutes, afforded a good opportunity of observing it minutely, and so far as this one, (which seemed to be like all the others in sight at the time,) can go in confirmation of a general theory, it inclines me to the belief of that part of Dr. Franklin's hypothesis, which supposes it to be a body of warm air rising from the surface of the ocean to the upper and cooler region, where its moisture begins to be condensed into thick vapor by the cold, thus causing the spout to become first visible at its upper end. As the vapors continue to ascend, by constant addition they become denser, and consequently their centrifugal force greater, until being risen above the concentrating currents which compose the whirl, they fly off, spread and form the cloud.

Even Dr. Perkins, in one of his papers read at the royal society, June 24, 1756, favors this opinion so far as to say, "If spouts ascend, it is to carry up the warm rarified air from below, to let down all and any that is colder above." But he adds, "If this be so, they must carry it through the cloud, perhaps far into the higher region, making a wonderful appearance at a convenient distance to observe it, by the swift rise of a body of vapor above the region of the cloud." This is an appearance which I have never observed, nor do I conceive it to be at all necessary to the establishment of the fact that the air is carried upward. Such might be the case if the air ascended in a right line, but as I have already stated, it rises with a spiral motion, and as it becomes denser by contact with the colder atmosphere, it of course acquires a greater centrifugal force, which gradually enlarges the upper end of the spout to the trumpet form, until at length it flies off horizontally, thus uniting with, and increasing the cloud, instead of passing through it. It is possible that when the upper region is much colder than the lower, the condensation of the ascending air may be so great as to cause part of it to fall again through the spout, sometimes in the form of rain, or by a concentration of the drops, even a stream may be poured down, which would in a measure account for the theory of Doctors Lindsay and Perkins, but I could see no evidence of this in any of the spouts near our ship. Some of the officers, however, thought they could see water falling within the tube, but all admitted the gyratory motion *upward*, as it was too distinct for a difference of opinion.

As to the nature of electricity with water spouts, I must leave that point for others to determine. It is evidently largely combined with them, but whether as the cause, or merely the the consequence of their existence, is a question which you will, no doubt, be able to explain. Spanish navigators of former days, fully believed the water spout to be an electrical body, and that it might be broken or dispersed, by presenting to it the point of a bright sword; and even some modern writers have asserted that they *have been broken* by this means.

I know but little of the laws of electricity, but from its palpable force when attracted from one object to another, I should be very unwilling to hold the sword if I believed in the theory.

You will please excuse the length to which I have drawn out this letter. When I began, it was my intention only to give you a description of the water spouts as I saw them, and to this I beg leave to call your attention, rather than to my own opinions which are merely the result of observation. A scientific knowledge of the subject might perhaps bring me to very different conclusions.

Art. XIII.—*Researches on the Commercial Potash of the State of New York;* by Lewis C, Beck, M. D., Professor of Chemistry in the University of the City of New York, &c.

TO PROFESSOR SILLIMAN.

Potash is one of those articles, the manufacture of which, it has been deemed advisable to regulate by inspection laws, the avowed object of which is to protect the consumer against the negligence or frauds of the manufacturer. In this State, the propriety of legislative action on this subject is, perhaps, more apparent than elsewhere, in consequence of the value of the manufacture, which may be estimated at more than a million of dollars annually. But from the nature of the article in question, it became difficult to devise an unexceptionable mode of inspection, without the employment of some chemical processes which although sufficiently simple, have not been hitherto adopted. Hence potash of an inferior quality, has sometimes passed through the ordinary inspection, and found its way into our own markets and into those of foreign countries. This fact which was in a good degree attributable to the erroneous notions which prevailed in some parts of the State, concerning the principles of the manufacture, upon being communicated to Gov. Throop, induced him to present the subject to the consideration of the legislature. The result was a formal investigation, during the sessions of 1832 and 1833, by the committee on trade and manufactures of that body;

and as the enquiry involved chemical details, I was honored with a commission to examine into the various processes adopted in the manufacture of potash, and to analyze samples of the various kinds brought to market. That duty I endeavored faithfully to discharge, and made full reports of the results of my investigations. These reports were published among the documents of the legislature, but as their circulation was necessarily limited, I have thought that a summary of the facts which they contain, might be, with advantage, more widely diffused. I have accordingly prepared the following paper, which you will oblige me by publishing in your valuable Journal.

Various methods of Manufacturing Potash, pursued in the State of New York.

The most plausible view of the formation of the carbonate of potash, (the form in which commercial potash occurs,) by the incineration of wood, is that the acetate of potash exists in the wood, and that this by calcination, is converted into the carbonate. The wood is burned upon the earth, in a situation protected from the wind, the result of which is the formation of carbonate of potash and several other soluble salts, together with some substances upon which water has no action. By lixiviation with hot or cold water the soluble part is dissolved out, and this solution, when boiled to dryness, leaves behind a dark brown saline mass, consisting of carbonate of potash, a minute portion of one or two other salts and a small quantity of vegetable inflammable matter; and in this state it is known in commerce by the name of *Potash.* Calcination at a moderate heat, completely burns off the coloring particles, and the salt becomes of a spongy texture, and beautiful blueish white tinge; it is then called *Pearlash.*

Such are the simple principles upon which these important articles are prepared. But instead of following them, various substances are frequently added, either previous to, or during the boiling, *ostensibly* for the sole purpose of facilitating the manufacture, but which *really* have the effect of increasing the weight of the resulting mass at the expense of its purity.

To show what absurd notions were entertained on this subject, and the necessity which existed for legislative interference, I will here introduce the specifications of a patent obtained in February, 1831, by an inhabitant of Oswego County, N. Y., for what is termed "an improvement in the manufacture of potash." Strange as it may seem, many well meaning and practiced manufacturers were deceived by the specious pretensions of the patentee, and actually, for some time, pursued the process which he recommended.

The "improvement" thus proposed is announced in the following words. "The compound used is salt, lime and lamp oil. First, when beginning to melt, after the salt has done rising, it can then be ascertained what quantity of potash you are going to have. Suppose one barrel: First, take half a bushel of salt, sprinkle half of it over the top of the potash: Secondly, take two bushels of slaked lime, add that in the same manner, then the remainder of the salt, and when the lime has disappeared, then add half a pint of lamp oil. This is the quantity used for one barrel; but it may be varied as the nature of the case may require. First, the use of the salt is to create a heat, and to purify the potash; as it is supposed to burn up, and add nothing to the quantity, but to the quality: Secondly, the lime is supposed to melt and become the first rate potash: Thirdly, the oil is to create a blaze to consume: Fourthly, these are the contemplated uses of the above ingredients used by me."*

On the subject of this specification, I shall only express my entire concurrence in the remarks of Dr. Jones, the editor of the Franklin Journal. "If" says he "a patent had been required for deteriorating one of the staples of our country, the one under consideration would most completely have fulfilled the intention; and it is earnestly hoped that its validity may, in some way, be tested in our courts of law, where we apprehend, it would not be esteemed a 'useful invention' according to the intention of the patent law; as its inevitable result if acted upon, must be to injure the reputation of American potash in foreign countries; the material would be entirely spoiled as it regards its use in many manuractures."

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* It need not excite surprise that such nonsense should gain currency among ignorant manufacturers, when intelligent and even scientific men, often countenance the most absurd pretensions. I once saw the names of several respectable gentlemen, and among the rest that of a professor in one of our colleges, attached to a certificate in favor of a perpetual motion, which the inventor had the folly to exhibit. And, more recently, I have observed that a certain "improved compass needle," has received the approval of several of our naval officers, and has been noticed with apparent commendation in England. (*See Lond. and Edinb. Phil. Mag. &c., May*, 1835.) In regard to this "improved needle," I will only add that it is said to have been the means of losing for a friend of mine, a valuable vessel and cargo; and that the construction of it is false in principle, and its use must be hazardous in practice. Scientific men often do themselves great injury and subject those who place confidence in them to serious losses by their endorsements of of such valueless paper.

There is another patent which deserves a more detailed notice, as it contains a process much more extensively introduced and which in in some respects is a real improvement upon the ordinary mode of manufacture. At least the samples thus prepared, contain, as we shall hereafter see, a larger proportion of alkali, than any at present in market.

The patent to which I now refer, was secured in July 1831. The original specification may be found in the 9th volume of the Franklin Journal. The process however, has recently been varied, and now consists, essentially, in employing small leach tubs which are to be prepared in the usual manner, by placing sticks, straw and quicklime at the bottom. Over this is to be placed a layer of ashes, of about four inches in thickness, which is then to be treated with a boiling liquor, prepared by adding eighteen pounds of salt, and one bushel of quicklime to ninety gallons of water. Another layer of ashes is then to be added, which is to be treated with the liquor as before, and so on until four layers of ashes have been introduced,—when cold water is to be added, and to remain five or six hours. The lixivium is then to be boiled and "melted down" in the usual way.

It is asserted that by the above process of working, about one half the quantity of ashes will be saved, the potash melts easily in consequence of its purity, the kettles last much longer, and less fuel is required in the melting than by the ordinary method.

This patent, in its principal feature, closely resembles one obtained in England by Thomas Howard, in 1801;—the specification of which is recorded in the Repertory of Arts, 1st Series Vol. 16. It is entitled "specification of a patent for a method of making a British barilla and potash, and of obtaining a greater quantity of alkali than hitherto discovered." In this process, quicklime, in large proportion, is added to refuse alkaline salts, by which means their decomposition is effected, and a large quantity of pure alkali obtained.

I will now briefly state what I consider to be the advantages and disadvantages attending the American process above described.

Increased amount of alkali obtained from the ashes.—From the certificate of a respectable gentleman which was submitted to the committee of the Legislature, it appears, that in an experiment which he tried, twelve bushels of ashes yielded upon the old or common plan, seventy eight pounds of potash, whereas the same quantity of ashes treated according to the process in question, yielded one hundred and forty five pounds. The general correctness of this result is confirmed by the testimony of several intelligent manufacturers, with whom I have conferred. There is said also to be a great saving of time in performing the operation.

The above advantages are, of course, derived from the use of small leach tubs and the employment of hot, instead of cold water; by which the alkaline salt is more completely as well as more speedily dissolved.

Employment of Quicklime.—Another benefit resulting from this process, arises from the mode in which the lime is mixed with the ashes in alternate layers. It should here be distinctly observed, that the effect of the employment of lime in the manufacture of potash, depends altogether upon circumstances. When mixed with the ashes, previous to the lixivation, the resulting alkali is more pure or caustic, because the lime combines with the sulphuric and carbonic acids existing in the sulphate and carbonate of potash, and forms salts which are insoluble in water. This indeed is the mode in which the pure potash of chemists is obtained. In the ordinary process, the lime is placed only in the bottom of a large tub; but in the one under consideration, it is distributed throughout the whole mass of ashes, and thus its action is rendered more efficient.

The correctness of these views is strikingly confirmed by M. Becquerel, who has ascertained by his numerous analyses of different kinds of ashes, that those of the lime burner contain very little sulphate of potash, which is undoubtedly due to the action of the lime upon the sulphate of potash with the assistance of charcoal. This fact, M. Becquerel remarks, may lead to some advantage by adding lime to the wood, the ashes of which are intended for the manufacture of potash. (*Lond. and Edinb. Phil. Mag.* 1833.)

The case, however, is very different, when the lixivium is treated with lime and boiled down, without a second filtration. It becomes then a fraudulent operation, because the salts of lime formed by the decomposition of those of potash will all remain in the resulting mass. And in the law regulating the inspection of Pot and Pearl ashes, it is made the duty of every inspector to condemn every cask thus adulterated; a fact which can be very easily determined by the want of solubility in the sample, and the effervescence of the insoluble portion upon the addition of a dilute acid.

Upon enquiry, I find it to be a common practice, to use lime in the manner just described.—The reason which the manufacturers urge is, that its addition to the ley while boiling, assists in "keeping back the nitre" as they term it, and thus facilitating the subsequent steps of the process. By "the nitre" is undoubtedly meant the sulphate of potash, which, being much less soluble than any of the salts contained in the ashes, begins to crystallize long before the others, and forming a solid crust, proves somewhat troublesome, and should be removed, if the quantity be considerable. Instead of this, however the manufacturers add lime, which, by decomposing this salt forms the sulphate of lime and this with the portion of lime not acted on, falls to the bottom of the kettle, while the potash resulting from the decomposition of the sulphate, enters into other combinations. The lime rapidly absorbing carbonic acid from the air, is converted into carbonate of lime, and hence carbonate and sulphate of lime constitute the largest proportion of the insoluble matters, which are often found in such large quantity in our samples of potash.

I have been the more particular upon this point because, in the original specification of the patent now under consideration, it was proposed to add lime to the lixivium, a practice which, however general it may be, I have uniformly condemned. But I have the depositions of two manufacturers, and the assurances of several others, that more recently, the mode adopted is that which I have given above, and in which it will be observed that such addition is omitted.

Addition of Common Salt.—The addition of this substance to the lixivium is a most unwarrantable practice, as it injures the quality of the potash, while its presence cannot easily be detected. The reason of this will be apparent, from the fact long known to chemists, that when common salt is added to carbonate of potash in solution, a double decomposition takes place, the result of which is the formation of chloride of potassium and carbonate of soda; the former being almost wholly useless, and the latter being employed for purposes, other than those to which common potash is ordinarily applied.

The danger attending the adulteration is, that the chloride of potassium and carbonate of soda thus formed, are both highly soluble in water, so that they would escape detection by the ordinary mode of inspection, and samples in which they were contained in considerable quantity, be branded as "first sort."

The reason advanced by the manufacturers in favor of the use of salt, is that it facilitates the "melting of the potash." But this advantage can by no means make up for the positive injury done to the potash by its addition.

It was not until I had proceeded in this investigation, that I ascertained how general this mode of adulteration had become. Several manufacturers have assured me, that salt is almost always added to the lixivium, in the ordinary method of preparing potash. If this is so, the objection which I have to this part of the patented process will equally apply to the other. It is proper, however, to state, that while the proportion of pure alkali in the specimens of potash, which I have analyzed, is in favor of those manufactured by the patented process, the chlorides of sodium and potassium, which may be fairly set down to the admixture of common salt, are also contained in them in larger proportion.

There is one consideration in connection with the use of salt, which is deserving of some attention. And it is that at present, the only object of the manufacturer is to produce an article, which shall pass inspection as "first sort." It is by this brand, that the market price is regulated, and the extra time and labor required to manufacture a more pure potash, would, under the present system of inspection, be entirely lost. A premium is thus, in effect, set upon ingenious adulterations, and, under all the circumstances, we can scarcely attach blame to those, who endeavor to avail themselves of its benefit.

In concluding this part of my paper, justice obliges me to state, that the specimens of potash manufactured according to the patent process, which has been here described, equal, if they do not exceed, in purity, those which have been ordinarily ranked as "first sort." And if the facts, with regard to the increased amount of alkali obtained from the ashes, can be at all relied on, it must be considered in many respects, a valuable improvement. But from the very nature of the case, its continuance, as such, must depend, in a great degree upon the honesty of the manufacturer, and upon the vigilance and skill of the inspector.

Analysis of several varieties of Potash.—In the examination of these specimens, my chief object was to determine the proportions which they contained, of what are usually called impurities. The other substances which commercial potash is known to contain, in minute proportions, I did not consider it necessary to separate, as it would have occupied much more time, and after all, would have been attended with little practical advantage. My design was, not so much to present complete chemical analyses, as to show, in the plainest manner, the comparative value of the specimens which I examined. The following is the process which I adopted.

A. Five hundred grains of the specimen under examination were dissolved in six or eight ounces of water, heated to about 200° Fahr. and the solution filtered. The matter on the filter was again washed with a small quantity of water, and after being perfectly dried, was weighed, and the amount set down as insoluble residuum.

B. The insoluble matter was treated with dilute nitric acid, and then tested with various reagents. It generally consisted of carbonate of lime, oxide of iron and silex, although the proportions were very various. These I did not think it necessary, in each case to determine.

C. The weight of the filtered solution A, was now determined, and to a known portion of it, acetic acid was added until the alkali was completely neutralized.

D. To this neutral solution, solution of acetate of baryta was added as long as it caused any precipitation, and the whole then filtered; the resulting sulphate of baryta, being dried and weighed, gave by estimation, the amount of sulphuric acid contained in the whole solution (A.) Supposing this acid to be combined with potash, the amount of sulphate of potash, in the sample under examination, was easily settled. No account was taken of the small quantity of sulphate of lime, which might be contained in the solution.

E. To the filtered solution D, nitrate of silver was now added, as long as any thing was thrown down by it. The resulting precipitate was dried and weighed. This was chloride of silver, and from its weight, by estimation, the whole amount of chlorine was determined. Supposing this to have been originally combined with potassium, the amount of chloride of potassium was deduced.

Although from several experiments, I was satisfied that soda was also contained in most of the specimens which I examined, the curious play of affinities between the salts of soda and of potash, rendered it difficult to determine the exact state of combination in which it existed. Indeed, the process required for their separation, especially when the soda is in small proportion to the potash, is so delicate as to preclude its employment in ordinary inspection. It may, however, be of use to the inspector, to be aware of the different effects produced upon the carbonates of potash and soda by exposure to the air; the former as it is well known to chemists, soon becomes moist and assumes the liquid form, while the latter is not thus affected. I am the more particular in adverting to this fact, because I have heard it urged as an objection to some samples of potash that, by exposure to the air, they rapidly deliquiated or became moist. But of course the more rapidly potash undergoes this change, the more pure is it to be considered. It should not however be understood, that moist potash is the purest; for in this state, it contains a large quantity of water, which adds nothing to its value. I performed an experiment to ascertain the increase of weight which common potash experiences, by exposure to a moist atmosphere. The mass weighed four hundred and thirteen grains. After three hours exposure, it had gained five grains; in twenty four hours, its weight was increased twenty seven grains, or more than six per cent.

As I have observed, the presence of soda was inferred in several of the specimens and, had time permitted, might probably have been detected in all. In two of these, however, it existed in such large proportion, that it could be readily separated by adding muriatic acid, and carefully crystallizing the solution. I would particularize No. 7 in the following table, which was designated by the inspector, as "highly salted," a decision which my analysis fully confirmed. It is probable, for reasons which have been given in the former part of this communication, that the soda existed in the form of carbonate, and its occurrence, in such large quantity, may be fairly ascribed to the employment of common salt.

The following table will exhibit the comparative purity of the specimens which I analyzed, and in order to show in what respects they differ from the American potash, analyzed many years since by the celebrated Vauquelin, I have prefixed his results, reduced to the same number of grains which I employed.

Table showing the composition of several varieties of Commer-mercial Potash.

	Insoluble matter.	Sulphate of potash.	Chloride of potassium with chloride of sodium.	Carbonated alkali and water.	Total.	Impurities in 100 parts of potash.	Carbonated alkali in 100 parts of potash.
1	.8	66.8	8.7	423.7	500	15.3	84.7
2	58.	37.5	36.5	368.	500	26.4	73.6
3	2.5	31.5	75.	391.	500	21.8	78.2
4	12.	61.	54.	373.	500	25.4	74.6
5	8.	57.5	50.	384.5	500	23.1	76.9
6	57.	22.	46.	375.	500	25.	75.
7	38.	52.	161.	246.	500	50.8	49.2

No. 1. Is the result of the analysis of Vauquelin made about 1802.

No. 2. A specimen received from an Inspector at Albany and marked as "first sort, but not of the best quality."

No. 3. Supposed to have been made according to the original patent of Ephraim Pearce, (*Franklin Journal Vol.* 9,) in which lime and salt were employed.—It was nearly white with a pearly lustre.

No. 4. From the same parcel as the last, but of a darker color, the average per cent of carbonated alkali in the two specimens is 76.4.

No. 5. Received from an Inspector and labelled "made partly on the patent plan"—color whitish.

No. 6. Another specimen of the same kind as No. 5, but of a darker color. The average per cent of carbonated alkali is 75.8.

No. 7. A specimen of a beautiful reddish color which had been condemned by the Inspector at New York and labelled "highly salted." A large proportion of the one hundred and sixty four grains consisted of common salt, which had apparently undergone no change. Although the insoluble residuum was much less than in No. 2, the total amount of impurites was more than fifty per cent. This is an instructive lesson, to those who have been deceived by the notion expressed in the first patent, that the salt is "burnt up."

Having now determined, with what I conceivedto be a sufficient degree of accuracy, the nature and proportions of the impurities contained in the above, I dissolved three other specimens in water, and to the filtered solutions added nitric acid of known specific gravity, until the alkali was completely saturated, according to the ordinary chemical method of ascertaining the value of samples of potash or soda. The following are the results.

*Table of the composition of specimens of Potash determined by solution in water and saturation by nitric acid.**

	Insoluble matter.	Pure alkali.	Soluble impurities, carbonic acid and water.	Total.	Carbonated alkali per cent. by estimation.
8	3.	252	245.	500	From 65 to 70
9	5.5	251	243.5	500	
10	6.	256	238.	500	

No. 8. Was common potash, "second sort" from New York. No's 9 and 10 were from Albany, but the mode of manufacture was not certainly known.

* This process is perhaps open to the objection stated in the concluding part of this paper.

I subsequently analyzed two specimens made with great care, expressly for the purpose of testing the relative merits of the common and patent processes. Depositions of these facts were presented to the committee of the Legislature, and the boxes, containing the parcels were transmitted to me unopened. Portions of them were carefully analyzed, in most cases repeating the processes and deducing the mean. The general formula which I adopted, was that already given, with the addition that during the operation C, I ascertained the amount of carbonic acid, which had been expelled by the action of the acetic acid.

Table of the proportion of hydrate of potash, carbonic acid, &c. contained in two specimens of commercial potash.

	Insoluble matter.	Sulphate of potash.	Chlorides of potassium and sodium.	Carbonic acid.	Pure hydrate of potash.	Total.
11	1.7	12.5	6.9	5	73.9	100
12	2.5	10.2	11.1	2	74.2	100

No. 11. Was manufactured according to the common method.

No. 12. Manufactured according to the patent already described. Both were prepared expressly for trial as above stated.

In reviewing these analyses it will be found, that there is almost every variety in the parcels of potash brought to market. In those kinds which pass inspection, the proportion of what is called carbonated potash, varies from about sixty to eighty per cent. It is proper to remark, however, that I use the term "carbonated" in an indefinite sense, for the carbonic acid is seldom in the proportion necessary to constitute the true carbonates. In some instances, as in the two last, the amount of carbonic acid was exceedingly small, which is perhaps to be ascribed to the free use of lime, and to the cautious exclusion of the atmosphere, and also to the fact that I always selected fragments from the interior of a large mass.

Improvements of the manufacture.—From the facts which have now been presented, some opinion may be formed of the nature and extent of the adulterations of the potash, manufactured in the State of New York. It is a question not easily settled, whether any further legislative provisions are necessary to ensure the purity of this article. Taking it for granted that inspection laws are right and proper, in cases like the present, it seems to me that they should be rendered more efficient in their operation. I know it is urged, with some plausibility, that the reputation of our potash is now higher in foreign markets, than that of any other country, and that it is not for our interest to improve the manufacture. In answer to this however, one or two facts deserve to be mentioned. The first is that although when potash can be largely adulterated and still, by the ordinary inspection, pass as first or second sort, there is a premium placed on the most successful adulteration, the fraud cannot long escape detection. The large manufacturing establishments, both in England and the continent, are generally conducted by practical chemists, who are familiar with the modes of testing the purity of the substances which they employ. Such tests, if I do not mistake, they constantly apply in the case of commercial potash, and by them its true value is determined. American potash cannot surely retain its high character, if the consumer finds it to contain one third or one fourth its weight of soda salts.

Another consideration worthy of notice is, that the carbonate of soda, the barilla of commerce, is now extensively manufactured in England and France, and its abundant supply appears destined to exert an important influence, upon the manufacture of potash in this country. The soda-ash, as it is commonly called, is much cheaper and answers equally well for most of the uses to which alkaline substances are applied. Potash, however, will still continue to be preferred in many of the arts and in some indeed it is indispensable. But to retain its value in this respect, it is necessary that it should be of tolerable purity. When it contains a large admixture of salt, it can be of little more value in foreign markets than the soda-ash, and such will soon be its level, if these adulterations become, as all past experience leads us to fear they will, increased in their proportions and extended in their employment.

It is therefore plainly our interest by all means, to prevent the adulteration of our potash and to encourage the adoption of those chemical principles, which should regulate the manufacture. But this desirable result can scarcely be expected, without some improvement in the mode of inspection. I am aware of the tact which the inspectors acquire, by the constant examination of samples of potash and of the accuracy with which they ordinarily judge of their relative purity. But there are cases in which they are liable to be deceived and against which, it is important to guard. Being sensible of the extreme difficulty of introducing new regulations into such an every day business, it is not without some hesitation, that I am induced to offer the following suggestions.

1. There are now, I believe, three sorts of potash recognized by the inspectors; but if my information be correct, the samples passed as "first sort," always contain a considerable proportion of lime, to say nothing of soluble impurities. Another brand designated "pure" or by any other convenient term might, in my opinion, be advantageously introduced. Samples thus branded, should contain no lime or salt, and at least eighty five per cent of carbonated potash.

2. The insoluble impurities may be easily determined, by dissolving a known quantity of potash, as five hundred or one thousand grains, in pure rain water, conducting the operation in a glass flask and applying a gentle heat to facilitate the solution. Then filtering the solution, washing the precipitate if any, and drying it carefully, the per centage of insoluble matter can at once be ascertained. When the proportion exceeds two or three parts in the hundred, it is probably due to the carelessness of the manufacturer, or to the addition of lime to the alkaline liquor during its evaporation.

3. The soluble impurities are more difficult of detection; and it is by no means easy to reduce the process to a single trial. The mode ordinarily prescribed in chemical works, consists in determining the saturating power of the specimen under examination, and very convenient instruments for this purpose are described by Mr. Faraday, and by MM. Descroizilles and Gay Lussac. In these instruments sulphuric acid of known specific gravity, is employed in a fixed quantity and added to a given weight of the sample, (previously dissolved in water, and the solution filtered,) until by a test paper, it is shown, that the alkali is exactly neutralized. The amount of acid required to produce this effect, will if its strength be exactly known, indicate the proportion of pure alkali, contained in the specimen under examination.

It is evident however that this process is insufficient to detect the presence of soda, and when that substance is in large proportion, it is too objectionable to be relied on, for the reason that the saturating powers of potash and soda are very different. For example, fifty parts of soda will saturate as much of any given acid as seventy five parts of potash; so that in practicing with this test, a mixture of twenty five parts of soda and 37.5 parts of potash $=62.5$, would give the same result, as seventy five parts of potash. In this instance then, there would be an error of 12.5 per cent, to say nothing of the difference in the value of soda and potash.

4. If the above remarks are correct, it follows as a consequence, that in all cases where carbonate of soda is mixed with potash, the relative proportions of these alkalies must be determined, before we can fix the real value of the sample under examination.

The only unexceptionable mode of separating potash from soda, is by means of nitro-muriate of platina; but this is an expensive aticle, and its successful employment requires a nicety of manipulation which can be expected only from the experienced chemist. An approximation to a correct decision on this point may be attained by adopting the steps prescribed in D and C, in the preceding formula. By adding to a known quantity of the alkaline solution, an amount of nitric acid sufficient for its neutralization, the sulphates and chlorides may be thrown down, first by the acetate of baryta, and afterwards by the nitrate of silver. If the latter test occasions an abundant precipitate, we may infer that the solution contains an admixture of common salt; for although chloride of potassium is contained in the purest samples of potash, it seldom constitutes more than two or three per cent.

It may also be mentioned that tartaric acid, when added to a portion of the solution, will throw down the potash in the form of a difficultly soluble salt, (the bitartrate of potassa, or cream of tartar,) but the soda will be retained in solution, and may be separated by subsequent evaporation.

Difficult as are these methods of separating the salts of soda and potash, and desirable as it would be to devise a more simple one, if it is really an object to maintain a system of inspection worthy of the name, heavy penalties should be affixed to the use of all adulterants and complete analyses of the various samples in market should be made at short intervals by the inspector, or by some competent person under his direction.

Art. XIV.—*Remarks on the theory of the Resistance of Fluids;* by Eli W. Blake.

TO PROFESSOR SILLIMAN.

Two of your correspondents, whose communications have appeared in recent numbers of the Journal of Science, advocate what they suppose to be different theories in relation to the resistance of fluids. Mr. L. R. Gibbs, (vol. 28, page 135) advocates what he considers a new view of the subject, advanced by Professor Wallace. Professor Keely, (vol. 28, page 318) defends the old theory in opposition to these supposed new views.

Having bestowed some thought on the subject of the resistance of fluids, and having arrived at conclusions differing essentially from those advocated by either of these gentlemen, and of course, from the usually received theory, a hint at these conclusions, and at the process by which I arrive at them, may not be uninteresting to your correspondents, and perhaps to some other of the readers of the Journal of Science. I say a *hint;* because for the want of leisure I shall be able at present to do little more than make a few suggestions.

I must first premise that the present state of knowledge on the subject does not enable us to take into consideration *all* the circumstances which combine to constitute the resistance encountered by a body in moving through a fluid; and therefore the conclusions of theory should not be expected to coincide with the results of experiment, but should be regarded simply as showing what would be the result of experiment, if the circumstances taken into consideration were the only circumstances tending to modify the result. It is not safe therefore to advocate a theory, as one of your correspondents does, (vol. 28, page 137) on the ground that its conclusions coincide more nearly with the results of experiments, than do the conclusions of other theories; for it is evident from the consideration just stated, that the theory whose results differ most widely from the results of experiment, may nevertheless be the true theory.

In order that the views which I have to express may be fully apprehended, it is necessary that I should remark further, that a great source of confusion and error in Mechanical Philosophy, as treated of in books, is an indiscriminate and ambiguous use of the terms, *Power*, *Force*, *Resistance*, and others of corelative import, to signify *several different sorts of quantities;* accompanied by a corresponding vagueness of apprehension in regard to the existence and nature of these differences. Whether the ambiguity of language is the *cause* or the effect of the indistinct notions on the subject, I need not inquire. It is certain that they tend mutually to perpetuate each other; and I have no doubt that collectively, they have done more to retard the progress of Mechanical Philosophy, and to bring it into disrepute among practical men than all other causes united. That there may be no misapprehension in regard to the precise meaning I attach to the language I shall use in speaking of these different quantities, I shall, before I proceed further, point out the differences to which I allude, and the mode in which I shall distinguish them.

Mechanical agency may be contemplated under several different aspects; in each of which respectively, its magnitude is a different species of quantity. My present purpose requires me to notice three of these.

1. It may be considered with reference solely to the simple pressure or effort, exerted at any *point* or *indivisible instant of time.* In this view its magnitude is expressed simply in pounds. This quantity I call *force* or *force* of resistance.

2. It may be considered with reference not only to the *force*, or pressure at any point of time, but also with reference to the distance through which it is exerted, but without reference to the time occupied in moving through that distance. In this view its magnitude is expressed by the product of force and distance. The cost and value of all mechanical effects, and of course the cost and value of all mechanical power are proportional to this product. For this reason I designate the quantity resulting from the product of force and distance, by the name *power.* This product is the true measure of mechanical power in all cases, when contemplated as an agent, producing a *determinate* amount of any of the various ultimate effects aimed at in practical mechanics; for the amount of effect produced will always be proportional to this product in the moving power.

3. Mechanical agency may be contemplated as a quantity depending for its magnitude, not on the total amount of its effects, but on the rapidity with which it produces given amounts of effect; that is, it may be considered not only with reference to the force and distance, but also with reference to the shortness of the time occupied in pass-

ing through that distance. In this viewi ts magnitude is expressed by the product of force and distance divided by time, or which is the same thing, the product of force and velocity. This product of force and velocity is not a measure of power, but of a ratio which power bears to time, or in other words, it is a measure of the rapidity with which power flows out and is brought into action. This quantity, therefore, I call *fluent power.*

I will recapitulate these distinctions.

Force is the pressure in pounds.

Power is the product of force and distance.

Fluent power is the product of force and velocity.

Again.—Force is simple pressure, irrespective of duration or motion.

Power becomes developed as this force moves, in proportion to the distance moved through.

Fluent power is the ratio of this developement to the time in which it takes place.

These are three quantities which are totally different in their nature, and between which it is of the utmost importance clearly to distinguish, in every branch of mechanical philosophy in which they are introduced, and in none more so, than in that which treats of the resistance of fluids.

It may seem incredible to some that distinctions so obvious and simple, and the propriety and even necessity of which is so manifest, can need to be laid down and insisted upon in the nineteenth century, especially in a branch of science which has been cultivated ever since the days of Archimedes. But if any one to whom this sentiment may occur will first clear up his own views in regard to these distinctions, and will then in the light of them examine the books, he will be astonished to find what a medley of confusion and error they contain in every branch of mechanical philosophy to which these distinctions are applicable. Even the treatise by Olinthus Gregory, who perhaps brought as high a degree of mental and mathematical accumen to bear upon the subject, as any who have preceeded or followed him, should not be excepted from this remark.

It was an oversight or misapprehension of these distinctions that embarrassed the views of your two correspondents to whose communications I have already referred, and which has led them to suppose that the different results at which they have arrived, in estimating the perpendicular action of a fluid on a plane oblique to the line of its motion, are at variance with each other. Correctly understood, these results are in perfect accordance not only with each other but with the common theory. They differ, it is true, not however in principle, but only in the *nature* of the quantity deduced ; a difference arising necessarily from the different circumstances taken into the account by each of these gentlemen. Professor Wallace considers the number and effect of the particles acting at any instant, and consequently the quantity which he deduces is the *force* of resistance. Professor Keely and the common theory, consider the effect and number of the particles encountered in a given time, and therefore the quantity which they deduce is the *fluent power* of resistance. Professor Wallace makes the *force* of resistance, estimated in a direction perpendicular to the plane, as the sine of the inclination. Professor Keely and the common theory, make the *fluent power* of resistance, estimated in the same direction, as the *square* of the sine of inclination. Both these results are legitimate deductions from the common theory, and if either of them were true, it would follow of course that the other must be true also. Unfortunately however they are neither of them true. The *force* of resistance is as the square of the sine, and the fluent power of resistance is as the cube of the sine of inclination; as I think I shall satisfactorily prove before I close.

The common theory supposes the resisted body to move in the fluid, to be equally submerged at every velocity, and to be resisted only by the inertia of the fluid. As the objections I have now to make to this theory lie to the argument and not to the hypothesis, I shall take the same hypothesis.

First.—Let the resisted body be a plane of given area, perpendicular to the line of direction in which it moves.

The velocity communicated to the fluid encountered by the plane, is as the velocity of the plane.

When any velocity is communicated to a given quantity of matter, the force into the time of its action, is as the velocity communicated.

The time of the action of the plane on a given quantity of the fluid, is inversely as the plane's velocity.

From these three analogies, which need no illustration, I deduce another viz.

The force at any instant on the plane, is as the square of the velocity of the plane.

Since the area of the plane is given, the number of particles in action at any moment is given, and consequently the force of each, at any instant, is as the square of the velocity of the plane.

We may now note a fundamental error in the received theory, which assumes, usually without argument, that the force of each particle is as the velocity of the plane, instead of the *square* of the velocity, as we have now shown it to be.

Since the *power* of resistance is as the *force* into the distance moved through, the power of resistance that will have been encountered at the end of any distance, will be as the square of the velocity into that distance, or if that distance be given, it will be as the square of the velocity simply.

Since the fluent power of resistance, is as the product of the force into the velocity, it will be as the square of the velocity into the velocity, or as the cube of the velocity.

In order to bring these results together in a concise form, I will recapitulate them.

The force exerted by any particle of the fluid, is as the square of the velocity of the plane.

The force felt by the whole plane at any instant, is as the square of the velocity of the plane.

The power of resistance, or the amount of resistance encountered by the plane, in moving a given distance, is as the square of the velocity of the plane.

The fluent power of resistance, or the amount of resistance encountered in a given time, is as the cube of the velocity of the plane.

Second.—Let the plane be oblique to the line of motion, and let its velocity be given in the direction of that line.

It is manifest that the plane will now strike the fluid with a force corresponding to its velocity, estimated in a direction perpendicular to the plane; and that this velocity will be to that of the plane, as radius to the sine of inclination. But it has been shown already, that the force is as the square of the velocity; therefore the force estimated in a direction perpendicular to the plane, is as the square of the sine of inclination.

The *power* of resistance, being as the product of the force and distance, is as the product of the square of the sine of inclination into distance, estimated in a direction perpendicular to the plane. But this distance, when the distance in the other direction is given, is as the sine of inclination. Therefore the *power* of resistance on the oblique plane estimated in a perpendicular direction, is as the cube of the sine of inclination.

The fluent power of resistance, will also be as the cube of the sine of inclination, for it will be as the product of force and velocity, and the force is as the *square* of the sine, and the velocity estimated in a direction perpendicular to the plane, will be as the sine and consequently their product will be as the cube of the sine.

I have now shown, if I mistake not, that the perpendicular *force* on the oblique plane is *not* as the sine of the inclination, as found by Prof. Wallace, and that the perpendicular *fluent* power of resistance is not as the square of the sine, as found by Prof. Keely and the commonly received theory, but that the former is as the square, and the latter as the cube of the sine.

It may be proper to remark here, that the common theory in proceeding to the determination of the above result, assumes that the perpendicular force of each particle, is as the sine of inclination. Sometimes this is given without illustration, as a self-evident step in the argument; at others it is said to flow from the resolution of forces. The propriety of referring to the doctrine of the resolution of forces in this case, is not seen. There is no force until the particle acts, and when it acts, the force is perpendicular to the plane, and therefore can require no resolution to bring it into that direction. But there is a *velocity* which may be resolved, and from this resolved velocity, the force may be deduced; and this is the course I have pursued. The course of the common theory, however, at this point, though illogical, would involve no error, if it were true as assumed by that theory, that the force of a particle in any direction is as its velocity in that direction; for we should in that case arrive at the same result, whether we resolved a velocity and deduced a force from it, or resolved some imaginary force that is assumed to be proportional to the velocity. But when we consider the force to be as the *square* of the velocity, as I have shown it to be, the mode pursued by the common theory tends to serious error.

Third.—Retaining the same hypothesis, the next step is to determine the value of these several resistances, estimated in the direction of the plane's motion. Prof. Keely pursues the subject in opposition to the views of Prof. Wallace, only to this point. Yet, this is the very point at which Prof. W. first begins to diverge from the theory which Prof. K. defends.

Both Prof. W., and the common theory, in order to obtain the value of the results found by them respectively, in the preceeding step, when estimated in the direction of the plane's motion, *resolve* them after the usual manner of resolving forces. This course on the part of Prof. Wallace is correct; for the quantity he had deduced, being a *force*, may be resolved; but on the part of the common theory this course is fallacious, for the quantity it had deduced was the *fluent power* of resistance, a complex quantity, resulting from the product of two unlike factors. Such a quantity cannot be resolved after the usual manner of resolving forces. It must first be separated into its original elements or factors, and the value of these must be estimated separately in the new direction, and not collectively. It is a curious fact that the error in the common theory at this point, exactly balances the fundamental error before pointed out, and in this way makes the ensuing result correct. Whereas Prof. Wallace, on the other hand, by the greater purity of his logic, avoids the second error, and leaves the first in full force to destroy the truth of the result he deduces. But let us proceed with the investigation.

We found under the last head, that the force of resistance, in a direction perpendicular to the plane, is as the square of the sine of inclination. This force resolved, gives the force in the direction of the plane's motion, as the cube of the sine of inclination.

We found under the last head, also, the power of resistance perpendicular to the plane, to be as the cube of the sine of inclination; being the product of two factors, viz. of *force*, which is as the square of the sine, and distance, which is as the sine. Estimating the value of these two factors in the new direction separately, the *force* becomes as before, as the cube of the sine, and the distance becomes a quantity which is given by the hypothesis. Consequently, the *power* of resistance encountered by the plane in the direction of its motion, in moving a given distance, is as the cube of the sine of inclination. The same reasoning precisely, mutatis mutandis, applies to the *fluent* power of resistance, and, therefore, the fluent power of resistance, or the resistance encountered by the plane in a given time, in the direction of its motion, is as the cube of the sine of inclination. It has been shown, therefore, that the force, power, and fluent power of resistance on the plane in the direction of its motion, are each respectively, as the cube of the sine of inclination. Prof. Wallace makes the first of these, as the square of the sine. The common theory, by the fortunate coincidence of two errors, makes the last in the same ratio as I have found, viz., as the cube of the sine.

It is worthy of remark, that it appears from the results just deduced, that although the *force* of resistance in the direction of the plane's motion, is less than that perpendicular to it, in the ratio of the sine of inclination, yet the *power* and *fluent power* of resistance are not only relatively, but actually the same in both directions. I may add further, that this is a universal law of oblique action, and is in perfect accordance with the views expressed by me, in a communication to this Journal, Vol. xii, p. 338, in which among other things, I endeavored to show that there is no loss of power in machinery, in consequence of oblique action, unless it gives rise to an increase of friction, or other resistances of an adventitious nature.

Fourth.—We have hitherto, in speaking of the oblique plane, supposed its velocity to be given, and its obliquity to vary. Let us now suppose the obliquity to be given, and the velocity to vary.

We have already seen that the *force* and velocity respectively, perpendicular to the plane, are as the force and velocity respectively, in the direction of its motion. We have also seen that the *force* perpendicular to the plane, is as the square of the velocity in that direction. Therefore the *force* is as the square of the velocity, when both are estimated in the direction in which the plane moves. In the same manner it might be shown that the power of resistance in this case, is as the square of the velocity, and that the fluent power, is as the cube of the velocity. It will be seen that these results correspond to those deduced under the first head—which they should do; for that is a case in which the inclination is given, viz., ninety degrees.

When both the obliquity and velocity vary, the resistances are expressed, by combining the results found under the third and fourth heads, viz.—

Force of resistance is as square of velocity into the cube of the sine.

Power of resistance is as square of velocity into cube of the sine.

Fluent power of resistance is as *cube* of velocity into cube of the sine.

The common theory makes the fluent power of resistance as the *square* of the velocity into the cube of the sine; showing that though by better luck than logic it deduced one correct result in a preceding step, yet when in succeeding steps it comes to combine that result with others before deduced, the first error becomes again involved and destroys the truth of the result.

In applying these results to a boat or other vessel, the plane we have been contemplating may be considered a unit or given portion of the area of the prow; and consequently the several resistances will be expressed by the results already found, multiplied respectively by a quantity denoting the whole of that area. If however all parts of that area be not equally inclined to the line of motion, the *mean* cube of the sine of inclination must be taken.

If the breadth of beam and depth of immersion be given, and the form of the prow be that of an isosceles wedge, as was the case in the experiments tried by M. Bossut at Paris, then the area of the prow will be as the cosecant of the inclination, and the expressions for the resistances will be as follows :—

Force of resistance will be as the product of square of the velocity, cube of the sine and cosecant of the inclination.

Power of resistance will be in the same ratio.

Fluent power of resistance will be as the product of the cube of the velocity, cube of the sine and cosecant of the inclination.

Since the sine of any angle is inversely as its cosecant, the product of the cube of the sine by the cosecant of inclination is equal to the square of the sine; and therefore the square of the sine may be substituted for that product in each of these expressions.

If the breadth of beam and depth of immersion be not given, the area acted upon by the fluid will vary with each of these respectively, other circumstances being given. Hence, when all the circumstances vary, except that the prow retains the form of the isosceles wedge, the expression for the force of resistance, and also for the power of resistance, will be,—the product of breadth of beam, depth of immersion, square of the velocity and square of the sine; and for the fluent power of resistance, the product of breadth of beam, depth of immersion, cube of the velocity, and square of the sine.

These results, as I have already intimated at the commencement of this paper, do not involve the whole resistance experienced by a body in moving through a fluid, but only so much of it as arises from the inertia of the fluid encountered. And therefore, since there are other important sources of resistance, not taken into the account, these results must not be regarded as being, in themselves considered, of any practical value. A true and complete theory of the resistance of fluids, is a great desideratum in mechanics, and I am not without hope that such a theory will yet be developed. The views which I have given, if correct, are valuable as auxiliary to the attainment of that object; for if it is ever attained, it will doubtless be done by a correct mathematical appreciation of each of the several sources of resistance separately.

In the foregoing remarks, I have endeavored to give a prominence to the distinctions I have made, between the different aspects in which mechanical agency may be contemplated, corresponding to my views of their importance. That the quantities between which I have endeavored to distinguish, are different, is no new discovery. Their difference has always been recognized, whenever it has been adverted to. It has, however, been so little adverted to, at least in treatises of mechanics, that it is scarcely too much to say, that it has been wholly overlooked. Nothing is more common, not only in loose conversation and writing, but even in the books which profess to *teach* on this subject, than to find these several quantities spoken of under one and the same name, without any discrimination at all, and evidently without any apprehension of their difference. It is to this circumstance, as I have already suggested, that I chiefly attribute the well known fact that, in reference to the application and use of mechanical power, theory and practice have hitherto wooed each other almost in vain. Whenever a good treatise of mechanics shall be given to the public, in which these distinctions are laid down *in limine* as fundamental, and carried out through all branches of the subject, as I have endeavored to carry them out here, that moment, in my view, theory and practice on this subject, will be wedded, and a new era in their history will commence.

Art. XV.—*A Letter on Otaheite;* addressed to B. L. Oliver, Esq. of Boston, and by him translated.

Communicated for insertion in this Journal.

TO B. L. OLIVER, ESQ.

Sir,—Agreeably to your request, I proceed to give you a short account of the traditions among the native inhabitants of the Islands in the Pacific Ocean, relative to their religion and their ancient condition. The traditions, I have collected during a residence at Otaheite of six or seven years, within which time, I have also visited many of the other Islands of this great Ocean. These observations constitute a part of a manuscript, which I have prepared, and which I design to publish on my arrival in Europe.

What I have already communicated and shewn to you in the course of a conversation, which I have had with you on the subject of these traditions, must I think satisfy you, that these singular ancient monuments of a people, formerly very numerous, separated and dispersed among Islands a thousand miles from the rest of the world—of a people, of whom little is correctly known, must be a subject of general interest, to all well informed persons, but that they are especially deserving the attention of the literary and scientific; since they cannot fail to throw some light upon the origin and the ancient state of a people, who, although they have furnished a subject, for unwearied discussion for a considerable time, still present an enigma, which has never yet received a satisfactory solution. For, all the researches, which have heretofore taken place, have produced nothing more than superficial and unsatisfactory speculations, which, a mere knowledge of their language, or an acquaintance with their habits and customs, is sufficient to prove unfounded; but which, a consideration of their means of communication and transportation from place to place, with a knowledge, of the prevailing winds and the current of the sea refute incontestably.

If it is a great mistake as to the origin of these Islanders, to suppose them to pass from one extremity of the earth to the other, against winds and currents, and for this purpose, using means of transportation over a vast ocean, of which the authors, who use such magic pens, would hesitate to avail themselves in order to pass the Seine or the Thames, and there is a still greater one as to the ancient condition of this people, as respects their advances towards knowledge and civilization.

You know, Sir, when we use the expressions "savages," "persons in a state of nature," &c. the ideas attached to such expressions, are, that the people of whom we are speaking, are mere barbarians, have never been civilized, or in any other state, than they now are, but are nearly the same, as when they first received existence. Among the people, supposed to belong to this class, the inhabitants of these Islands are usually ranked; and certainly if anthropophagy, infanticide, human sacrifices, and some other barbarous and cruel practices, constitute the primitive state of man, these Islanders make the nearest approach to what is called the state of nature.

These vain speculations however, which are created and sustained by nothing but the difficulty of raising the veil of the past, are immediately refuted, with regard to the inhabitants of the South Sea Islands, by the remarkable traditions, which are still preserved among them, some passages, from which I have transcribed for your perusal. These passages, I have taken from the article, on the subject of their religion, contained in the work alluded to, before. The article itself begins thus :

" Who could have believed, that among nations so barbarous, as those that inhabit the Islands in the South Sea, there should be discovered, the ancient doctrines *that there is only one God; that he is the soul of the Universe; that it is he, that imparts life and intelligence to every thing that lives and has nnderstanding; that he is, at the same time, both cause and effect; that he is both active and passive; both substance, and what animates substance;* in a word, *that he alone, is all, and in all; both creation, and the creator; the great mover of life, as well as motion and action.* But let us hear how the traditions remaining among them speak on these subjects. The translations of them, which I have subjoined to the traditions in their original language, which is here expressed in letters agreeably to English orthography, contain as near an approximation, as I could make to their meaning, as understood by the natives themselves.

" Pah–rah–hee, Tah–ah–ro–ah, tee–ee–o–ah. Ro–to, eah
There was an immense being, so he was called. He sustained
te ah–e–ne. Ah–ee–tah fanuah ; ah–ee–tah rah–ee ;
himself in immmensity. There was no earth ; there was no heaven ;
ah–ee–tah tah–ee ; ah–ee–tah, tah–ah–tah ; Tee–ah–o–rah
there was no sea ; there was no man ; The Supreme being or
Tah–ah–ro–ah ; ee nee–ah ; Fah–ah–ree–ro,
Tah–ah–ro–ah called ; but there was no answer ; Being alone in
no–ah, ee–ho–rah, o–ee–ah ee te ho e nah–ree–ah i.
existence, he transformed himself into the universe."

In some of the other Islands, there is this variation. " He called to the east, but there was no answer ; he called to the north, but there was no answer ; he called to the west, but there was no answer ; he called to the south, but there was no answer ; then being alone in existence he transformed himself into the universe."

This is an extract from their traditions in relation to the creation of the world. I would gladly give you the whole of it, but my limits will not permit. You see how noble they are in expression, in this simple, yet harmonious language; how magnificent in their thoughts and images; yet, I can assure you, I find a difficulty in transfusing their full force into my translation.

Having in this manner, described this great being and his attributes, they pass to the instant when he is in the act of forming, or arranging the universe, and uniting together the elements of which it is formed; which, it should be observed, agreeably to their opinions, constituted part of himself, and that he organized and arranged them, but being part of himself, they were self-existent, and not created. The passage is as follows, Tah-hah-ro-ah speaks or calls.

" Ye pivots; (*axes of orbits, centres of circles, supports or props*) Ye stones; (*or rocks, or foundations*) Ye sands; (*or elements, or atoms!*)

(*They answer instantaneously.*) Here we are. (He speaks, or calls again.) Ye that are to form this new world, draw nigh." Then he pressed them together, (*as if with his hands;*) then he pressed them together again with greater force, but they would not adhere, (*or coalesce.*) Then with his right hand, (*as if with immense power*) he cast forth (*or spread abroad*) the seven heavens, to form the first basis, (*foundation or firmament,*) and light was created. There was no longer any darkness; every thing became visible; and the interior of the universe became illuminated. Tah-hah-ro-ah stopped (*or rested,*) gazing, rapt in delight (*or, well pleased*) with the sight of this vast interior. Immobility exists no longer. The office of messengers, now ceases. The office of the speakers is performed. The axes (*or pivots of the orbits*) are fixed, or supported; the seats (*or beds*) of the rocks (*or foundations*) are laid; the sands (*earth, or atoms*) are *placed.* The heavenly constellations revolve; the heavens are elevated; the sea is in its depths; the creation of the universe is finished."

In an article in my intended publication, in which I treat of the antiquity of this people, I have made the following remarks in relation to the preceding extracts from their traditions.

" However obscure one or two phrases, or expressions, used in the above passages, may be, the reader will readily perceive, that they are not the language of a mere savage, dancing on the bank of a river, or brandishing his arms in defiance of his enemies. On the contrary, it is the language of a Zoroaster—of a Pythagoras—of a recluse philosopher, who has long been engaged in contemplating the wonders that surround him; that discerns in every thing about him, the hand of a divine being; this language contains the thoughts of one who has an enlightened understanding, has been taught the sublimest of all religions, and has been instructed in the duties of gratitude and adoration to one omnipotent being."

But besides those extracts from their traditions, which together with the elevated idea of a single first divinity, do not recognize either in their cosmogony, or in their description of their angels or messengers, the doctrine of sabeism, or the worship of the stars, a doctrine spreading almost every where, and found among the religious principles of almost every heathen people on earth; their names of "Angels of day;" "Angels of night," the former, the guardians of the earth, the latter, the guardians of the sea; the union of their divinitities with the different elements; their just notions respecting the effects produced by the elements; their opinions of the moon and of the earth, lead to the same reflection.

In addition to these considerations, a singular fragment of their ancient astronomy, which I have in my possession, and in which like the Egyptians, they make the stars travel in vessels; in which they call the stars, Castor and Pollux, "THE TWINS;" in which Sagittarius has two faces, as in the monument of Dendera, and in their language, is spoken of as "THE RED DOUBLE FACED STAR, THAT SHINES IN THE EVENING;" furnishes a strong confirmation; since a coincidence so remarkable, seems to indicate some common source or origin.

There are also other passages, which plainly indicate that the ancestors of this people had made advances in knowldge, of which the present inhabitants have preserved traces in their striking, although imperfect traditions, without knowing what they mean.

These inhabitants, however, like many other races of men, have corrupted their first and more just religious opinions, by the superstitions of Sabeism, and the personification of the operations and forces of nature; and it is probable, that, at a period of time anterior to their dispersion among these Islands, they adopted, embodied and converted into idols, those symbolical and allegorical beings, and as a natural consequence, soon came to consider their natural operations and motions, as the effects of volition and power.

On the supposition, however, that these traditions were wholly uncertain in their meaning and tendency, yet we could not fail to discover in them, thoughts and reflections, which, far from being the creation of minds wholly savage and uncultivated, must necessarily be considered as the result of profound reasoning, and of a philosophy, the existence of which, it is impossible to suppose, except among people in a high state of mental cultivation. Of this, any one may easily satisfy himself, not only by their system of creation, but by all the ideas, on these subjects, which are contained in their traditions, and, which, however, imperfectly comprehended by the present inhabitants, must have been as intelligible to their predecessors, as they seem clearly expressed and easily understood by us. Their description or account of Tah-ah-ro-ah, or the infinite being, may be adduced as a striking example. Is it not the most sublime, that the human mind can conceive? "*An uncreated being, self-existent, the supreme intelligence,*" the source of existence, of animation to the universe. The Sovereign Lord of nature; from whom all substance, all being, is derived; to whom the hierarchy of heaven, owe their existence; in the presence of whom, agreeably to their view, the most powerful of the other Gods, and those whom they most dread, reign only by his permission in the different parts of the universe; and although in some measure, partaking of his divine nature, and associated to a certain extent in his power, are merely subalterns, intermediate divinities, with limited authority; whom he created, and whom he can in like manner, annihilate.

What I have said, can only serve to give you a very imperfect idea of the interesting nature of the matters, which are the subject of the single article referred to. But, as my letter is growing long, I will merely remark, that according to their traditions, Tah-ah-ro-ah, who existed alone in a state of rest in Chaos, is all that came afterwards to constitute the universe; and that light, motion, the heavens, in short, every thing that exists, consists in him alone, and that the universe, the whole creation, is nothing more than the developement of his immensity. In their own language, "the great, the holy creation, is nothing but the envelope (*or shell*) of Tah-ah-ro-ah. It is he that moves it, and causes its harmony; or causes its harmonious movements."

I am sorry, that I cannot furnish you with more adequate conception of these matters, nor give you more full information of a system of religion, which is sublime and astonishing, nor have room for further extracts from the traditions, which I have discovered in relation to it, and which contain a complete view of it.

To show you, however, the gradual and surprising connection, which exists throughout of the whole of it, and which descends in gradual progression from the contemplation of the most sublime objects, even to the most minute details, and which inculcates the belief that a man cannot take even a single step, without meeting his God, and the angels, or some other divinities in his walk, it must suffice to remark, that, in this religion, which refers every thing to the action of divine power, not only the whole world is animated by the divine presence, and with guardian spirits, which watch over man and keep him on his guard; but, every action, every circumstance, even to the most minute action in life, is submitted to their superintendence, and is done under their auspices. As I cannot here descend to minute particulars, I will conclude with a last short extract from my manuscript, which will serve to confirm what I have mentioned above.

"But besides these Gods, which are the inhabitants of the higher regions, and are the invisible overseers of all creatures, as well as of all the productions of the earth, they have an infinite number of inferior divinities, which dwell in the waters, in the forests, in the mountains, precipices and caverns. They have their Dryads, and their Naiads, and in fine, there is not another people on earth, whose glowing imaginations, have created such an immense number of invisible and superior beings. In the enchanting scenery, and under the fervid climate of these Islands, all nature, thus animated with divinities and *intelligences*, gives a force and ardor to their religious worship, and a *reality* to the objects of it, of which, it is difficult for others to conceive. In these Islands, a native does not find himself alone, in the thickets, and among the rocks; echo is a god, that answers, when he calls; *the thunders*, are the voice of Oro, in his anger; *the lightnings*, are the glances of his eyes. The winds, that howl and roar; the earth that quakes and trembles; the sea that swells and rolls, are Ru or Mahui, provoked to anger; even the hollow tree, and the whispering reeds have their divinities present with them, who see them and keep watch over them, for the purpose of punishment, or protection.

I remain, Sir, &c.

P. S. At your request, I subjoin the title of my work, with the contents of the different chapters.

View of Otaheite, containing a description of the Polynesia Islands, an account of their Natural History and inhabitants, and researches into their origin and antiquity. By J. A. Maerenhant.

CONTENTS OF THE CHAPTERS.

ART. XVI.—*Notice of some American Birds*; by CHARLES FOX, of Durham, England.

Communicated for insertion in this Journal.

SCOLOPAX PYGMÆA, (*Linn.*)? Length eight and a half inches; bill one and a half inches, black, arched, grooved; wrinkled at the base, (as in *Scolopax Noveboracensis*,) nostrils, linear; plumage, thick, compact; general color, chesnut red; front, reddish grey; crown and hind head black, thickly mottled with chesnut and a little grey; neck, deeper chesnut, slightly spotted with black; back, regularly mottled with black, chesnut and ash, each feather being black and bordered with one of these colors; primaries, clove brown, quills white, for one half from the tips, the other half the color of the feathers; secondaries and coverts tipped with white, the former, white on the inner vane; rump same as the wings; upper tail coverts white barred with dark brown; tail light ash, the interior vane of each feather, white near the quill end, and some of the feathers bordered with the same to the tip; entire lower parts deep ferruginous; chin much mottled with yellowish white; breast slightly marked with short streaks of black, thicker on the sides; belly mottled with dirty white; vent dirty white; under tail, coverts the same, stained with ferruginous and barred with black; round the eye runs a narrow line of white, legs black.

This bird does not appear to have been before described as found in America; it was killed on Long Island salt marshes May 27th, 1835, by a snipe shooter, and brought to Fulton Market in this city, where it was procured. No information could be obtained about it: it was a male specimen, and in fine plumage.

PHALAROPUS HYPERBOREA, (*Wils.*) Male. This bird agrees in all respects with Mr. Ord's description in Wilson's Am. Orn.; the stomach contained small worms and fish fry; it was procured May 22, 1835, in the same place, and under the same circumstances as the last.

CORVUS CANADENSIS, (*Linn.*) Wilson has described the female of this bird from a specimen he killed in winter, and supposes they do not remain in the United States during the summer; I had the pleasure of meeting with them near Dennison's, on the White mountains, N. H., June 24, and of finding the plumage of the female at this season, differ entirely from its winter colors. Here they were evidently breeding, although I was unable to find their nests. They were visible only for about two hours in the morning, from 6 to 8 o'clock, after which, they retired into the thickest woods and remained quiet. They were most frequent around the edges of the woods, and in partially cleared spots; the male and female flew together, and were always near each other, when on the trees or the ground. The male was restless, noisy, and garrulous, its note like *chack*, *chack*, *chack*, frequently and quickly repeated in different keys; it was sometimes on the ground, sometimes climbing up the long grass—but generally on low trees; the female was silent and more quiet; they were tame, and allowed me to approach near them; and flew only a short distance on being disturbed, their habits seemed a mixture of those of the crow and the jay families—not so grave as the one, nor so brisk and amusing as the other, and their plumage is a link between the dark colors of the former, and the brilliancy of the latter. On dissection, their stomachs were found to be very full of large green beetles; the only insect they had fed on, and there was no appearance of either "moss, worms, or flesh." The male agreed exactly with Wilson's description, the female has the following plumage. Length eleven inches, plumage soft, blended, dull; feathers shaftless, and unwebbed on the back; entire color deep leaden grey, deepening into dull black on the head and wings, and into blue on the tail, the latter tipped with dirty white; interior of the wings brown and glossy; exterior vane of the primaries edged with dull white; secondaries tipped with the same; plumage of the head loose and slightly crested; vent dirty white; bill deep horn color, the upper mandible tinged with grey at the base; a broad line of light grey runs along the edge of it; the quills of the wings and tail deep black; in other respects, it resembles the male, except that her plumage was not so thick, a common circumstance at this season, and that her shape was not so broad, but more delicately formed. The skin was much thicker than that of the male, and of a peculiar appearance, like parchment; her eggs were large, and one was ready for laying. This was without doubt, therefore, an adult. Wilson says, on the authority of Hearne, that they build early in the spring at Hudson's Bay; here they are either much later, or have two broods in the year.

Emberiza Pecoris, (*Wils.*) Both Wilson and Audubon agree in stating, that the eggs of the bird, in whose nest the cow bunting lays, are never matured; but are removed when the young bunting is hatched. The writer has lately found an instance of the contrary; which, although it proves that the removal of the eggs, is not invariable, may yet be explained without affecting the existing theories on this subject. Supposing, as Audubon does, that the egg of the cow bunting, requires a shorter period to hatch it, than the eggs of the bird in whose nest it is, yet if the original eggs had been sat on for some days before the other was laid, they might both be hatched at the same time, and the parent birds would in such a case, take equal care of the whole brood.

On the 16th of June, I found near the lower village of Ticonderoga, a nest of the chipping sparrow, (*Fringilla socialis, Wils.*) on a stunted cedar, about four feet from the ground; it contained four birds, three were sparrows, the other was a bunting. They were probably not more than three or four days old, were still blind, and nearly destitute of down. The bunting took up about as much of the nest, and was nearly twice as long as the other three; its belly was larger, extended much farther back, and protruded considerably, the only down on it was of a deep grey and running along the back, it was mute and sullen, the others were clamorous and apparently in want of food. On my hiding myself, the old birds fed them with worms, and as nearly as I could observe, they attended to all alike. As I procured the old birds, there could be no mistake as to the nest.

Memorandum of Birds and Animals in Fulton Market, N. York.

January.

1. Sciurus vulpinus.
2. Lepus Americanus.
3. " variabilis.
4. Mustela erminea.
5. Common wild Deer.
6. Emberiza Americana.
7. Turdus migratorius.
8. Alauda Alpestris.
9. Meleagris Galopavo, wild.
10. Columba Carolinensis, great variety of Ducks and sea-birds.

February.

11. Sciurus niger.
12. Red squirrel.

No. 1. A very few Ducks and sea-birds.

March.

13. Corvus cristatus.

Nos. 2, 8, 10, 6.

14. Strix nyctea. Ducks plentiful.
15. Scolopax gallinago.
16. Sturnus prædatorius.
17. Emberiza Pecoris.
18. Turdus migratorius.

No. 1.

April.

19. Fringilla tristis.
20. Rallus Carolinianus.

No. 14.
21. Perdix Virginiana.
22. Scolopax vociferus.
23. Tringa cinctus.
24. Columba migratoria.
25. Ardea Herodius, young.
26. Scolopax flavipes.
No. 10.
27. Alcedo Alcyon.
Ducks, &c. very scarce.

May.

28. Muscicapa Tyrannus.
29. Turdus Rufus.
30. Emberiza.
Nos. 26 and 23.
31. Scolopax grisea.
32. Tringa Alpina.
33. Rallus crepitans.
34. Tringa semipalmata.
35. Columbus glacialis.
36. Tringa pusilla.
37. " macularia.
38. " interpres.
39. " rufa. No. 25, old.
40. Tringa hiatecula.
41. Anus sponsa.
42. Scolopax Hudsonius.
43. Emberiza erythrophthalma.
44. Phalaropus hyperboreus.
45. Charadrius Apricarius.
46. " pluvialis.
47. Scolopax pygmæa.

In the fall, more are brought to market, than the spring. The above list is without doubt incomplete, as for many days at a time I have not been able to visit the market.

New York, July 27, 1835.

Art. XVII.—*Meteorological Notices in Indiana*; by D. Dale Owen.

Communicated for this Journal, by the author.

To the Editor.—*Sir,*—In perusing some of the last numbers of your Journal, I met with several very interesting meteorological tables, kept in various parts of this continent, and encouragement given to communicate similar observations. Since February, 1828, I have been in the habit of taking observations three times in the day, on the state of the thermometer, barometer, winds, clouds, and latterly, on the hygrometer, (with Daniell's new instrument.) I regret that they are not complete, up to this period, as I was absent several years in Europe; they were also interrupted last summer and winter, because I was then, too unwell to attend to it. Since the 1st of last January, they have been kept regularly.

The times of observation were in the morning soon after sunrise, at noon about 1 o'clock, and in the evening about sunset.

The thermometer which has been used latterly, is one of Pastorelli's spirit thermometers, which registers the lowest temperature. (Unfortunately the registering day thermometer was broken in bringing it to this country.) The barometer is one which was purchased in Liverpool in 1827, calculated for measuring heights. That it is quite accurate, I am not prepared to say: during my absence in Europe, it fell and the glass tube was broken; since my return, I have replaced it, taking care to purify the mercury and boil it in the tube. But, as it is the first barometer I ever attempted to construct, I fear it may not be quite free from air; indeed, in comparing my barometrical observations with those of Mr. Redfield, I must believe, that mine are too low, or else, there must be a remarkable difference between the indications of the instrument, here and in New York. However, such as they are, I shall give them; they will serve, at all events to show the range, and you can make use of them, or not as you please:

Barometer, New Harmony. Latitude 38° 11′ N., Longitude 87° 55′ W. From the 1st of February, 1828, to the 1st of February, 1829.

Months.	Mean.	Maximum.	Minimum.	Range.
February,	29.574	30.075	29.050	1.025
March,	29.583	29.886	29.150	0.736
April,	29.547	29.912	29.030	0.882
May,	29.547	29.830	29.360	0.470
June,	29.538	29.660	29.290	0.370
July,	29.604	29.780	29.450	0.330
August,	29.638	29.800	29.450	0.350
September,	29.688	29.890	29.490	0.500
October,	29.697	29.950	29.400	0.550
November,	29.555	29.990	29.140	0.850
December,	29.746	30.100	29.270	0.830
January,	29.611	30.150	29.200	0.850

Mean for the year, ... 29.609
Maximum for the year, . . . 30.150
Minimum for the year, . . . 29.030
Range during the year, . . . 1.120

Thermometer for the same year, viz. 1828.

Months.	Mean.	Maximum.	Minimum.	Range.	Days of rain, &c.
January,	40.2	64	12	52	9
February,	41.9	68	12	54	8
March,	51.6	82	20	62	5
April,	55.2	86	28	58	7
May,	68.1	91	42	49	9
June,	78.5	96	55	41	8
July,	77.6	92	53	39	4
August,	76.7	90	63	27	6
September,	62.	84	42	42	3
October,	55.3	79	27	52	2
November,	44.5	64	26	38	4
December,	40.4	63	16	47	3

Mean temperature of the year, . . 57.7
The lowest, (January) . . . . 12.
The highest, (June) 96
Range for the year, ... 84
Greatest range during a single month, (March) 58
The least, (August) 27
The number of days, during which any snow or rain fell, (about 1 in 5⅓) . . . 68

The most prevalent wind in January, 1828, was W.; in February, W.; in March, S. W.; in April, N. W.; in May, S. W.; in June, S. W.; in July, S. W.; in August, N. W.; in September, N. W.; in October, N. W.; in November, N. W.; in December, N. W.

Almost invariably, the barometer is the highest here, when the wind blows from the N. W., and lowest when it blows from the S. E. As a general rule it rises when the wind blows from the N. W.—N.—N. E., and falls when it blows from the S. E.—E.—S.

The N. W. wind generally brings clear, dry weather, and the atmosphere is then *highly* charged with electricity, (particularly in the months of November, December, and January.) The S. W. wind in summer, generally brings the thunder storms. The S. E. wind brings the rains of longest duration. The E. and N. E. winds bring the snow storms.

One of the most remarkable meteorological phenomena in this country, is the wonderful electrical state of the atmosphere, and all non-conducting bodies during the autumn and first winter months, when the wind blows from the north west. I have observed, at such times, the hairs of the horses tails so charged, that whole bunches would adhere with considerable force to the horses flanks, or, at other times, the individual hairs, repelled by their neighbors, would stand several inches apart. Distinct shocks, may then be obtained in the fingers, by rubbing the back of a cat with one hand, and holding the point of its tail firmly with the other. One day, last winter, I observed a silk apron attracted by the table so strongly, and at such a distance from it as to enable the wearer to keep it suspended in the air, at a full right angle. When silk or flannel, is removed rapidly from the body in the dark, it will exhibit for the moment, one luminous electric sheet, and a distinct crackling noise may be heard. Besides these facts, many very interesting electrical phenomena may be observed.

Should this prove interesting, I should take pleasure in furnishing regularly meteorological observations. If I do, I shall take every pains to procure instruments of unquestionable accuracy.

New Harmony, Indiana, May 28th, 1835.

Art. XVIII.—Chronometers. Communicated for insertion in this Journal, in a letter to the Editor, dated London, Sept. 8, 1835.

4, Change Alley, May 15, 1834.

TO CAPT. SIR JOHN ROSS, R. N., &c. &c. &c.

Sir—In compliance with your desire to be furnished with a report of the condition of the two chronometers of our make, which you took with you in your late expedition to the Arctic Regions, we have examined them with the most careful and minute attention, and find them in an excellent state: indeed, very far more perfect than could have been expected, after such a length of time, and the severe trials which they must have undergone.

With regard to their peculiar construction, which you at the same time requested us to describe, as you were desirous of publishing it for the benefit of science and navigation generally, we have no hesitation in complying with your wishes; and we do so the more readily, in the hope that our communication may prove useful.

The *peculiar principle* which we have discovered is of the highest importance in giving the final adjustment to chronometers, as by it we are enabled, *in all cases*, to give permanence to their rates, within the limits of exactness requisite in navigation.

We beg, in the first place, to disclaim all intention of insinuating that in the mechanical construction of our instruments there is any thing superior to, or materially different from, those made by other respectable makers; for we are well aware, that all chronometers lately made by intelligent artists, are on the same mechanical principle. But the fact is notorious, that of several instruments made with equal care, reference being had only to their mechanical construction, some are found to perform well, and others indifferently; while nothing can be discovered in the workmanship which will in any way account for the variation.

Chronometers in general, as at present constructed, are found progressively to accelerate on their rates, and in many instances this takes place to such an extent, that a new rate is required, rendering them ill suited for long voyages; on the contrary, some few have a continual disposition to lose on their rates, and are therefore equally unsuited to the wants of the seaman.

But whether the rates of chronometers were accelerated or retarded in use, there existed no *recognised* or *known* remedy for the evil, UNTIL WE MADE THE DISCOVERY, which it is one object of this communication to record our claim to. Some artists have trusted to *time* for its correction; and a writer in a scientific journal, (Nautical Magazine) has recently even assigned the period when the cure might be expected to be completed: but *time* being no party to the bargain, generally left the instruments thus turned over to its benevolence to pursue their vagaries without interference.

Tempered balance-springs have been in use for more than half a century, and forty years ago they were made by ourselves. If time, therefore, could have cured the defects of the tempered balance-spring, these old chronometers would now have been excellent instruments, which certainly they are not in general found to be.

The consequence has been, that the rates of most of the chronometers at this moment in existence, can be considered constant only for short intervals of time. Many years have elapsed since our attention was drawn to this peculiarity, from several mortifying circumstances which occurred in our own experience; and after satisfying ourselves that it was in vain to look for the cause of so perplexing a phenomenon in the *mechanical construction* of the instrument, we resolved to examine the *physical condition* of the materials of which the balance and its spring are made: and we discovered that the greater part if not the whole of the discrepances, were owing to circumstances in this *physical condition.*

After many experiments and much investigation, we had the good fortune to discover the means of correcting this physical peculiarity, either completely, or so nearly, that we can now undertake (after ascertaining the tendency) to alter its physical properties, and to make ANY chronometer, whose mechanical construction is otherwise satisfactory, perform with sufficient exactness for every purpose for which chronometers are generally required.

The acceleration of chronometers on their rates is produced by the constant action of winding and unwinding the balance-spring, which takes place two hundred and forty times in each minute, and it is thereby deprived of a portion of its elasticity. It becomes consequently stiffer, stronger, and more stubborn; and as the motions of the balance (the measure of time) are regulated by this spring, the vibrations become more rapid, and are performed in less time.

The cause of chronometers losing on their rates, is generally to be traced to the physical defect of the balance and spring; which, contrary to what takes place in tempered spring, becomes relaxed by constant action, combined with other causes, and consequently has less power over the vibrations of the balance. But independently of all accidental circumstances, the chronometer is continually changing its rate, with every alteration of tension in the balance-spring.

The scientific artist may, indeed, give to this spring the isochronal property, so far that under given and constant circumstances, unequal arcs of vibration in the balance, will be performed in equal time; but this adjustment will in no degree counteract the effect occasioned by change of tension to which we have been adverting.

We do not allude in the preceding remarks to defective compensation for change of temperature, but to that gradual deviation from the rate which many chronometers are found to exhibit, and to an extent that often inteferes with their usefulness.

It is true that all chronometer makers do occasionally produce instruments, which, for a sufficient length of time, keep steady rates; but they do so only from accidental circumstances, of which the makers themselves are not always aware. They approximate to the correction which we have discovered the means of making *in all cases.*

In our researches on this subject, we have found that the defect in the correction for change of temperature, is amongst the least of the difficulties to be contended with; and the value of the principle of adjustment which we have discovered has been eminently proved by the accurate performance of our chronometers, which have been exposed to the severities of the arctic winters, in all the Polar voyages. In one of those voyages, *eleven* out of *fifteen* chronometers stopped from the cold; whilst FOUR made by us, (all of ours that were sent) maintained the same rates at Melville island that they were found to have in London after the return of the expedition.

The chronometrical parts of our chronometers consisting of the compensation balance and the detached escapement, are the same as invented before 1766, by the eminently distinguished artist, M. Le Roy, of Paris, with the important improvement of the detant on a spring instead of on pivots, as made by the late Mr. Earnshaw; together with some minor but useful alterations of our own, in the execution and arrangement suggested by experience.

We have already said that chronometers made by the same artist, do not always perform equally well, although the same workmen are employed, the same labor is bestowed, and the same attention paid to each. Some modern artists have endeavored to remedy this defect by means of mechanical contrivances, some of which are of considerable ingenuity and apparent plausibility; but, however beautiful these contrivances are in theory, they have produced no practical advantage, no one has yet discovered the seat of the disease, or the cause of so remarkable an effect. We reassert that no *mechanical contrivances* can remedy the defect: it is to be attained only by a knowledge of the principle which we have discovered.

Le Roy's original inventions of the balance, for compensating for the changes of temperature, and the escapement, were entitled, from their beautiful simplicity, to the reward so justly bestowed upon him, and with the improvements above alluded to, by our countryman Earnshaw, continue unrivalled: in fact they are generally adopted by all intelligent chronometer makers.

We consider that the best balance is that composed of laminæ of brass and steel, when properly proportioned, and worked so that the particles are placed under no particular or partial constraint, which might prevent their free and natural action throughout the whole periphery of the balance. This we consider an important requisite;

for to the want of affinity in the condition of the particles, we attribute some of the irregularities observed in the rates of chronometers, when subject to the rigorous test of daily comparison, more particularly after sudden changes of temperature. There are inherent defects in the shape of the balance, which prevent its affording theoretically the means of a perfect compensation ; but it is doubtful whether other forms, which appear preferable in theory, would be found in practice to answer so well.

As evidence of our possessing means peculiar to ourselves, of bringing a chronometer to keep a steady rate, we may mention the fact, and we do it with much satisfaction, that of the *eight chronometers* entitled to the prizes for the most accurate performance during the last three annual public trials at the Royal Observatory, at Greenwich, *five* of those chronometers were constructed by us, and adjusted on the *principle peculiar to ourselves.*

We may add, that within the last fifteen years, during which period we have been adjusting our chronometers on THIS PRINCIPLE, we have had extensive experience of its efficacy, having made and sold more than twice as many marine chronometers as any other maker has done during thirty years ;—the best proof that the public have appreciated our discovery.

Attempts have recently been made to introduce *glass* in the construction of the balance-spring ; and the first performance of some of the instruments in which this alteration was introduced, were very satisfactory.

There is, however, reason to apprehend that this *material* will not be found to give to the instrument a *permanent* rate, as one of the very best of them has, in the course of a few months, deviated from its rate to the amount of seven seconds a day : while another chronometer, under the same circumstances, on the usual construction, with a steel balance-spring, and which at the last public trial (1833), was second in performance to one made by us, kept a remarkably steady rate.

We may also be allowed to state, that on this trial (1833), sixty chronometers were sent by various makers ; and at the termination, the numbers were reduced to ten, *four* of which were made by us ; and the extreme variation of each, in the twelve months, was considerably within the limits fixed in 1828 for the reward of Three Hundred Pounds. Three of them made less error than our chronometer, No. 1410, in 1828 ; for which we then received the premium of Three Hundred Pounds. The extreme variation of these five chronometers was as follows:

In 1828,	No. 1410	in 12 months	″ ‴ 1.41	actual extreme variation.
1833	679	do.	0.98	
	1600	do.	1.31	
	460	do.	1.24	
	1502	do.	1·52	

In 1830, one of our chronometers was entitled to the second prize, and some others of our making were within the limits.

In the trial of 1831, the chronometers made by us obtained the *whole of the three prizes*, and another was fifth on the trial list. We may be excused for making particular references to the trials of this year, from the remarkable circumstance, that in all the preceding years, from 1822, when the trials for prizes were first established, a period in which several hundreds of chronometers had been sent for trial, but four had performed within one second of *extreme variation* in the twelve months, whilst in this trial the WHOLE of our four chronometers went within less than a second of *extreme variation.* The following being the extreme variation as published by the Astronomer Royal.

No. 311	in twelve months	″ ‴ 0.70	actual extreme variation.
2	do.	0.86	
665	do.	0.89	
1	do.	0.99	

In 1832 and 1833, chronometers made by us were entitled to prizes; and several others of our manufacture have been frequently within the limits prescribed by the Goverment, forming a large proportion of the best chronometers submitted to *public trial.*

It has been repeatedly suggested to us, that a PRINCIPLE so important as ours has proved to be, should be imparted to the public, as every thing tending to the improvement of chronometers is a matter of national concernment. We are willing to give up to the public the benefit of our knowledge and experience on these matters, on receiving as others have done, an adequate compensation for the value which the discovery is of to us in our private business; but we hold ourselves justified in withholding an explanation of the principle, until it either ceases to be of importance, or we are adequately renumerated for disclosing it.

Goverment having directed that the public trials of chronometers at Greenwich, for prizes, shall cease after the present year, a few remarks on the origin of those trials, and on the favorable effect which they have had on the art of chronometer making, may not inappropriately close our observations.

Notwithstanding the encouragement which Goverment had long afforded to the art, by purchasing chronometers largely, and at liberal prices, for the use of the navy, and the very considerable rewards which had been given to three of the leading artists (3000*l.* each) for improvements which they had introduced in the construction of the instruments, yet the general state of the art was much below what was generally believed, and might have been expected.

Aware of this fact, and desirous that the art which we exercised should participate in the general improvement, we, in 1818, addressed a letter to J. W. Croker, Esq., at that time Secretary to the Admiralty, respectfully suggesting that Goverment might further and more essentially aid the progress of the art, by giving frequent and small rewards to ingenious workmen who made instruments that *actually performed well*, without reference to the principles on which they were constructed.

The public trials at the Royal Observatory commenced in 1820, and the performance of the chronometers on the first trial proved the correctness of the opinion which we had formed as to the general state of the art of chronometer making. The prizes of 300*l.* and 200*l.* were that year adjudged to chronometers which Goverment would not at the present time purchase at any price.

Several of the chronometers which we sent on trial in the various scientific expeditions to the Polar Seas and towards the Equator, having performed satisfactorily, we sent some of our experimental chronometers to Greenwich on trial, a few years after the public trials were first established, and the opportunity thus afforded us of having the effect of our successive alterations tested by daily observation, enabled us to discover and correct many minute sources of error, which we should otherwise most probably never have discovered.

The opportunity, too, of returning for trial chronometers which, having performed satisfactorily and which we had endeavored to improve gradually led us to the discovery of the principle which enables us now to control at pleasure, and to counteract, any general tendency in chronometers to deviate from their rates.

We are, Sir John, yours, respectfully,

Parkinson and Frodsham.

Art. XIX.—*Notices in Natural History*; by Judge Samuel Woodruff.

1. *Some snakes viviparous.*

Windsor, June 4, 1835.

TO PROFESSOR SILLIMAN.

Dear Sir—From my limited knowledge of the natural history of the various kinds of serpents in our latitude, I had supposed they were all oviparous; but by a late examination of the Water Snake,* I am inclined to a different opinion, and that all of this tribe are viviparous. It is well known, that many species of this reptile among us are oviparous, and in case of attack or threatened danger, receive their hatched young through their mouths into their bodies, and disgorge them again at pleasure. This I have witnessed several times, in what is commonly called the streaked or garter snake. But may not this be done, and for the same reason, by other snakes which are viviparous?

I have been led to these reflections by the following facts. A few days since, a large water snake, two feet eleven inches in length, was killed near my house, by one of my neighbors, who informed me "it was full of young ones." Upon opening the body, I found in the stomach two toads of a middling size, together with a variety of bugs and insects. Distinct from the stomach and other viscera, but contiguous to them, separated only by a thin membrane, lay a body of matter, of a cylindrical form, seven inches in length, and about one inch in thickness. This organ was of a milk color, and of a mammillary substance, full of pores, resembling those in a sponge, cellular but tortuous. Upon a slight pressure of this pap, which appeared full of lacteal vessels, a milky fluid issued. On the exterior parts of this organ, I observed the heads and about one inch in length of the bodies of the young snakes. They were so small and tender, that in drawing them out of their cells, several of them were broken, but I succeeded in drawing forth eighty two, all alive, but of different lengths, from three to six inches, and in thickness about the size of a large knitting pin. In killing the parent snake, a pointed stake, taken from a fence, had been thrust through the body, and had broken a part of the organ containing the young, by means of which my neighbor discovered them. The young reptiles in that part were also broken, so that I could not exactly ascertain their number, but judged it to be between ten and twenty.

* Supposed to be the *Coluber Sipedon* of Linnæus.

The extreme tenuity and tenderness of these young, forbids the supposition that they had ever existed out of the body of the parent snake; neither were they yet capable of receiving any food for their sustenance, other than that of a fluid nature, much less to acquire any themselves, of any kind.

I have therefore been led to the conclusion, that the mammillary organ, which I have attempted to describe, must be the vessel in or near which their existence commenced, as well as that which to a certain period of their growth must have supplied them with their food.

The following fact serves to strengthen my confidence in this opinion; several years since, I took out of the eggs, before they were hatched, a number of young snakes, apparently of the garter tribe, and found them of a much larger growth, as well as more active and vigorous than those I found in the water snake.

2. *Moulting of Snakes.*

Although not immediately connected with the preceding, I take the liberty to subjoin a few remarks on the subject of *moulting* or *sloughing* off the old skin of serpents, to which I have lately given some attention.

The season of moulting commences with the smaller species, in the latter part of May or former part of June, but with those of a larger somewhat. later, and closes with all about the end of September.

It has been observed by many, that for a period of two or three days before they perform this operation, the reptile is partially, and in some instances totally blind. The eye assumes a lightish sky blue color, similar to that of skimmed milk. This obstruction of vision may be occasioned by the formation of the new crystal, destined to cover and protect the eye, and in its growth is probably opaque and clouded, and probably causes an uneasy sensation in the animal and increases its efforts to rid itself of the incumbrance.

All the cast skins I have seen for many years past were inverted, or, as it is commonly expressed, "turned inside out," and were lying on the ground, fully extended and nearly in a straight line.

In a late conversation on this subject with a gentleman of my acquaintance, on whose veracity and correctness of observation full reliance may be placed, he informed me that some years since he had the satisfaction to witness the whole operation of a caged rattlesnake sloughing off his skin. His attention was attracted to the snake by his manifesting an unusual uneasiness, and frequently thrusting his head against and between the wire grates of his prison, as if endeavoring to effect an escape. After striving and chafing against the wires a few minutes, the skin at the point of the head began to cleave off and turn back over the head on to the neck, in an inverted form. After the animal, by pressing the part against the wires, had succeeded in thrusting back the skin three or four inches upon the neck, he left the wires, and throwing his body into a coil around itself, so as to embrace with the last fold the inverted skin, with a strong muscular pressure, made at the same time a powerful effort, shot his body forward through the coils, which unfolded, one after another, and thus drew off the entire skin. This is, in all probability, the *modus operandi* of the whole race, and of whom it may be truly said, "they are all turncoats."

To the enquiring mind, the question might naturally suggest itself—for what reason, and by what necessity, is it, that the serpent, different from other creatures in the animal kingdom, throws off his skin annually? To this it might be replied, the condition to which this animal is doomed, "Upon thy belly shalt thou go," &c. renders it necessary to his comfortable existence, that he be furnished with a covering suitable to that condition. Hence nature has provided for him a complete *coat of mail*, wonderfully contrived in all its parts. Plates, greaves, scales, joints, and ligatures, are all employed in the construction of this protecting armor.

The nicely polished scales, which cover the under side of the body, enable the reptile to glide along upon the ground, among grass, weeds, and other obstructions, with astonishing facility. This coat, however, is necessarily composed of a *material*, the nature of which renders it incapable of distension or expansion. At the return of the warm season of the year, the snake awakens from his torpidity, issues from his winter lodging, and having a full supply of food, which that season affords, soon begins to thrive, and his dimensions increase. He now finds himself too straitly *laced*, and takes measures to rid himself of so uncomfortable a garment.

I have inclosed a specimen of the cast skin of the garter snake, by which you will perceive the inverted convexity of the crystals of the eyes and form of the head; a fragment also of the skin of a small adder. You will notice a difference in the belly scales, as to their proportions.

ART. XX.—*Ornithichnology.—Description of the Foot marks of Birds, (Ornithichnites) on new Red Sandstone in Massachusetts;* by Prof. EDWARD HITCHCOCK of Amherst College.

THE almost entire absence of birds from the organic remains found in the rocks, has been to geologists a matter of some surprise. Up to a very recent date, I am not aware that any certain examples of these animals in a fossil state have been discovered, except the nine or ten specimens found by Cuvier, in the tertiary gypsum beds near Paris. In the third volume (third edition) of his *Ossemens Fossiles,** he has examined all the cases of fossil birds reported by previous writers, and he regards them, nearly all, as deserving little credit.

For this paucity of ornitholites, geologists have, indeed, assigned probable reasons, derived from the structure and habits of birds. These render them less liable, than quadrupeds and other animals, to be submerged beneath the waters, so as to be preserved in aqueous deposites; and even when they chance to perish in the water, they float so long upon the surface, as to be most certainly discovered, and devoured by rapacious animals.†

But although these circumstances satisfactorily explain the fact, above referred to, they do not render the geologist less solicitous to discover any relics of the feathered tribe, that may be found in the fossiliferous rocks: and I have, therefore, been much gratified by some unexpected disclosures of this sort, during the past summer, in the new red sandstone formation on the banks of Connecticut river, in Massachusetts.

My attention was first called to the subject by Dr. James Deane of Greenfield; who sent me some casts‡ of impressions, on a red micaceous sandstone, brought from the south part of Montague, for flagging stones. Through the liberality of the same gentleman, I soon after obtained the specimens themselves, from which the casts were taken; and they are now deposited in the cabinet of Amherst College. They consist of two slabs, about forty inches square, originally united face to face; but on separation, presenting four

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* P. 302. † Lyell's Geology, Vol. II, p. 246, first edition.

‡ The editor of this Journal was early indebted to Dr. Deane, for similar casts of these tracks.

most distinct depressions on one of them, with four correspondent projections on the other; precisely resembling the impressions of the feet of a large bird in mud. Indeed, among the hundreds who have examined these specimens, probably no one doubts that such was their origin. Having never been injured by exposure, they are perhaps the most perfect specimens, that I have been able to obtain. They were dug from a quarry in the southwest part of Montague, less than half a mile from Connecticut river, and elevated above that stream, not more than one hundred feet. The strata there, dip easterly, not more than five degrees; and the layer containing the impressions, was several feet below the surface. Only one variety of track has yet been discovered at that spot.

Not long afterwards, Col. John Wilson of Deerfield, pointed out to me similar impressions on the flagging stones in that village. Having ascertained that these were brought from the town of Gill, from a quarry on the bank of Connecticut river, at a place called the *Horse Race*, nearly three miles higher up the stream than Turner's Falls, and eight or nine miles north of the quarry in Montague, above described, I visited the spot, and was gratified to find several distinct kinds of similar impressions; some of them very small, and others almost incredibly large. This quarry lies immediately upon the northern bank of Connecticut river; the strata dipping southerly at an angle of 30°, and passing directly under the stream, without any intervening alluvium. The rock is a gray micaceous sandstone, very much resembling, in hand specimens, some varieties of mica slate, with about the same degree of hardness and not very fissile.

In passing over the side walks at Northampton, during the summer, I discovered several examples of similar impressions upon the flagging stones. These stones were obtained from a quarry in the southeast part of the same town, on the east side of Mount Tom: and on resorting thither, I found numerous examples, some of them very fine, of several kinds of tracks. The strata at this spot, dip to the east, not more than 10°, and pass directly beneath Connecticut river, by which they are washed. There are three varieties of the rock on which the impressions occur at this locality: 1, a reddish shale, or rather a fine micaceous sandstone passing into shale—the red marl, I suppose, of geologists: 2, a gray micaceous sandstone: 3, a very hard sandstone, not very fissile and quite brittle, composed of clay and sand. These varieties are interstratified in a rather irregular manner. By the water, and the quarrymen, the rock is here laid bare, in length forty or fifty rods, (even double this distance at low water,) and several rods in width; but it has not been extensively wrought for economical purposes. This spot is more than thirty miles south of the Horse Race; and these are the two extreme points of that region, in which I have discovered these impressions. Near the village at South Hadley canal, however, among the fragments of hard gray shale, blasted out for the canal, I found a single specimen; and a fine specimen has been found in the north part of South Hadley, near Mount Holyoke, on a coarse gritstone. South Hadley lies on the east side of Connecticut river, opposite to the quarry above described, on the east side of Mount Tom.

I know of no reason why these impressions, should not occur in any part of the valley of the Connecticut, where slaty sandstone, similar to the varieties above described, exists; (and this rock does extend southerly from Mount Tom, sixty or seventy miles); but I have examined the quarries in the vicinity of Hartford, and at Enfield Falls, as well as the flagging stones in Hartford and Springfield, and have made no discoveries. I have some reasons, however, to suppose that such impressions have been found in Wethersfield; and I should think it very strange, if they are not brought to light in that place, or in Middletown, or perhaps at Chatham.

It will be seen from the preceding statement, that I have ascertained the existence of these impressions in five places, near the banks of Connecticut river, within the distance of about thirty miles. Having repeatedly visited these localities within the few last months, I shall now present the results of my examination: and I shall first give a more general account of the impressions, and then attempt a classification and specific description.

Where the surface of the rock has been exposed for a great number of years, to the action of the weather, I have never found any of these foot marks. They occur only where the upper layers have been removed by human, or aqueous agency. And I know of no reason, why they might not be found in a hundred other places along this river, were quarries to be opened in so many places.

At the quarries above named, these impressions are exhibited on the rock in place, as depressions, more or less perfect and deep, made by an animal with two feet, and usually three toes. In a few instances, a fourth or hind toe, has made an impression, not directly in the rear, but inclining somewhat inward; and in one instance, the four toes all point forward. Sometimes these ternate depressions run into one another, as the toes approach the point of convergence: but they also sometimes stop short of that point, as if the animal had not sunk deep enough to allow the heel to make an impression. Nay, at that point the stone is in some cases irregularly raised, as if the weight of the animal had caused the sand or mud to crowd upwards in the rear of the step. In a few instances, also, behind this slight elevation, there is a depression as if a knobbed heel had sunk slightly into they yielding mass.

In a large number of instances, also, there is a remarkable appendage to the hind part of the impression. There radiates from it in the rear, in the larger tracks to the distance of several inches, the apparent impression of stiff hairs, or bristles. The drawings appended, will convey as good an idea of this appearance, as I can give.

In all cases where there are three toes pointing forward, the middle toe is the longest; sometimes very much so. In a majority of cases, the toes gradually taper, more or less to a point: but in some most remarkable varieties they are thick and somewhat knobbed, and terminate abruptly.

In the narrow toed impressions, distinct claws are not often seen, although sometimes discoverable. But in the thick toed varieties, they are often very obvious. Much, however, in respect to this appendage, depends upon the nature of the rock. If it be composed of fine clay, the claws are usually well marked. And then again, if we chance to cleave the rock a little above, or a little below the layer, on which the animal originally made the impression, the claws will be very likely not to be visible; as I shall show more clearly farther on.

If we lift out of its bed a portion of the rock, several inches thick, on which one of these impressions exists, and break it so that the fracture shall pass across the toes, we shall see on the edge, the successive layers of the rock bent downward, often two, three, or even four inches in thickness. If we carefully cleave open the specimen thus raised, on one face we shall have a ternary depression, as has been described; and on the other face, a correspondent figure, projecting more or less, sometimes in high relief. And these specimens *in alto relievo* often give us a better idea of the structure of the foot that made the impressions, than those that are depressed. For often it is difficult to cleave a specimen so perfectly, that the portions of the rock which fills the depression, shall all be got out; and in doing it with a chisel afterwards, the natural face of the layers is apt to be marred: whereas it seems to have been often the fact, that the sand and mud which filled the original track, are more firmly concreted than the rock generally, and are thus rendered scarcely fissile at all; and while the rock around the track becomes shaky, so as easily to be cleaved off, the track itself remains unaffected; and thus with care, a fine specimen may be obtained. I doubt not, but the quarrymen, had they known the nature of these relics, might have saved in times past, many specimens of this kind: as I found fragments of this sort among the rubbish thrown out of the quarry.

There is one case, in which we do not see the layers of the rock conforming to the depression produced by the track. It is when the track was made in very fine mud, or clay, and the depression is filled by the same material in a concreted form. If in these circumstances, a layer of coarser materials, is superimposed, this layer often exhibits no traces of the impression beneath. And I can easily conceive how such a change of circumstances, (perhaps a sudden rise of the waters,) as brought on the coarser materials, should have so filled up the depressions as to leave a level surface for the deposition. In such cases, we obtain specimens only in relief.

In descending into the rock in a quarry, by splitting up the successive layers, we first meet with the track in rather an imperfect state, the toes being short and blunt. But by cleaving off a layer or two, the impression becomes larger and more distinct; and sometimes claws are visible. If we continue to cleave off layers beneath where the impression is most perfect, we may find, perhaps, some traces of it; as for instance, the thickest or middle toe; but it is much sooner lost in descending, than in ascending from the layer where it is most perfect.

I early directed my attention to the enquiry, whether these tracks could be traced in succession: that is, whether they were made by an animal in the act of walking; and I have been agreeably surprised to find so many examples of this sort, of the most unquestionable kind. Drawings of some of the most remarkable of these, accompany this paper, (Figs. 1 to 10, with Fig. 15, 16, 17, 23 and 24.) But a particular description of them will come in more conveniently, in another place. In one instance, (Fig. 6.) it will be seen, that no less than ten tracks succeed each other in such a direction, and with so nearly equal intervals, that it is impossible to doubt that they resulted from the continuous steps of an animal. Nor does there seem to be any reason why they may not be traced farther, except that the layer of rock containing them, is not laid bare beyond the tenth track. It is also impossible to doubt that this, and all other continued tracks, were made by a biped. For we search in vain to find any corresponding or parallel row of impressions. They are not, indeed, exactly on a right line; but the alternate tracks deviate a little to the right, and the remaining ones to the left, sometimes more and sometimes less, the toes being ordinarily turned outwards. The interval, also, between the different steps, varies; sometimes several inches in the smaller impressions, and even a foot or two in the layer: just about as much, indeed, as we should expect in an animal moving at different paces.

It has been interesting to observe, in almost every case where the impression is distinct, how easy it is to determine whether it were made by the right or the left foot of the animal. Even in an insulated impression, this can be generally decided; and where the tracks are continuous, it is easy to see that the left and right foot alternate. In the right foot, the toes, especially the middle one, are slightly curved towards the left, so as to make the exterior side of the bow on the right side of the track; an effect resulting from the effort of the animal to throw the body forward. The same effort causes the outer part of the heel in the large tracks to appear as if thrown behind the inner part, and the reverse of all this, is true of the track made by the left foot. (See the plate appended, exhibiting a proportional view of the tracks.)

The inclination, or dip of the rock at the different quarries, varies from 5° to 30°. Yet the animals seem to have passed over it, while in a plastic state, in every direction with equal facility. At the Horse Race, where the dip is 30°, they sometimes appear to have ascended, and sometimes to have descended, and sometimes to have passed diagonally; yet the tracks are not at all changed by the steepness of the declivity. There is no appearance as if the animal had scrambled upwards, or slid downwards, except in one or two tracks of great size, where the mud appears to have been rolled up a few inches before the feet. But in this case, the animal was moving horizontally, that is, along the line of bearing of the strata; and even on level ground, a heavy animal, moving at great speed, will produce this effect upon plastic matter. So that upon the whole, the evidence is quite decisive, that these tracks were made before the rock was elevated to its present situation; that is, while it was horizontal, or nearly so; a conclusion, to which the geologist would come, from evidence independent of the impressions.

I have stated, that often the tracks can be traced in regular succession: but this is by no means always the case. Sometimes different species of animals, and different individuals, have crossed one another's tracks so often, that all is confusion; and the whole surface appears to have been trodden over; as we often see to be the case, where quadrupeds, or ducks and geese resort, upon the muddy shores of a stream or pond. Fig. 10 exhibits a case of this kind on a specimen of sandstone in my possession from the Horse Race.

I trust I have proceeded far enough in these details, to justify me in coming to the conclusion, that these impressions are the tracks of birds, made while the incipient sandstone and shale were in a plastic state. This is the conclusion, to which the most common observer comes, at once, upon inspecting the specimens. But the geologist should be the last of all men to trust to first impressions. I shall, therefore, briefly state the arguments that sustain this conclusion.

1. These impressions are evidently the tracks of a biped animal. For I have not been able to find an instance, where more than a single row of impressions exists.

2. They could not have been made by any other known biped, except birds. On this point, I am happy to have the opinion of more than one distinguished zoologist.

3. They correspond very well with the tracks of birds. They have the same ternary division of their anterior part, as the feet of birds. Frequently, and perhaps always, the toes, like those of birds, are terminated by claws. If the toes are sometimes slender and sometimes thick and blunt, so are those of birds. If they are mostly wanting in the hind toe, so are many genera of birds, especially the Grallæ.

I am not aware that the tracks of living birds have been much noticed; and I regret that it has not been in my power to make more observations of this sort, than I have done. But so far as I have examined them, they bear a striking resemblance to the impressions under consideration. I was particularly struck with the resemblance at two of the quarries, that have been described; viz. at the back side of Mount Tom, and at the Horse Race. The rock at these places, passes under the river, whose waters have deposited a thin stratum of mud, just at the margin of the stream. Here in the summer, a few small species of Grallæ, particularly the snipes, resort for food. Their tracks of course, are numerous; and, were the mud to be suddenly hardened into stone, they would scarcely be distinguished from some of the tracks on the sandstone in the immediate vicinity. Indeed, in one instance, the process was well nigh completed: for the water had fallen several feet and left the mud with the tracks exposed for some weeks to the sun in a dry season; so that it was almost as hard as stone; and had I taken a cast of the impressions, as I might have done, I am sure it would easily have passed for the tracks in sandstone.* I merely took a sketch of a few of the impressions, which is given in Fig. 14. I could not, however, but feel, that I was witnessing a repetition of the very process by which the tracks in the stone were produced.

Fig. 12, is a sketch of two steps of the common goose, (Anas Canadensis) on mud. The length of the foot is four inches, and of the step, seven inches. The space beneath the web connecting the toes, is quite obvious on the mud; it being sunk below the general level, but not so deep as the toes. The entire absence of any such appearance in the fossil tracks, makes it almost certain, that none of them were produced by web-footed birds. The lateral distance of the successive tracks in Fig. 12, to the right and left of the central line of the bird's course, is much greater than that of any of the fossil tracks of the same size.

Eig. 13, exhibits the tracks of a bird, probably of the genus Tetrao, which I met with last summer; but I caught only a glimpse of it. The length of the foot, not including the hind toe, is one inch and a half, and of the step, five inches.

Fig. 14, has already been referred to, as exhibiting the steps of a small species of snipe, wanting in the hind toe. Its foot is only an inch long, and its step two and a half inches. The same tracks are shown in Fig. 11, laid off from the same scale as the fossil impressions in the first two figures, in order to exhibit their relative size in respect to the fossil foot marks.

Fig. 20, shows a case of the tracks of the domestic hen (Phasianus gallus) in mud. The foot, without including the hind toe, is nearly three inches long; the length of the step, six inches. This is the ordinary distance between the tracks of this species. Only the alternate track shows the hind toe; owing to the foot's not sinking deep enough in all cases.

* Such tracks as are the subjects of this paper.

A few tracks of the domesticated turkey, (Meleagris gallipavo,) are shown in Fig. 18, taken from impressions in snow. The foot (that of a large cock turkey,) is four inches long, and the step twelve inches. The hind toe points inward, so as to be nearly on a continuation backward of the outer toe.

In Fig. 19, a view is given of the tracks of the peahen, (Pavo cristatus.) They very much resemble those of the turkey, except that in those of the peahen, the impression of the hind toe appears rather as a hole made by the end of a stick, and does not extend so as to reach the other toes, except where the snow is deep. Not including the hind toe, the length of the foot is three and a half inches; and of the step nine inches.

The tracks of living birds on Figs. 12, 13, 14, 18, 19 and 20, are laid down on a much larger scale, than the fossil foot marks. But the resemblance between them, cannot escape notice; and it is much more obvious in the real specimens. The Gallinæ, however, present a more distinct impression of a heel, than I have seen in the fossil species, except one. This is shown by the small circle near the point, from which the toes diverge. Where the impression was very perfect, I have observed all the little protuberances and depressions of the bottom of the foot; but generally they are not visible, and the claws are very rarely seen, as a distinct part of the impression.

Assuming it then as established, that the tracks under consideration on stone, were those of birds, I shall proceed to give a more specific description of the several sorts, which, I think I can recognize. And since this is a department of oryctology hitherto unexplored, I suppose I shall be justified in proposing some new terms.

I include all the varieties of tracks under the term *Ornithichnites;* (ορνισ and ιχνοσ) signifying *stony bird tracks:* and if it be convenient to speak of the subject as a distinct branch of knowledge, I should call it *Ornithichnology.*

All the varieties of tracks which I have discovered, I include under two divisions: 1, the *Pachydactyli,* or thick toed: 2, the *Leptodactyli,* or slender toed. In the former, the toes are of almost equal thickness through their whole extent, except that they are somewhat tuberous; and they terminate rather abruptly; not, however, without a claw. In the latter, the toes are far narrower, and less thick, with an equal span: and, indeed, some of them are quite delicate, (Ex. gr. Fig. 15.) They taper gradually to a point, and the claw is not often distinctly perceived. Under these divisions, I repose much confidence in the distinct existence of the following species and varieties. Indeed, had I followed my own impressions, I should have regarded some of the varieties, as species. But I prefer to make the number too small, rather than too large.

When I speak of species here, I mean species in oryctology, not in ornithology. And I doubt not, that in perhaps every instance, what I call a species in the former science, would be a genus in the latter; that is to say, these different tracks were made by birds that were generically different.

I am aware, that even where the whole skeletons of birds are found, it is very difficult often to distinguish species. "The difference," says Cuvier, "between two species, is sometimes entirely inappreciable from the skeleton. Even the genera cannot always be distinguished by osteological characters."* Is it not then presumptuous to speak of distinct species when we have nothing but a mere impression of the foot? I presume that in following the indications derived from this single source, we cannot always avoid confounding several distinct species of birds under a single species of ornithichnites: and observation upon the striking resemblance between the tracks of several living species of birds confirms me in this opinion. But if we take into the account the size and form of the track, and the distance between the successive steps, I am confident we can distinguish, often between those birds that were considerably unlike one another. "The places where birds live, and the manner of their moving forward," says Duméril, "are, so to speak, indicated beforehand by the disposition of their feet. Indeed, it is by the form, the length of the feet, and the disposition of the toes, that birds are divided into six orders, &c."†

ORNITHICHNITES.

1. *Pachydactyli.*

O——— giganteus.
O——— tuberosus.
α dubius.

2. *Leptodactyli.*

O——— ingens.
α minor.

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* Ossemens Fossiles, Tome troisieme, p. 524, third edition.
† Elemens des Sciences Naturelles, Tome II, p. 258, fourth edition.

O——— diversus.
    α clarus.
    β platydactylus.
O——— tetradactylus.
O——— palmatus.
O——— minimus.

Specific Descriptions.

O. giganteus. Toes three; length of the foot, fifteen inches, exclusive of the claws. In one specimen, the claw is at least two inches long, and even then a part of it appears to be missing: in general it is not more than one inch, but seems to be broken off. The whole length of the foot, consequently, is sixteen or seventeen inches! Length of the successive steps, between four and six feet! toes somewhat tuberculated; the inner one, in some specimens, distinctly exhibiting two protuberances, and the middle one three, although less obviously. Average thickness of the toes, one inch and one fourth; breadth of do. two inches. Occurring only at the quarry in Northampton, on the east side of Mount Tom, where it is abundant. I found in one spot, six tracks of this species in succession, the average distance between them, being four feet. This case is represented in Fig. 1, along with three other tracks of the same size, and one of smaller size, on the same rock. Indeed, I suspect from the numerous examples which I have seen of tracks at the distance of four feet, that this was the ordinary step of the bird when walking; while it was able to lengthen it to six feet, when moving rapidly. The examples where the steps are six feet, are not common.

In one part of the quarry above referred to, I found the steps of four individuals of this species, all pointing in the same direction, and nearly parallel to one another; showing that four birds must have moved along nearly together; and rendering it probable, that this species was gregarious. The distance between the several rows of tracks, is four or five feet. An attempt is made in Fig. 21, to represent the *O. giganteus* of the natural size, as it extends out in bold relief, on a specimen in my possession. The claws are broken off. It is the under side of the foot, that is shown in the figure.

Incredible almost as this description may seem, the specimens which I have obtained of this enormous species, are nevertheless more satisfactory, perhaps, than of any other species. The whole cavity made originally in the mud by the foot of the bird, has been filled by a siliceous concretion, differing somewhat from the surrounding rock; so that the latter may be in a good measure detached, and the former be left standing out very naturally from the rock—presenting in fact a petrifaction of the entire foot. Such specimens, indeed, are not common, but I have obtained a few of them; and by means of gypsum casts, they may be multiplied to any extent.

O. tuberosus. Toes, three; length of the foot, seven to eight inches; claw distinct in some specimens; from one inch to one and a half long; tuberous swellings on the under side of the toes, quite distinct. Heel very obvious. In one or two specimens in my possession, the inner toe presents two prominences, and the middle one, three; those on the outer toe not being distinguishable. This corresponds, so far as the inner and middle toes are concerned, with the number of joints in the three toed living Grallae. Length of the step in this species, twenty four to thirty three inches; occurs in Northampton, east side of Mount Tom; and I have seen a loose specimen of apparently the same species, obtained in the vicinity of the Horse Race, in Gill.

The most important difference between this and the last species, consists in its smaller size. It might, indeed, be thought that the *O. tuberosus* is but the young of the *O. giganteus.* But I have not noticed intermediate specimens; and besides, the middle toe of the former is longer in proportion to the others, than in the latter species; while the toes of the latter are a good deal more divaricate than those of the former.

a. dubius. I have lately obtained from the quarry on the east side of Mount Tom, in Northampton, a few specimens a good deal worn, which have the general form of *O. tuberosus*, but they are much smaller, the foot being only four inches long, and the steps twelve inches. Not improbably, it is a distinct species; but at present I shall regard it as made by the young of *O. tuberosus.*

Fig. 2, exhibits two rows of the tracks of *O. tuberosus*, pointing in opposite directions; the impressions at one extremity interfering with one another. The length of the foot in the right hand row, as well as of the three insulated tracks, near the upper left hand corner of the figure, is eight inches, and the length of the step is twenty eight inches; but the foot of the left hand row is scarcely seven inches long, and the step is twenty four inches. The feet of different species, and sometimes of different genera of living birds, differ even less than these impressions; yet as the smaller ones might have been made by the young of the larger birds, I shall regard them only as varieties.

Fig. 5, exhibits three tracks of *O. tuberosus*, on a flagging stone, directly in front of the door of the Court House in Northampton. The foot is eight inches long and the step thirty three inches; the longest I have noticed in this species. This stone was brought from the quarry on the east side of Mount Tom.

O. ingens. Three toed; length of the foot, exclusive of the hairy appendage, fifteen to sixteen inches. No claws visible in any specimens that I have found. Toes much narrower than in *O. giganteus*, and tapering gradually to a point; quite divaricate. The best specimen that I possess, exhibits, at a few inches behind the heel, a depression nearly an inch deep, and several inches across; the anterior slopes to which, in the rear, appears if large bristles had been impressed upon the mud. I have been led to suspect that the bird possessed a sort of knobbed heel, covered with wiry feathers, which sunk into the mud when the track was deep. Yet I do not feel very confident as to the nature of this appendage. The impression of the bristles extends backwards from the heel, at least eight or nine inches; so that the whole length of the track is not less than two feet! The length of the step appears to have been about six feet; although I have had but few opportuties to ascertain this fact.

The rock on which this species of track appears, is composed of a fine blue mud, such as is now common in ponds and estuaries; and where the bird trod upon it, in some cases, it seems that the mud was crowded upwards, forming a ridge around the track in front, several inches in height. Indeed, I hesitate not to say, that the impression made on the mud appears to have been almost as deep, indicating a pressure almost as great, as if an Elephant had passed over it. I could not persuade myself, until the evidence became perfectly irresistible, that I was examining merely the track of a bird.

O. ingens, α minor. Length of the foot, about twelve inches; step from forty two to forty five inches. In other respects, it corresponds with *O. ingens:* and although I was at first inclined to regard it as a distinct species, I prefer upon the whole, to put it down as a smaller variety of *O. ingens.* Fig 3, exhibits a series of tracks of this variety, copied from the face of the rock in the quarry at the Horse Race. The hairy appendage is scarcely visible on the rock, and is therefore, omitted in the figure. It is wanting, probably because the layer of rock now laid bare, is either above or below that on which the bird originally trod. The foot is twelve inches long, and the step varies from forty two to forty five inches. The smallness of the foot may result merely from the situation of the layer containing it; in the manner that has been already explained. Yet as the length of the step is also less than four feet, I conclude these tracks to have been made by the young of *O. ingens*, or by a different species of the same genus.

The *O. ingens*, has been found only at the Horse Race. Several of these impressions, brought from the same place, may be seen on the side walks in Deerfield.

O. diversus. Three toed, with a hairy appendage in the rear; length of the foot, exclusive of the hairy appendage, from two to six inches; length of the step, from eight to twenty one inches.

Under this species, I have embraced a great variety of specimens; because I could not draw between them so definite a line of demarcation, as would be desirable. The two following varieties, however, are too distinct to be passed unnoticed; and I have little doubt, that they were produced by distinct species of birds. Indeed, I am persuaded that several species must have been concerned in making all the foot marks, that I have grouped together under this species.

α clarus. Foot, exclusive of the hairy appendage, from four to six inches long. Toes generally somewhat approximate and acuminate; inner toe shorter than the outer one. Hairy appendage very distinct, from two to three inches long; perhaps a knobbed heel. Step from eighteen to twenty five inches. Found in the south west part of Montague; also at the Horse Race, and probably also in Northampton, and at South Hadley canal. The specimens from Montague and Gill, are sometimes exceedingly distinct, so as to arrest the attention of every one. Fig. 22, exhibits one from the former place of the natural size. I have represented it in relief, because I found I could thus make the drawing more distinct.

Fig. 17, is a sketch of several tracks of this variety, on a slab of red micaceous sandstone, between three and four feet square, from Montague, now in my possession. The impressions are exceedingly distinct and striking, and appear to have been made by two birds walking side by side, at the distance of eighteen inches; one of them, taking steps two feet long, and the other, but eighteen inches. In the right hand row, a third step just begins to appear on the margin of the stone. The length of the toes, exclusive of the hairy appendage, is about five inches.

Fig. 16, is a very similar case to the last, except that the side toes are scarcely visible; probably because the layer of rock containing them, was somewhat below the layer on which the bird originally trod. The steps in the right hand row are twenty one inches, and in the other, eighteen inches. From the Horse Race on gray micaceous sandstone.

Fig. 10, was sketched from a specimen in my possession, from the Horse Race. The tracks are exhibited very distinctly in relief, and also on the opposite side of the stone as depressions. There are at least two varieties, as to size, of *O. diversus;* and the tracks are irregularly situated upon the stone. The length of the foot varies from four to six inches.

Fig. 23, represents a similar specimen from the same place, and of the same species. The tracks are depressions, and most of them very distinct. There are at least, three pairs of tracks connected by dotted lines; that is, they are the steps of birds moving in different directions. The length of the step, varies from twelve to fourteen inches. Six of the tracks are insulated; that is, not connected with others upon the specimen. The length of the foot in all the tracks, except *n*, is four inches; that of *n*, six inches. The rock is fine gray micaceous sandstone.

Fig. 24, shews another similar group of the same species and size as in the last figure; *n* being six inches long, and the other tracks four inches. Three tracks on the lower part of the figure, and two along the central part, are obviously the steps of birds moving in different directions; the shorter steps being twelve inches, and the longer one eighteen inches. Four of the tracks, from the Horse Race quarry, on gray micaceous sandstone, are insulated.

β platydactylus. Middle toe from two to three inches long, swelling out towards the extremity in an unusual manner. Hairy appendage behind very large and distinct. Length of the step six to eight inches. At the Horse Race; rather common. The five small tracks crossing Fig. 6 diagonally, belong to this variety; a sixth being wanting to complete the series. It differs from the variety *α clarus*, chiefly in the swelling of the middle toe, and in its diminutive size.

Since the radiating lines behind the foot in *O. ingens* and *O. diversus*, are much fainter than the furrows made by the toes, we might expect, that by the deposition of new matter, when the rock was forming, these lines would sooner be obliterated. And such I find to be the fact; for I have sometimes taken a specimen, which, although quite distinct, exhibited no traces of a hairy appendage, and by carefully cleaving off successive layers of the rock, have come at length to a layer that exhibited it. Hence, I have learned to refer a specimen to *O. diversus*, which was destitute of a hairy appendage, if in other respects it corresponded to that species. So that, for the most part, the examples of continued tracks of that species given in the drawings, are represented as destitute of this scopiform appearance; because, in fact, they do not exhibit it on the rock.

Fig. 4 was sketched from a flagging stone, brought from the east side of Mount Tom, and lying on the side walk in front of the north door of the first parish church in Northampton. The tracks, although a good deal worn, are yet remarkably well characterized. The right and left feet are very distinct; and the toes have almost exactly the same divergence in each track. The foot is six inches long, and the toes are much nearer to equality, as to length, than in *O. diversus, α clarus;* so that I have been almost disposed to regard these tracks as a distinct species. But I supposed it most safe to refer them to *O. diversus*. The length of the step is twenty one inches.

Fig. 6 has been already referred to. The toes of the two principal rows of tracks are shorter and more divaricate than is usual in *O. diversus, α clarus;* and no marks of a hairy appendage are present, yet I rank them under that species. The length of the foot is four inches, and the average length of the step twelve inches, varying from that not more than two or three inches. On the left is the commencement of another similar row of tracks, of the same species, and one insulated track. I found this example in the quarry at the Horse Race; and by enlarging the sketch, I might have brought into view many other tracks. But none of them would have exhibited so many steps in succession, as are shown in the present drawing.

Fig. 7 was sketched from a specimen about three feet long, in the possession of Dr. Dwight of South Hadley. He obtained it, twenty years ago, from a farmer in the north part of that town, who had used it as a step stone, before the door of his house, and it was found in the vicinity. It is a coarse gritstone, much coarser than any other rock on which I have found these impressions. The foot is between three and four inches long, and has no hairy appendage. Length of the step ten inches. The tracks exist on this stone in relief, and are very distinct. Dr. Dwight informs me, that one has been broken off; and this is supplied in the figure by dotted lines.

The rock from which Fig. 8 was taken, is a gray micaceous sandstone, or rather shale, brought from the Horse Race, and now forming a flagging stone, in the village of Deerfield. The foot is about four inches long, and the toes are a good deal divaricate, and there appears no scopiform appendage behind. The average length of the step is twelve inches. The third track is nearly obliterated, and it appears that the bird moved in a somewhat curvilinear direction.

It will probably be suggested, that *O. diversus*, with all its varieties, was made by the young of the species that produced *O. ingens.* And I confess, that it is not easy to point out any other distinction than in size. But my specimens of *O. ingens* are few, and much more imperfect than those of *O. diversus;* so that it is only in their general features that I can compare the two species; and I suspect, that better specimens would bring to light other differences. For I can hardly believe that the young of a bird, with a foot sixteen inches long, would accompany their mother, in search of food, along the margins of estuaries, while their feet were only two inches long, if, indeed, they could ever have been so short as this; and I hope to show, in another place, that all these tracks must have been made by birds, thus wading along the shores of estuaries or lakes. Besides, the *O. diversus* is fifty times more common than the *O. ingens;* and can we suppose, that in such circumstances, such a great disproportion would exist between the old and the young birds? Is it so with living species? I suspect it is not, although I confess myself but little acquainted with the facts in the case.

O. tetradactylus. Length of the foot, exclusive of the hind toe, from two and a half to three and a half inches. Toes divaricate; more slender than in *O. diversus;* the hind one turned inward, so as to be nearly in the line of the outer toe, prolonged backward. A space, however, usually remains, between the heel and the hind toe, as if its insertion were higher on the leg than the other toes, and its direction obliquely downwards. Length of the step, ten to twelve inches (?) Hairy appendage wanting. At the Horse Race. Probably several kinds of birds are embraced under this description, for the size of the tracks, and especially the direction of the hind toe, vary considerably. Indeed, in existing birds, these differences are sometimes the only marks, exhibited by their tracks, between different species and genera. In the tracks of the domestic hen,

(Fig. 20,) the pea-hen, (Fig. 19,) and the turkey, (Fig. 18,) we see the hind toe turned inward, almost exactly as in the fossil specimen, as shown on the Proportional view of the Ornithichnites appended. But in the foot marks of a bird, probably of the genus Tetrao, that I lately met with, (see Fig. 13,) the hind toe seems to be merely a prolongation of the middle toe backwards. In the tracks of the hen, exhibited in Fig. 20, it will be noticed, that the hind toe is seen only in some of the tracks, because it is situated so high up the tarsus, that it made an impression only when the bird sunk deep into the mud. In the tracks of the pea-hen, the hind toe appears sometimes only as an insulated and rounded impression, as if made by the end of a stick; because of its peculiar position, form, and direction, in that bird.

These facts render it probable, that some of the specimens of Ornithichnites, which I regard as produced by a three toed bird, may have been made by one with four toes; indeed, in some instances, in which I had referred the specimen to *O. diversus*, careful cleavage has brought to light the fourth toe. Yet I am confident that such a discovery would rarely be made. And in regard to the larger tracks, I have not noticed any thing that resembles a fourth toe, even if it should turn out that *O. diversus* is possessed of one.

To the examples above named of living birds, I might have added that of the whooping crane, (*Ardea Americana,*) the tallest bird in the United States. Its hind toe does not reach the ground where it is hard; but in deep mud it may make an impression.

O. palmatus. Four toed, and *all the toes directed forward.* The fourth toe is very short, proceeding from the inner part of the foot. The heel is broad, and the toes proceed from it somewhat in pairs; that is, the two inner and the two outer ones are closer together, and radiate less, than the two middle ones. Toes very slender: foot from two and a half to three inches long. Length of the step, in the only specimen where it could be measured, eight inches.

This is a remarkable species, and as I discovered it only on my last visit to the Horse Race, I do not feel certain that I may not have mistaken its characters; yet the specimens in my possession are very distinct. One in particular contains two tracks, and as naturalists may probably doubt whether they were made by a bird, I have given in Fig. 15, as accurate a sketch of them as possible, and of the natural size, although the distance between them, which on the stone is eight inches, is much diminished on the drawing. The toes in one of the tracks are turned slightly to the left, and on the other to the right, (scarcely visible in the drawing,) corresponding exactly to the step of a bird, but not to that of a quadruped. The thumb, or short toe, also, is on opposite sides in the two tracks, proving the animal that made them to have been a biped; for had they been produced by the two right or the two left feet of a quadruped, the short toe would have been on the same side in both tracks.

I am aware, that these impressions do not correspond to the foot of any existing bird; at least, I cannot find any one of this description in the ornithological works within my reach. Four toed birds are, indeed, the most common, but in no instance do they all point forward.* Yet, since peculiarities of structure occur in most other animals, found petrified deep in the secondary rocks, ought we to be surprised to find them in the birds of early times? And can any one suppose, that the slight addition of a short inner toe, ought to exclude the animal, when the proof of its being a biped is so clear, from the class of birds?

O. minimus. Three toed; destitute of a hairy heel; foot from half an inch to an inch and a half long; toes spreading widely; nearly of equal length; step three to five inches; quite common at the Horse Race. Generally, the foot is rather over an inch long, but one very distinct specimen is only half an inch.

Fig. 9 exhibits a succession of tracks of this species, four inches apart, found at the Horse Race.

It will probably be suggested, as I have already intimated in one case, that all the smaller tracks were made by the young of the larger species of birds; and although I doubt very much whether this is the fact to any great extent, yet it will be seen, that I have regarded no track as a distinct species, that does not differ from the others, by some other peculiarity than the size, except perhaps *O. ingens* and *O. diversus*, about which I have already remarked. And besides the peculiarities that have been named, there are others, which will be obvious to a practiced eye, but which it is not easy to express in language.

Naturalists may perhaps doubt as to the nature of the appendage that produced the radiating impression in some of the species that have been described. Yet it is well known that some species of living birds have the tarsus very low down covered with hair like

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* In some drawings of the feet of the genus Paradisea, especially that in Rees' Cyclopedia, it would seem as if all the toes were directed forward; but ornithologists inform us, that this is not the case. See Dictionnaire Classique d'Histoire Naturelle, Art. Paradisea.

feathers, as, for instance, the sharp tailed grouse,* (Tetrao phasianellus,) and I do not see why such an appendage would not produce precisely the impression on soft mud which the fossil specimens exhibit.

In comparing the descriptions that have been given of the species, it is interesting to observe how the length of the step increases in proportion to the size of the foot; from the huge *O. ingens*, with a foot sixteen inches long, and a step of at least four feet, down to the *O. minimus*, with a foot one inch long, and a step between three and five inches. In order, however, to present this correspondence before the mind at glance, as well as to give an idea of the peculiarities of the different species, I have prepared the appended "Proportional view of the Ornithichnites." On this the proportional size of the different tracks is shown as well as the comparative length of the steps. The whole is laid down from a scale of five inches to an inch. The plate does not present the appearance of any one specimen; but a connected view of the results obtained by an examination of all the specimens that have come under my notice. Very few single specimens are as perfect as those here represented; but a careful examination of various specimens has brought to light new characters, so as to justify me in exhibiting the tracks of as perfect a form as those on the plate. Where rows of several tracks are given on this plate, the toes are represented as turned outwards, and slightly curved, as they are seen in the most perfect specimens.

The two first species on this comparative view are exhibited in relief; and the others as depressions. This was done in order to give a more distinct sketch of the protuberances on the under side of the toes of the two first species. It should be recollected that such a representation will invert the position of the feet; so that what appears to be the left one is in fact the right one, and *vice versa.*

In the series of figures extending from 1 to 9, and including 16, 17, 23 and 24, an attempt is made to exhibit the tracks just as they appear on the rock. Yet the scale (twenty four inches to one inch,) from which they are laid down, is so small, that the representation probably falls short of the truth; since no attempt has been made to show the claws, which do sometimes appear. Yet in general, where the rock has been for some time exposed, these and other more delicate parts of the impression are obliterated; and it is only by cleaving down insulated specimens that I have discovered them.

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* Also the Bantam domestic fowl.—*Ed.*

Being laid off from a scale, the figures above referred to, exhibit to the eye the relative, although not the real size of the different species. Fig. 15 is the only one drawn of the natural size.

It is a natural enquiry, whether the facts that have been stated, will enable us to refer these birds, of the new red sandstone era, to any of the families of existing birds. The idea, that they belonged to existing species, can be indulged only by those unacquainted with the history of organic remains. Judging from that history, the geologist will expect only slight resemblances to existing species. I cannot, however, but believe that several of them, at least, were Grallæ. They correspond with this tribe of birds in two respects; first, in having but three toes; as is the case with several genera of the existing waders. The great length of their step, also, proves them to have been very long legged; another characteristic of the Grallæ. I have had but few opportunities for making a comparison; but I am satisfied that the step of our common birds, not belonging to the Grallæ, is generally shorter with the same size to the foot than in the Ornithichnites. Thus, the common domestic hen, with a toe three inches long, takes a step of only six or seven inches; while the step of *O. diversus*, of the same size, will average ten or twelve inches. The domestic goose, with a middle toe four inches long, takes a step of only seven or eight inches. The turkey, however, with a foot four inches long, takes a step of just about the same length as that variety of *O. diversus* shown in Fig. 6, (with a similar foot,) that is, twelve inches long; and the pea-hen, with the same length of foot as the *O. diversus*, shewn in Fig. 7, falls but an inch or two short of the fossil tracks in the length of the step; but the turkey and the peacock are birds with rather unusually long legs among the Gallinæ.

I have not been able to obtain any examples of the length of the step of the larger existing Grallæ. And of the smaller species I can mention only a few. The small snipe, whose tracks are represented in Fig. 11 on a small scale, and in Fig. 14 on a larger scale, takes a step of only two and a half inches, with a foot an inch long. And as I am informed by Dr. Richard Harlan, the step of the *Ardea Canadensis*, with a foot three inches long, measures from four to six inches. On comparing these steps with those of *O. minimus*, whose foot is one inch, and its step four inches long, and with *O. diversus*, *β platydactylus*, whose foot is from two to three inches long, and its step from six to eight inches, we perceive that the steps of the existing species are shorter than the fossil foot marks. As to the larger species of Ornithichnites, however, we can make no comparison with existing species; because no birds now on the globe have feet which approximate in size to *O. giganteus* and *ingens*. One cannot but see, however, that birds which measured from four to six feet at each step, must have had very long legs, and were therefore waders.

But the zoologist will object, that some of them appear to have had their legs covered, even to the toes, if not with feathers, yet with bristles; while all the known Grallæ have naked legs. This is certainly a very strong presumptive evidence against their having been waders in the literal sense, and perhaps it is an insuperable objection against ranking them among the Grallæ at all. Yet I would remark, in the first place, that it is not certain I understand the nature of this peculiar appendage to the heel, although I cannot explain it in any other way than I have done, and I do not see why that is not satisfactory. Again, since we should expect *a priori*, great peculiarities of structure in animals that inhabited the globe so early, is it incredible that even the genuine wading birds of that epoch might have had an appendage to their feet of filaments like bristles? We may not be able to see their use; nor can we understand that of the thoracic filaments attached to the genus Polynemus among fishes; nor to the byssus of the Pinna, among shells. Once more, these Ornithichnites, with the appendage under consideration, might have been produced by that portion of the Grallæ denominated *Cursores* by Temminck, and which might have frequented the shores of lakes and estuaries for food. Between the genus Rhea of these birds, and the *O. ingens*, there is one point of resemblance which I ought perhaps to notice. The Rhea has a callous knob in the place of a hind toe; and in the *O. ingens*, a protuberance of that sort seems to have left an impression. But finally, whatever we may think of the radiating appendage, I think it quite certain, and in the sequel shall endeavor to prove, that all the tracks which I have described must have been made either beneath the waters of an estuary, lake, pond, or river, or on their margin, where the waters would often overflow the place. If so, the habits of all these ancients birds must have corresponded to those of the modern Grallæ.

I have stated in the commencement of this paper, that the rock on which these Ornithichnites are found, is the new red sandstone; or perhaps I ought to call it the equivalent of that group of rocks in Europe; that is, it seems to have been formed under similar circumstances, and probably at nearly the same geological epoch.

However strenuously, geologists, a few years ago, contended for the perfect identity of the rock formations of different continents—this opinion, especially in the case of the secondary and tertiary rocks, is now abandoned. All we can hope for, in respect to two such rocks, in different countries, is, that there may be so much similarity between their lithological characters, mineral contents, and organic remains, as to show that they were the result of similar causes, and produced under similar circumstances as to temperature, climate, &c. In respect to the sandstone of the valley of the Connecticut, on which these Ornithichnities occur, there are peculiar difficulties in determining precisely its position on the geological scale. But having examined it with no small care for the last twenty years, with reference to this very point, I have come to the full conviction, as above expressed, that at least the higher beds of this sandstone belong to the new red sandstone of De la Beche and other geologists. The reasons of this opinion I have given in full in my report on the geology, &c. of Massachusetts, made to the government of that state. But it may be desirable to give a summary of these reasons in this place.

The sandstone in this valley extends nearly one hundred miles, from New Haven in Connecticut to the north line of Massachusetts, varying in width from eight to twenty four miles. It is divided by one or two ridges of greenstone, protruded through the sandstone, and running nearly north and south. The strata of the sandstone have a general easterly dip, varying from 5° to 30°; so that the lowest or oldest portions of the sandstone lie along the western side of the valley. These lower strata consist, for the most part, of thick layers of red sandstone, not much diversified in appearance. But the upper strata, that is, those on the easterly side of the greenstone ranges, consist of slaty sandstones, red and grey conglomerated sandstones, very coarse conglomerates, shale, and perhaps red marl,* with occasional beds of fetid limestone. These are interstratified in almost endless variety. Now as to the lower strata, some geologists have supposed that they belong to the old red sandstone; and perhaps they do: but as none of the Ornithichnites occur in these strata, we need not discuss this question. In endeavoring to show that they are the equivalent of the new red sandstone, I confine myself, therefore, entirely to the upper strata.

* The red sandstone at Hartford, is decidedly marly—it effervesces with acids and even contains numerous veins of calc spar.—*Ed.*

1. *Their lithological characters.*—De la Beche describes the new red sandstone group, as a "deposit of conglomerate, sandstone and marl, in which limestones occasionally appear in certain terms of the series"—and such a deposit, we have seen, is the sandstone in this valley. I have no doubt in respect to any member of this list, unless it be the marl. There occurs here, indeed, a fine red rock, resembling the English red marl; but not usually containing much carbonate of lime. It is rather a reddish shale, although it will frequently effervesce with an acid. The variegated aspect of the new red sandstone, which in some deposits of that rock is so striking, is frequently present along the central parts of the valley, although I should judge, less common, than in Europe. In fine, I can hardly distinguish a suite of specimens from the Connecticut valley, from a suite obtained in Nova Scotia, from a group of rocks proved to be new red sandstone by containing beds of gypsum.

2. *Their mineral contents.*—Excepting a minute quantity of gypsum, this rock is wanting in that mineral and rock salt—and this seems to be the principal difficulty in deciding whether it is the new red sandstone; since these minerals are so generally present in that formation, and are regarded as characterizing it. But since it is admitted that limestone may occasionally be absent from it, without destroying its geological identity, why may not gypsum and rock salt be sometimes wanting, without taking away its essential characteristics?

In this rock, however, other minerals occur, that are somewhat peculiar to the new red sandstone. Copper may be mentioned, which is frequently found near the junction of this rock with the greenstone; and also to some extent disseminated through its layers. In Germany, it is well known that one variety of this group, the copper slate, is wrought as an ore of that metal. The sulphates of baryta and strontia are found, also, in our rock, as they are in the new red sandstone in England: and the same is true in respect to magnetic iron sand.

3. *Their organic remains.*—A few years since, there were found in one of the coarser varieties of this rock in Connecticut, the remains of a vertebral animal, of what kind, has never been ascertained. But, as no vertebral animal, except perhaps a few fish, has been found below the new red sandstone, the presumption is, that the rock in the valley of the Connecticut, containing these remains, cannot be older than the new red sandstone. The occurrence of birds, so low down in the rock series, however, contrary to all pre-

sumption, shows us that little dependence is to be placed upon such an argument as this, to prove the rock in question, to be new red sandstone. But the Ichthyolites occurring in it, present a much stronger case. They belong to the genus Palaeothrissum, and are found in bituminous shale, or what used to be called bituminous marlite; and the specimens, both of the fish and the rock, so exactly resemble those from the new red sandstone of Mansfeld, in Germany, that an able European geologist, to whom specimens were sent, could not distinguish them. This genus, also occurs at Autun in France, and at one or two places in Great Britain, in the new red sandstone, and in that alone. How can it be doubted, especially when the other evidence to the same point is considered, that it is the same rock in Massachusetts, in which they are found? It ought to be stated, that one of the localities of ornithichnites, occurs only a mile distant from the most abundant locality of ichthyolites in Sunderland, and almost on the same continuous layers of rock.

These statements, it seems to me, decide, beyond all reasonable doubt, the geological situation of the ornithichnites that have been described. But if any are not satisfied, it ought still farther to be stated, that no geologist, who has examined the sandstone of this valley, has ever suggested that it is more recent than the new red sandstone. For the most part, they have placed it lower in the series; regarding it either as the coal formation, or the old red sandstone. So that all would agree that these ornithichnites are at least, as low down as the new red sandstone. If they are lower, their situation is still more surprising.

Since the deposition of this sandstone, no geological change seems to have taken place in this valley, except the deposition of a thin and apparently very recent tertiary, or quaternary formation, composed of horizontal layers of clay and sand; and afterwards those diluvial and alluvial agencies succeeded, which have been in operation in every part of the globe.

Having now given such a statement, as I am able, of the facts in this case, and shown, if I mistake not, the geological position of the ornithichnites, I trust, I may be indulged in a few theoretical considerations.

The circumstances under which these tracks were made, furnish a topic of enquiry that will suggest itself to every mind; and it seems to me that the true theory on the subject, can hardly be mistaken by any intelligent man, even although not acquainted with the principles of geology. He sees that the rock on which the impressions are made, is composed of mud and sand; and although he may not be able to explain how these materials were consolidated, yet he can hardly doubt but this rock was once in a soft state, and that these tracks were then made.

Thus far, it seems to me, all must agree. And when, as already remarked, we see upon the mud that covers these rocks, where they pass under the waters of the Connecticut, the tracks of living birds, exceedingly analagous to those upon the dry rocks, can we doubt that we witness the precise mode in which the ornithichnites were produced;—and especially when we find that the character of the foot, and the length of the step, indicate that most of the birds that formed them, must have had the habits of the existing waders or Grallæ, we cannot but infer that the impressions on the ornithichnites were made by the birds of the new red sandstone era, that frequented the margins of estuaries, streams and lakes, whose muddy shores, where they trod, were afterwards converted into the existing rock.

I know it has been usual, to regard the early geological changes on the globe, as having taken place in a very different manner, from those which are now going on; and I cannot resist the conviction, that the intensity of the causes has varied exceedingly at different times; but this could affect only the magnitude, not the similarity, of the results; and I have been struck with the remarkable resemblance between the state of things, as shown by these ornithichnites, to have existed so many thousands of years ago, and that now passing before our eyes. Our imaginations are carried back by these relics, to that immensely distant period, when the new red sandstone birds were travelling along the shores of the then existing estuaries or lakes, just as is now done by congeneric races.

There is, however, one striking point of difference between the ancient and the modern races. I refer to the enormous size of many of the former. Some, indeed, appear to have been no larger than the smallest of existing birds of their class: but what shall we say of those that produced the *O. giganteus* and *ingens*, taking strides of four feet, as their ordinary step! As to their real size, we may forever be left to conjectures. But I am not sure that a practiced comparative anatomist, could not determine the size of a bird, having the size of the feet, and the length of the step given. I shall not attempt the problem any farther than to state one fact by way of comparison. The African ostrich, (*Struthio camelus*) the largest of known birds, has a foot only ten inches long, reckoning from the back part of the heel to the extremity of the claw;* and yet, it sometimes weighs eighty or one hundred pounds, and in walking, its head is as high as that of a man on horseback; or from seven to nine feet. May we not infer, that some of these ancient birds, whose feet are sixteen or seventeen inches long, must have been almost twice as heavy and high as the ostrich? I do not believe that any man will doubt this, after having examined their tracks. From a few trials, I do not believe that the legs of a bird, (including the thigh,) whose ordinary step was four feet, could have been much less than six feet.

Such must have been the feathered tenants, that once occupied the now delightful valley of the Connecticut. At that time, we have every reason to believe that valley to have been an estuary: for the organic remains of the new red sandstone, are chiefly marine, as is shown in my Report on the Geology of Massachusetts. And to show that other organic beings, that were cotemporaries with these huge birds, were their compeers in size, I would refer to a description in that work of a sea fan, (*Gorgonia Jacksoni,*) found in the new red sandstone of West Springfield, that has been uncovered without reaching its limits, eighteen feet in length, and four feet in width! Indeed, the colossal bulk of these birds, is in perfect accordance with the early history of organic life in every part of our globe. The much higher temperature that then prevailed, seems to have been favorable to a giant like development of every form of life.

The enquiry is often put, by those who examine these ornithichnites, how near the spots are, where they are found, to Connecticut river: and when told, that for the most part, they occur upon its immediate banks, they often infer, that the rock was deposited by that stream; but the geologist knows that the Connecticut river, certainly not then in existence, has had nothing to do with the deposition of the new red sandstone, that forms its banks; and from the facts mentioned in the last paragraph, he infers, with strong probability, that it was deposited beneath the ocean, and has since been elevated.

Another enquiry often made, is, how deep in the quarry the tracks are found? But this in the view of the geologist, is of less impor-

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* For this fact, I am indebted to Prof. Mussey of Dartmouth College, which he obtained from a skeleton of the ostrich in his museum. He adds, also, that "the length of the leg, viz. the distance from the hip joint to the ground, is four feet and one inch, and the distance of the head from the ground is seven feet and eight inches. The elevation of the head, it is obvious, must vary with the direction of the axis of the body, which, as the skeleton now stands, is not quite horizontal, but rises a very little anteriorly." All that is now wanting, to enable us to form a probable estimate of the size and height of the bird that produced the *O. giganteus* and *O. ingens*, is the length of the ordinary step of the ostrich. If I may be allowed to conjecture, I should say, that the head of the new red sandstone bird must have been elevated from twelve to fifteen feet above the ground!

tance than their situation, in respect to the formation generally. In point of fact, they occur only a few feet below the immediate surface of the rock, where the excavations are made. But they are found on the western margin of a formation some miles in extent, reckoning across the strata; and those strata dip to the east several degrees; so that in fact, all those strata whose edges crop out to the east of the quarries containing the tracks, were deposited above the Ornithichnites, making a perpendicular thickness of rock of several hundred feet, over these relics, instead of six or eight feet. Indeed, at the locality in the south west part of Montague, the layers containing the Ornithichnites pass laterally under Mount Toby, which rises six or seven hundred feet above the spot, so that it is perfectly fair to say, that these foot marks are found several hundred feet deep in the rock. But this statement, although adapted to make a popular impression, is by no means as striking to the geologist, as the fact that they occur in the new red sandstone at all; for he knows, that since the deposition of that rock, there has been time enough for the formation of those vast masses of rock, constituting the oolitic, cretaceous, and tertiary groups, each of them many thousand feet in thickness, and formed by slow processes; and the only reason that they are not piled immediately above the Ornithichnites is, that the causes, by which those particular sorts of rock have been formed, have not here operated. In other words, after the new red sandstone was deposited, no new rocks were added, in this part of the world, during the immense periods in which the groups above named were in the process of formation in Europe.

Admitting that these tracks were originally produced by birds, travelling upon mud, let us enquire in what manner the process of covering them up, and of their consolidation, would take place. Alluvial deposits, it is well known, are arranged in layers, brought on by the successive charges of mud and sand, diffused in the waters; and these will be finer or coarser, according to circumstances. If a bird be quite heavy, its foot would sink considerably deep into these layers, either breaking through them, or, if plastic, causing several of them to bend downwards. Yet, I apprehend, that the lighter birds would rarely make any such indentation, that would sensibly affect the layers of mud more than an inch deep. But as successive layers of mud were deposited, after the impression had been made, if the movement of the water were very slight, they would be scarcely thicker where the track existed, than in other places; and consequently, the impression would be continued upward for a considerable distance, the slighter indentations first disappearing, and finally those that were deepest; so that, after the mud had been consolidated into stone, several successive layers might be split off, each one containing an Ornithichnite. In the highest layer the track would be smallest, and its more delicate extremities would be wanting. Each successive layer beneath, would exhibit it more and more perfect, until the precise layer was reached, on which the bird originally trod. A few layers beneath this, might exhibit the track imperfectly, but it would soon be lost. Now, by looking back to my description of the actual manner in which the Ornithichnites occur, it will be seen that the facts correspond to these deductions of theory.

The results above stated, however, would be very much modified by circumstances. The more quietly the deposition took place, after the track had been impressed upon the mud, the longer time would it require, and the greater the number of superimposed layers, before it would be effaced. But if a sudden and more tumultuous rise of waters, either from a land flood, or a violent storm acting on the ocean, should bring a coarser coat of materials over the track, somewhat violently, it might be filled up and effaced at once, as the specimens show was sometimes the case. Or should the matter deposited in the track, assume a concretionary form, so as in fact to become a real petrified foot, the depression in the superimposed layers would almost immediately disappear, as I find to have been the case frequently with *O. giganteus* and *O. tuberosus*.

There is one fact respecting these foot marks, which deserves to be mentioned, and which is not so easy to explain. Where successive layers of the rock are bent downwards by the impression, the curves are sometimes not placed perpendicularly above one another, but they are considerably oblique; so that when the track is visible on both sides of the specimen, on one side it appears thrown forward, or backward, or laterally, an inch or two. I have noticed as great a difference as this, where the rock is not more than an inch thick.

I can conceive of only two modes in which such an effect could be produced. It could result, as it seems to me, in no way, from a slide of the animal's foot in the mud. But suppose the impression made in mud, which was so very yielding that a slight action upon it would cause the upper portion of it, almost suspended by the water, to be carried somewhat forward, in the direction in which the disturbing force impelled it. Suppose now, either winds or floods should produce a gentle current, where a track had been made in such mud; might not the impression be gradually slid a little from its original position, without injury; and if the cause continued to act, as the successive layers were deposited, might not all the disturbance which we witness, have been thus produced? Or, suppose the track was made on very yielding mud, which had a rapid slope beneath the waters; is it difficult to conceive how, as the new layers of mud were deposited, the mere force of gravity would cause them slightly to descend, and thus carry downward the track, without effacing it?

I have asserted that these tracks must have been made in a spot which was constantly, or frequently, beneath the waters; for if made on dry land, instead of having a new deposit brought over them quietly, to preserve them, they would be exposed to rains, and other denuding and disturbing agencies, that must speedily deface, if not obliterate them. Judging from what we now see of the tracks of living animals, a single month, nay, often a single week, or a day, would be sufficient to destroy them. And even if, in some rare cases, abundant rains and floods might cover the spot with a new deposit, yet ordinarily the action must be so violent, as to ruin the track; but beneath the quiet waters of an estuary, or lake, or even of a large river, after a few layers of mud had been brought over them, they might remain, for aught I can see, age after age, uninjured. The quiet waters above them would be their security. For these reasons, I suspect, that in almost every case, these tracks must have been made beneath still waters. I can, indeed, conceive it possible, that a track might be preserved, although made above low water mark, provided that an early but not violent rise of the waters should cover it with a thick deposit of mud. And yet the chances, even in such a case, are very much against its preservation, long enough to be converted into stone; so that, whatever objections the ornithologist may raise, against admitting that all the tracks which I have described were made by Grallæ, it seems to me, that the exigencies of the case require us to suppose them produced by birds, whose habits were those of Grallæ.

The most interesting aspect in which the facts that have been stated present themselves to the geologist, is as to the evidence they afford of the very early existence of birds, among the inhabitants of our globe. Heretofore there has been no proof of their existence, until within a comparatively recent period. But it now appears, that they were among the earliest of the vertebral animals that were placed on the globe. The discovery of some monument, that reveals the history of a people, a few hundred years earlier than had before been known, affords a high gratification to the antiquary. But in these simple foot marks, the existence, and some of the habits, of an interesting class of animals is proved, at a period so remote, that the entire population of the globe has since been changed, at least once or twice, and probably several times more. For, to say nothing of minor divisions of the strata, the animals and plants of the secondary rocks must have all been extinct, before the creation of those in the tertiary deposits, and most of these last must have ceased to exist before the production of the present races. The number of years that have since elapsed, we cannot even conjecture; for, in respect to all the races of animals and plants that have occupied the globe, previous to the existing tribes, the scriptures are silent, giving us to understand merely, that a period of indefinite duration intervened, between "the beginning" and the creation of man; and geological monuments, although they clearly point out successive epochs in the natural history of the globe, yet furnish us with few chronological dates.

It may prove, also, an instructive lesson to the geologist, that the mere foot marks of these early animals should have remained so distinct, although every relic of their skeletons has disappeared.* If birds lived during the deposition of new red sandstone, they doubtless existed during the formation of each successive group of rocks to the highest. Yet, with perhaps one or two very doubtful examples, no trace of them is found in all the wide interval between the red sandstone and the tertiary beds around Paris.† Surely, the geologist will be led to enquire, whether he has not been too hasty in inferring the non-existence of the more perfect animals and plants, in the earlier times of our globe; and whether, after all, it may not be that they did exist, even along with the earliest animals and plants, which we now find imbedded in the strata. The recent discovery of phenogamian vegetables in Scotland, below the coal formation, gives additional force to this suggestion.‡

In pursuing my investigations on this subject, I confess that I was greatly surprised to discover so readily, so many distinct species of the Ornithichnites, or rather distinct genera of birds, for such I can hardly doubt they are. All the present Grallæ in Massachusetts do

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* Their bones may yet be found.—*Ed.*

† Dr. Mantell has recently described them in the Wealden, below the chalk—above the oolite. See our micellanies.—*Ed.*

‡ Observations on Fossil Vegetables; by Henry Witham, Esq. Edinburgh, 1831.

not exceed twenty genera, and fifty species; yet I have found at least seven tracks, (and were I to express my own convictions, I should say ten,) so distinct that they must have been made by different species, if not genera, and that too, in three or four quarries, that have been opened only a few rods square. I exceedingly doubt, whether any three spots of that size can now be found in the valley of the Connecticut, where the tracks of a greater number of the existing species of birds occur on the mud. Shall we then say, that the birds of the new red sandstone era were as numerous as they now are? Perhaps it would be unsafe, from such premises, to draw such an inference; yet, if any birds existed then, why may they not have been even more numerous, in a climate so favorable to their development, than at present?

I have met with only one account of any thing similar to what I have now described, and that is the statement of the Rev. Mr. Duncan, respecting the foot marks of a quadruped upon the new red sandstone of Dumfries-shire, in Scotland, ascertained with much probability to be those of a tortoise. Judging from his account, and the accompanying lithographic plate, in the eleventh volume of the Transactions of the Royal Society of Edinburgh,* I should infer that these impressions will not compare in distinctness, with those in the valley of the Connecticut. It is interesting, however, to learn, that tracks made on new red sandstone, on both sides of the Atlantic, have been preserved to the present day.†

I am aware that the presumption derived from geological analogies, is decidedly opposed to the facts and inferences, which I have presented in this memoir; for it goes to prove the existence of birds, nearest in the perfection of their structure to the Mammalia, among the very earliest of vertebral animals; a few saurians and fishes only having been discovered, as low as the new red sandstone.‡ Hence I expect that geologists, as they ought, will receive these statements and conclusions, not without hesitation and strong sus-

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* For the loan of which I am indebted to the kindness of Dr. N. Bowditch.

† In a catalogue of scientific works that have been published within a few months past, in Europe, lately brought within my reach, I find one by Jabez Allies, printed in London, "on certain curious indentations in the old red sandstone of Worcestershire and Herefordshire, considered as the tracks of antediluvian animals, &c." but I know nothing more of these impressions, besides the title of this work.

‡ Tracks of marmpial or quadrumanial animals have been recently discovered in new red sandstone, in Germany. See our miscellanies.—*Ed.*

picions, that I may have been deceived. I too, at first, was entirely sceptical; for in former geological excursions, I had so often found that the reputed foot marks of animals, were but the result of aqueous or some other alluvial agency, or of human skill, that I would scarcely turn out of my path to see an example;* but I soon perceived that here was something entirely different. Yet had I found only a single specimen, however distinct, I should still have disbelieved. Or had I found the tracks at the quarries, sometimes a depression, and sometimes rising above the surface, I might have styled them concretions. Or had I found little or no correspondence between the impressions, and no regular succession of steps, I should have attempted to account for them in some other way, or have left them unexplained. But when I found that in all these respects, there was no room for scepticism, when I saw that the right and left foot could be clearly distinguished, when I could hardly distinguish

* Encouraged by the facts that have been detailed, and led to hope for success from several very glowing descriptions that I had received of foot marks upon stone in Rhode Island, I was led recently to perform a journey of two hundred and fifty miles, for their examination. They occur about two miles north of the village of Wickford, on the road to Providence; and every person of whom I enquired, within twenty miles of the spot, seemed to be acquainted with the impressions there, under the name of "the Devil's Track." But I saw no evidence of any agency there, except that of water. And it seemed to me that the only reason why every one does not impute the effects to water, is the difficulty of conceiving how a stream could have ever flowed in that spot for a long time, as it must have done, to produce the excavations; for it is near the top of a ridge of gneiss rock, passing into mica slate; and no excavation exists that could have formed the bed of the stream. But the geologist is not surprised to find marks of powerful aqueous agency any where on the earth's surface, even though he cannot explain its *modus operandi.* I could not explain it satisfactorily in this instance; for the direction of the current seems to have been from N. E. to S. W. or the contrary, and I know of no other marks of aqueous agency in New England, (except existing streams,) where the waters moved in either of these directions; but that the excavations called tracks, were the result of running water, I can have little doubt. They extend for several rods in the direction in which the rocks run, and imagination has made some of them resemble the foot of a man, others of a dog, and others of an animal with a hoof. I saw but one or two that had much resemblance to any of these, and in some instances, they were a foot or two in length, and generally from one to four inches deep. But if you found one of them resembling the foot of an animal or a man, you could not find any corresponding impressions in any direction to show a succession of steps. I might proceed much further with this description, and present sketches of some of these excavations; but I judge it unnecessary, as similar ones may be seen wherever water has been running for years with violence over rocks. Yet from the strong impression that exists on the public mind, as to the mysterious if not supernatural manner in which these excavations were made, I should not think it strange if several generations should pass away, before the delusion vanishes.

the tracks of living birds from those on stone, and when among hundreds of examples which I have seen, not one was opposed to the idea of their being the veritable foot marks of birds, it seemed to me that the case was a very strong one. It would be strange if I should not have failed to get at the exact truth, on every minor point of the subject; especially as my insulated situation in respect to Zoological collections, has prevented me from making all the comparisons which I could wish; but I shall be happy to be corrected wherever I am erroneous, even if it be in my fundamental conclusions; and with no little trouble, I have made such arrangements, that for a reasonable return of specimens in natural history, especially petrifactions, I shall be able to furnish geologists, who may desire them, with accurate casts of my best specimens colored so as to resemble the rock; and probably with some specimens in the rocks; while my own specimens will always be accessible to their inspection; so that if the views I have presented, are not satisfactory to geologists, I shall at least have put within their reach, the means of arriving at the truth.

Art. XXI.—*On Currents in Water;* by Alan W. Carson.

Whitemarsh, Montgomery County, (Penn.) 2d mo. 17, 1835.

TO PROFESSOR SILLIMAN.*

About twelve months ago, I received a letter from my friend, George Kenderdine, an ingenious and scientific master millwright, in which he stated that Samuel D. Ingham had called his attention to the circumstance, that water drawn out of a vessel, through an aperture in the middle of the bottom, acquires a rotary motion in an opposite direction to the apparent motion of the sun; and stating that after much thinking upon the subject, he believed he had discovered the cause, which he explained at considerable length. With his permission the letter was read at a meeting of the Montgomery County Cabinet of Natural Science, and after making some enquiry into the subject, it was believed that few persons had noticed the circumstance of the revolutions being always in the same direction, and for aught that could be discovered, it did not appear to have

* We have retained this paper for some months, wishing for an opportunity to examine the facts in the case; but as this has not been in our power, and as the communication is well written, we conclude to give it room, and let it take its chance with the scientific world.—*Ed.*

been accounted for. I therefore asked and obtained permission to forward, for publication, a brief sketch of his theory, which, if it shall be found to be new, and worthy of insertion in the American Journal of Science, may hereafter be more fully explained and illustrated, by further extracts from the original letters, in my possession. The following is a brief abridgment and rather free version of part of his letter.

If a tub or other vessel be filled with water, and a hole made near to the middle of the bottom to discharge it, the water will acquire a rotary motion from west to south, or opposed to the apparent motion of the sun; and if means are used to produce an opposite motion, upon withdrawing those means, the former direction will be resumed. This cannot be the effect of chance, but of natural laws, constantly operating.

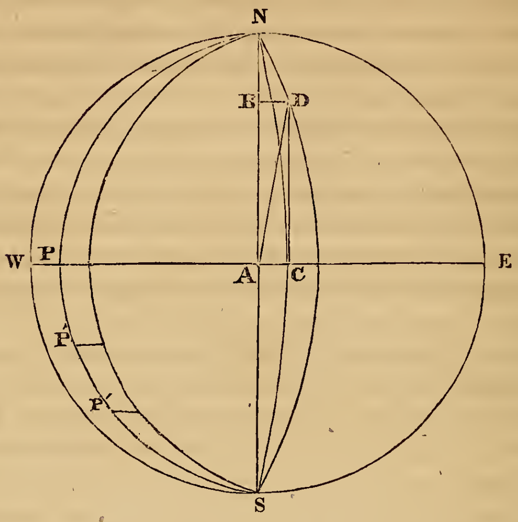
Whirlpools appear to be produced by the force of currents, nearly, but not exactly, opposite in direction, for in a vessel of fluid discharging at the center of its bottom, gravitation causes the fluid to move from all parts of the circumference towards the center; and if, in obedience to this law only, the particles all moved *directly* towards the center, and met there, there could be no whirlpool, because the currents from the opposite directions would exactly balance each other, and no impulse would be given to produce a whirling or rotary motion; it would therefore seem to be evident, that the particles of fluids passing from the circumference, and discharging downward at the center, do not move in a direction *exactly* towards the center, and meet there, as in that case no whirlpool would be formed; whereas it is found by experience, that under common circumstances the rotary motion is always produced.

The cause producing this effect, I believe to be the rotation of the earth on its axis, which may be explained as follows.

At the equator, any point P is carried forward in an easterly direction, with a greater velocity than any other point P′ at any place between the equator and the poles, at which latter places progressive motion entirely ceases. Therefore, if a body at the equator was projected due north, it would only be in case of an instantaneous passage, that the track on the earth, over which it passed, would be a north and south line; for if time was taken in the passage, it would be in a direction eastwardly of north, inasmuch as the motion eastwardly, which it had at the time of its projection, would continue, and by the composition of forces, the body would move in a direction between north and east.

Suppose it possible to project a body due north from the equator, to reach the sixtieth degree of north latitude in one hour.

Fig. 1.



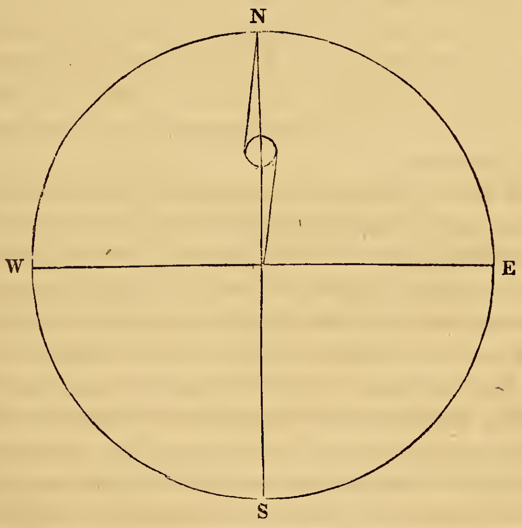
Let EW (fig. 1.) represent the equator, and NS a meridian, on which a body is projected from A, to reach B, in the sixtieth degree of north latitude, in one hour, in which time the point A would be carried to C, fifteen degrees eastwardly. Now, according to the law respecting forces, the body thus impelled in two directions, viz. towards B and C, would not move in a direction towards either, but upon the diagonal line AD between them, arriving at the latitude of sixty degrees north, at the distance of thirty degrees of longitude eastwardly from the meridian upon which it was projected, equal to fifteen degrees of longitude measured upon the equator. In this calculation no allowances are made for resistances; it is only used to show that bodies passing northwardly or southwardly are deflected from their course by the motion of the earth upon its axis.

Upon the same principles, it may be shown, that a body projected from the north pole towards the equator, would arrive at the latter place upon the westerly side of the meridian upon which it was projected.

This may be illustrated by causing a horizontal plane to revolve about its center, when by rolling a ball upon it from the circumference towards the center, it will be found to pass forward in the direction of the motion of the plane, and when rolled towards the circumference, it will fall behind the part towards which it was directed.

If the waters of the North Pacific Ocean were discharged by an under current or aperture, at the latitude of forty five degrees, upon the foregoing principles, the currents from the pole would pass upon the western side of the aperture, and those from the equator upon the eastern. These currents would therefore not meet to balance and destroy each other's force, but falling upon opposite sides of the center of the aperture with opposite directions, and being acted upon by the attraction of gravitation, producing a current from the higher surface at the circumference of the aperture, towards the less elevated part near its center, by the composition of forces a rotary motion would be produced in the direction of east, north, west, south, (fig. 2.)

Fig. 2.



I am aware that some persons may be satisfied that the cause assigned is sufficient to produce the effect upon large bodies of water, who may not believe that any possible effect can be produced by it, on the contents of a small vessel, as a tub or bucket, the diameter of which, when compared with the distance from the equator to the poles, seems to shrink into nothing. They, however, should recollect, that if any cause thus acts upon large bodies of fluids, a like action, not differing in kind, must be exerted upon the smallest and most minute quantity; and that a perfect equilibrium will be destroyed, by the least appreciable disturbing force.

If the cause assigned is the true one, we may deduce the following consequences.

1. That whirlpools and whirlwinds, in the southern hemisphere, revolve in the contrary direction to those in the northern.

2. That at the equator this tendency to rotary motion does not exist, and if such motion is produced by other causes, the direction will be determined by the cause producing it.

3. That this cause, producing whirlpools, acts with more force near to the poles, than near to the equator.

4. And that, in a long narrow vessel, a whirlpool will be more readily formed, when the vessel is placed north and south, in the direction of its length, than when placed east and west in that direction; inasmuch as the currents from the east and west are not influenced or acted upon, so as to produce a difference in direction, by the motion of the earth on its axis.

The motion, caused by the diurnal revolution of the earth, of any point P′ on its surface, is as the cosine of the latitude of that point; and the tendency to produce whirlpools increases or decreases, as the ratio of the cosines of the consecutive degrees of latitude increases or decreases.

It is therefore probable, if the foregoing theory is true, that the tendency to produce whirlpools exists, in different degrees of force, in every different parallel of latitude, and that the rotary motion produced in fluids, contained in vessels of equal size and under equal circumstances, will differ in velocity and force in different latitudes, and that the velocity and force will be constant in the same latitude. It is therefore possible that an instrument may be formed, by which the latitude may be determined, especially towards the poles, where it would be most sensible, and where it is most needed. It is not expected that such an instrument would supersede those now used for the purpose, but that it would be a valuable addition to them, when

"Nor sun, nor moon, nor stars appear."

As the truth or falsity of this theory may be established, by determining whether whirlpools move in different directions in the northern and southern hemispheres, it is desirable that this should be enquired into by scientific travellers, for if it shall be confirmed, it will afford additional data for accounting for currents, trade winds, and other motions in fluids, and will be additional evidence of the diurnal revolution of the earth.

ART. XXII.—*Of the Parallelogram of Forces;* by Prof. THEODORE STRONG.

SUPPOSE that two forces denoted by x and y, whose directions form a right angle, are simultaneously applied to a particle of matter M; to find the direction and quantity of their resultant.

Put P=3.14159, &c. = the semicircumference of a circle whose radius =1, z = the resultant, and θ = the angle which its direction makes with that of x, then $\frac{P}{2}-\theta$ equals the angle which its direction makes with that of y.

Since z, is the resultant of x and y, it is manifest that x is that part of z which acts in the direction of x, or that x denotes the value of z, when resolved in the direction of x, also y represents the value of z, when resolved in the direction of y; and z equals the sum of the values of x and y, when resolved in the direction of z.

If x equals y, it is evident that the direction of z bisects the angle $\frac{P}{2}$, which the directions of x and y make with each other, $\therefore \frac{P}{4}$ equals the angle which the direction of z makes with that of x or y in this case; put $x=y=n'z=$ the value of z when resolved in the direction of x or y, then we shall manifestly have $n'x, n'y$, for x and y, when resolved in the direction of z, whose sum must equal z, hence $n'x+n'y=2n'x=z$, or since $x=n'z$, we get $2n'^2z=z$, or $n'=\sqrt{\frac{1}{2}}=\cos.\frac{P}{4}$, by trigonometry; also by trigonometry, if n represents any integral number, (which we shall suppose to be positive,) $\cos.\frac{P}{4}=\cos.\left(\frac{P}{4}+2nP\right)$, $\therefore n'=\cos.\left(\frac{P}{4}+2nP\right)$. Put $\frac{P}{4}+2nP=a$, (1), then suppose the direction of a force represented by z' bisects the arc a, or makes the angle $\frac{a}{2}$ with the direction of x; it is evident that z' may be considered as the resultant of two equal forces R and S, of which R acts in the direction of x, and S in the direction of z, which makes the angle a $\left(\text{or } \frac{P}{4}\right)$ with that of x, supposing R and S, to be resolved in the direction of z'. Let x' equal the value of z' when resolved in the direction of x, and suppose that we have $n''z'=x'$, (2); then, since the directions of R and S, make equal angles with that of z', each of which is expressed by $\frac{a}{2}$ which equals the angle made by the direction of z', with that of x, we shall evidently have n''R and n''S, for the values of R and S, when resolved in the direction of z', whose sum must equal z', $\therefore n''(R+S)=z'$; hence (2) becomes $n''^2(R+S)=x'$, (3).

Again, by resolving S in the direction of x, we have by what has been proved, S cos. a=the value of S when resolved in the direction of x, and by adding R, which acts in the direction of x, we shall have S cos. a+R $=x'$, since by the nature of the components and their resultant, the resultant when resolved in any direction, must equal the sum of the components when resolved in the same direction; hence by substituting the value of x' in (3) we get S cos. a+R$=n''^2$(R+S), or since R=S, we have $2n''^2=1+$ cos. a, (4), but by trig. $1+\cos. a=2\cos.^2\frac{a}{2}$, $\therefore$ (4) becomes $n''=\cos.\frac{a}{2}$, (5). By (5), we have $n''z'=z'\cos.\frac{a}{2}=z'$ resolved in the direction of x; and in the same way for a force z'', whose direction makes the angle $\frac{\frac{a}{2}}{2}=\frac{a}{2^2}$ with that of x, we shall have $z''\cos.\frac{a}{2^2}=z''$ resolved in the direction of x, and so on; hence, if Z denotes any force whose direction makes the angle $\frac{a}{2^m}$ with the direction of x, where m represents any positive integer, and if X denotes the value of Z, when resolved in the direction of x, we shall get Z $\cos.\frac{a}{2^m}=$ X, or by restoring the value of a, we have Z $\cos.\left(\frac{\frac{P}{4}+2nP}{2^m}\right)=$ X, (6). Hence, the force z, whose direction makes the angle θ with that of x, is easily resolved in the direction of x; for since the integers m and n, are arbitrary, they may evidently be taken such, that $\frac{\frac{P}{4}+2nP}{2^m}$ shall differ from θ by an angle less than any given angle, that is we shall have $\frac{\frac{P}{4}+2nP}{2^m}=\theta$; $\therefore$ by (6) $z \cos. \left(\frac{\frac{P}{4}+2nP}{2^m}\right)=$ $z \cos. \theta = z$ decomposed in the direction of x, $=x$; or $z \cos. \theta = x$, (7); and by changing θ into $\frac{P}{2}-\theta$, we have $z \cos. \left(\frac{P}{2}-\theta\right)=z \sin. \theta = y$, (8); by adding the squares of (7) and (8), since $\cos.^2 \theta + \sin.^2 \theta = 1$, we have $z^2 = x^2 + y^2$, (9); hence by (7), (8), (9), two forces x and y, whose directions form a right angle, have for their resultant the diagonal of the rectangle, of which they are the adjacent sides. The usual rules for compounding and resolving forces, can now be easily obtained, but for these, we must refer to Vol. XXVI, No. 2, Art. V, of this Journal, to which this paper is intended as a supplement. We will add that the method here given is new to us, and if we do not greatly err, it is as simple as the nature of the subject admits.

Note.—We have in this paper used (for brevity,) the term angle, to denote arcs, whether they are greater than two right angles or not.

MISCELLANIES.

FOREIGN AND DOMESTIC.

1. *Fifth Meeting of the British Association for the Advancement of Science at Dublin, Ireland, July,* 1835.—In our No. for April, 1835, we gave some account of the proceedings of the British Association for the advancement of Science at Cambridge University in 1833, and at Edinburgh in 1834. The recent meeting at Dublin, (August, 1835,) appears to have been equally spirited and interesting, as its predecessors, and we are indebted to the London Atheneum for a detailed account, from which we have room to extract only a few notices.

The President of the Association, was the Rev. Dr. Lloyd, Provost of Trinity College, Dublin.

Vice Presidents, Lord Oxmantown and Rev. Wm. Whewell, of the University of Cambridge.

Secretaries, W. R. Hamilton, astronomer Royal of Ireland, and Rev. W. Lloyd, Prof. of Nat. Philos.

Treasurer, Henry Aspen, M. D.

The Association was divided into six sections, which met daily between 11 and 3 o'clock.

Section A. Mathematics and General Physics.
B. Chemistry and Mineralogy.
C. Geology and Geography.
D. Natural History.
E. Anatomy and Medicine.
F. Statistics.

Able men were appointed to take charge of each of these sections, which held daily sessions, and reports were made, from time to time, to the general meeting.

Our limits will not allow us to follow them in detail; we can present only a few notices of more important and interesting things.

Aurora Borealis.—Sir John Ross read a paper on the origin of the Aurora Borealis, the result of twenty five years of reflection on the subject; he having frequently noticed that the aurora took place *between* two not very distant ships, also between the ship and an iceberg. He concluded, long since, that Wollaston's opinion, that this meteor takes place at great altitudes, must be erroneous; and he came to the conclusion, that it was caused by the sun's rays striking on the circumpolar fields of ice and glaciers, and then reflected from very thin clouds aloft in the atmosphere.

A theory of a similar nature, was presented by a correspondent in Vol. xix, p. 235 of this Journal, with the omission of the effect of the icebergs.

Protection of Iron from the action of salt water, by attaching to it portions of zinc, to alter its electrical state. Experiments were detailed by Mr. Davy, made at Shingstown, upon wrought iron buoys. Such experiments, originally suggested by Sir H. Davy, have been successfully made by Dr. Revere in this country.

Strong attraction for the magnetic needle, was stated by Mr. Fox, to be exerted by iron cooled down to a low red heat, while the same metal running in fusion produced no such effect.

Mr. Fox considered this fact to be of great importance in geological discussions respecting the central heat of the earth.

Carbonate of magnesia discovered in lava, immediately after the recent eruption of Vesuvius, was considered by Dr. Daubeny as the result of sublimation by the volcanic fire.

Suspension of respiration by the whale.—Dr. Houston in a paper on peculiarities in circulating organs in diving animals, stated it to be a well established fact, that a whale can suspend respiration for twenty minutes, and sink to the depth of an English mile in the ocean. This fact is very familiar to whalemen, and is frequently observed by all who sail in regions of the ocean occupied by whales.

Instruction of children.—From a report by Mr. Langton of Manchester, it appeared that in a population of 200,000, there are 50,000 children, of whom two thirds between the ages of five and fifteen, are educated at common schools, and one third receive no instruction whatever, while in Prussia and several of the German States, all children of every class between seven and fourteen, are by law obliged to attend school, and it appears by statistical returns that they generally do so.

Age of Peat Mosses.—Prof. Babbage brought forward a plan for ascertaining the age of Peat Mosses by annual layers of the trees found in them. If for instance, there were two wide rings separated by a narrow one, it would show that at some period, two years of favorable growth had been divided by one unfavorable year; and it is possible that by observing similar rings in some very old trees still standing, we might be able to ascertain the period of their growth to have been the same as that of the timber found in bogs or mosses. This subject, as far as regards the growth of trees was ably illustrated by Mr. Alexander C. Twining, in a notice in this Journal, Vol. xxiv, p. 391. There can be no reason to doubt that this opinion is well founded, and we have now lying before us decisive evidence, that ligneous layers were deposited of a very different thickness, in different seasons, in ancient as well as in modern times. We allude to a section of a fossil tree from Antigua, which we have caused to be cut and polished; its diameter is eleven inches by six, and its surface about sixty square inches. It presents the annual layers with the most perfect distinctness, as much so as recent wood of any kind whatever. These layers vary in thickness from one fourth or one third of an inch, to one fifteenth or even one twentieth of an inch; there are about fifty layers, indicating, according to common opinion, the same number of years, and in some parts several thin layers, and in others several thick ones succeed each other, and in other parts thick and thin alternate, indicating all the variety of seasons that exists now on the earth.

Heat.—Prof. Whewell at the conclusion of an able paper upon heat, remarked that the sun is, from day to day, pouring upon the earth a quantity of heat; this, as it descends by the conducting powers of the parts of the earth, follows certain laws of increase and decrease; and the entire quantity of each year descends to a certain depth, where it is succeeded by the quantity thrown upon the earth in the preceding year, which has not yet been dissipated; below that, lies the stratum occupied by the solar heat of the preceding year, and so on, until at length, at a certain depth, this solar heat ceases to be perceptible. He shewed that the mean annual quantity of this solar heat, was such as would melt fourteen metres, or about forty five feet of ice, encircling the entire surface of the earth. He next considered the central heat of the earth, and the experiments and observations by which its existence was placed beyond doubt, and the law of its distribution, as it ascended to the surface, traced; and he stated that the issue from the surface at each part was so much in a century, as could be capable of melting three metres or about ten feet of ice heated upon that surface. He then discussed the subject of Cosmical heat—shewing the probability that the regions of space were not of a uniform temperature; and hence he concluded that all the bodies of the solar system had a tendency to acquire the temperature of that part of space in which they are placed; and that the heat of the planetary spaces, was only about 50° below the freezing point.

Sound.—Prof. Reid stated, that when the English fleet was engaged in the blockade of Copenhagen, being in a very extended line, ships at the one end distinctly heard, and recorded in their logs, a loud cannonade which they heard on a particular day, and it was afterwards found, by a comparison of the logs of the ships, that this very cannonade proceeded from the proving of large pieces of ordnance which had been conducted for the greater part of a day, at a dock yard, in the vicinity of one end of the fleet, from which the other end, at which the reports were heard, was distant (if the reporter heard correctly,) some hundreds of miles. Dr. Reid then showed how the reverberating of sound, from the ceiling, walls and floor of a room, by being continued too long, and interfering with each other, would have the effect of producing a confusing noise, and thus interfering with the hearing of the succeeding parts of the discourse.

He concluded that low roofs to buildings, and consisting of many planes, set at various angles, rough and interrupted walls, and a floor possessing very little resilience, such as earthen floors do, or, if boarded, then much broken and interrupted by irregular seating, produced a building best suited to the hearing of a speaker in many directions.

Resistance of fluids to bodies moving in them.—Mr. Russell stated, that the law of resistance most relied on since the days of Newton, was that the resistance increased as the square of the velocity, and that this law did not cease until the resistance became very great. But there is a wide difference between a body totally immersed and one partially floating. Mr. Russell had been enabled, by the liberality of the canal commissioners, to make experiments upon a very great scale; the result is, that a canal boat is more and more retarded, up to a certain velocity, when the resistance becomes a maximum; and that, beyond this, the velocity being increased, the resistance actually diminished, and consequently the force of traction required to keep up that velocity, was less than the force of traction required to keep up a less; by which it happened that there was a velocity, below which it would be less profitable for a ship or a boat to be propelled, than any velocity above it, a circumstance of no small importance to canal companies.

Consumption of coal in steam engines.—Mr. Taylor stated, that the work done, in the best engines now employed in Cornwall, by the consumption of one bushel of coals, required, ten or twelve years ago, the consumption of two bushels; that during the period of Bolton and Watt's patent, four bushels were consumed to do the same work; and that, in the earlier stages of the employment of steam power, the quantity of coal used was sixteen bushels. The steam engines now at work, in the mines of Cornwall, are equal in power to at least forty four thousand horses.

Trap Dykes.—In the west of Ireland are many trap dykes, seven of which, described by Archdeacon Verschoyle, run parallel through the counties of Sligo and Mayo, for forty, fifty, and even sixty miles, with a thickness often of forty feet.

Prof. Sedgwick expressed his conviction, that the effect of trap dykes on limestone, is to convert it into dolomite, by introducing into it magnesia, in some unknown mode.

Mr. J. Bryce stated, that when columnar trap is present in the north of Ireland, chalk and other secondary rocks are generally absent, and that the Giant's Causeway does not, as is commonly supposed, rest upon chalk rocks.

Belemnites and Fishes, according to Prof. Phillips, are confined to the chalk and oolites; they have long since disappeared from the earth, and are very analogous to the chambered shells of the Cephalopodæ. Prof. Phillips pointed out the peculiar characters of the belemnites, and stated that he had identified thirty four British species. Prof. Agassiz of Neufchatel, showed that belemnites differed from recent cuttle fish, chiefly in the superior development of particular organs. This very able naturalist, in consequence of researches conducted entirely by himself, has discovered that the coal formation, the oolites, and the chalk, have a set of fishes peculiar to them, and distinguishable by certain fixed characters from the fishes of every other formation. Fishes are, therefore, the most exact chronometer in geology; and their distribution may be accounted for, by considering, that being of a high organization, they were unable to survive changes in the inorganic world, which would not prove fatal to mollusca and zoophytes. It would appear, from the position and appearance of many of the remains in the seas, that great portions of these formations were very suddenly deposited.

Fossil forest near Glasgow.—This is seen at the aqueduct over the Kelvine river, and consists of a number of trees, standing in an upright position, and throwing out roots in all directions, just as if they had grown on the spot. They rest on nearly horizontal strata of sandstone, at the bottom of a quarry, and terminate upwards at the height of a few feet, as if cut right across. The trees are all dicotyledonous, and some of them are so near one another, that it is difficult to conceive how they grew. The quarry is covered by diluvium, many rolled fragments of which must have come from the northwest, thus confirming what was shown at a former meeting, by Mr. Bryce, respecting the diluvial currents of the north of Ireland. Prof. Sedgwick suggested, in explanation, that as the trees were probably of the fir tribe, they may have been nearly bare of branches and have grown close together: the celebrated Craigleith tree was not vertical, like these, but lay obliquely across the strata.

The two north magnetic poles, seem to revolve around the poles of the earth, in periods which never exceed four thousand years: it is worthy of remark, that the rock strata, all over Europe, range in the same direction as the lines of equal magnetic intensity.

The ancient stratified deposits of the border counties of England and Wales, have been elaborately examined, during several years, by Mr. Murchison and Prof. Sedgwick, in different parts.

Mr. Murchison has discovered extensive deposits, covering a large tract, before unexamined, in which fossils teem—many of them of new and varied forms, and all of perfect organization, and much higher in the scale of being than it was formerly supposed possible that such ancient deposits could have contained. Mr. Murchison's splendid work on this region is, we believe, already published in England.

A toad in sandstone, was discovered at Park Gardens, Coventry, during the making of excavations now in progress there; "the animal was reinstated in his narrow bed by the engineer, but it survived only four days."

Longevity of the yew tree.—Mr. Mackay produced a section of a yew tree, which proved that it must have been more than five hundred years old. Another person mentioned the well known stump near Bangor, which was calculated to be more ancient than the Christian era.

Fixation of the spines of the echinus; this is effected by immersing the animal, for some time, in chloride of lime, dissolved in water, when the spines become perfectly fixed; whereas, when they are dried in the common way, they usually fall off.

Hydatids found in human muscles.—Dr. Shoe, of Canaan, stated the remarkable fact, of a horse leech having entered the skin of a young girl, near the ancle, and having lived for some time in the cellular tissue of the limb, without exciting uneasiness; but inflammation and an abscess coming on, an incision was made in the thigh, when the animal was discharged in high activity.

The polarity and dip of the compass needle in different places, were attributed by Captain Sabine, to the existence of two northern and two southern magnetic poles of the earth; numerous maps were exhibited, by which the progress of the lines of no variation was represented, from time to time, and a suggestion thrown out of the necessity of an expedition to the South Seas, to discover the position of the southern magnetic poles. In Halley's time, one of them was near Van Dieman's Land, and the other in or near Terra del Fuego.

The line of no dip, (or lines of places where a well balanced needle would be horizontal,) is not a great terrestrial circle, but differs most materially from it; the curves of no variation have an easterly motion in the northern, and a westerly motion in the southern hemisphere. The Russian government engaged Prof. Hansteen to proceed to Siberia, to observe the magnetic dip, variation and intensity; he returned two years since, and has fully established the fact of a second pole existing some where in that neighborhood. Captain Parry was engaged, at the same period, near the other magnetic pole in the north.

Proportion of rain at different heights in the air.—Prof. Phillips has ascertained, that as you ascend, the quantity of rain increases; this was proved by three rain guages placed on York Minster, one on the top, one on the ground, and one midway.

Electricity retained in a vacuum.—Mr. Snow Harris, in opposition to the idea that electricity is retained in excited bodies by the air which surrounds them, stated that he had succeeded in retaining the electrical charge, for some days, upon a brass ball enclosed in a vacuum, so perfect that the air pump guage showed the exhaustion to be two hundred and ninety nine parts in three hundred; an electrometer, connected with this ball, showed an almost unimpaired degree of divergence, for more than twenty four hours. This statement has been confirmed by an eminent practical philosopher in London.

Galvanic machine.—In this Journal, Vol. xx, p. 340, may be seen a drawing and description, by Mr. now Prof. Joseph Henry, of a galvanic machine, invented by him, which is upon exactly the same principles as the one described below. Prof. Henry's invention is long prior to those which in different countries have claimed this discovery.

The Rev. Mr. Ganby exhibited the working model of a machine, for producing moving power, by the application of electro-magnetic influence. The model consisted of a pendulum, the lower part of which was a magnet, placed with its poles opposite to the ends of two horse shoe bars of soft iron, around which were coiled helices of wire, so arranged that by the end of the helices dipping into cups of mercury, the poles of a simple galvanic battery could be alternately made to communicate with the cups in one order, and the next instant the machine reversed that order, by means of a system of bent wires, caused to vibrate upon an axis, the ends of these bent wires alternately dipping into one pair of cups and the next vibration into another; by these means, the soft iron horse shoes are at one instant a magnet, with the poles in one order, the pendulum being then attracted towards both these poles; but the next instant, the poles being reversed, the pendulum is thrown forcibly back, while the opposite soft iron horse shoe is now a magnet, ready to attract it; then again it is thrown back from this second temporary magnet, by the instantaneous reversing of its poles, and so on. The model worked smoothly and with a very uniform, regulated motion, and appeared to be capable of working for a great length of time. Mr. M'Gauley stated, that the erosion of the zinc plate was so inconsiderable, that there was hardly any limit to the length of time that the model would continue working. The acid best suited to this purpose, was a mixture of one part nitric, two parts sulphuric, and one hundred water; he also stated, that, in practice, the acid could be always renewed, by having a constant dropping of fresh acid liquor into the trough, while a similar gentle discharge of the spent acid from the trough could be kept up. He stated, that a numerical comparison of the economy of this mode of producing motive power, with that depending upon the agency of steam, would give a vast preponderance in favor of this method, while the part of the power consumed in working the machine itself might be left entirely out of the account, since the apparatus which changed the poles in this model, would equally suffice in a machine capable of working with the power of one hundred horses. In this model, he only worked with one of the two soft iron magnets, and its power was only that of lifting seven pounds, and yet this appeared sufficient to overcome all the friction, inertia, and other impediments to motion, of the several parts of the machine.

Heights of mountains, &c. according to Col. Sykes, are ascertained with sufficient accuracy for every practical purpose, by a common thermometer, of accurate construction, applied to boiling water, whose temperature is lower as the station is higher, according to a well known ratio.

2. *Report of the fourth meeting of the British Association for the Advancement of Science.*—This handsome 8vo. volume of seven hundred pages, we have just received, as a gift from the Association. It contains the following important reports.

1. Report on the geology of North America, Part I, by Prof. H. D. Rogers.

2. Report on the laws of contagion, by Dr. William Henry, of Manchester.

3. Report on animal physiology—on the blood and its circulation, by Prof. William Clark, Univ. Cambridge.

4. Report on zoology, by Rev. Leonard Jenys, M.A. F.L.S. &c.

5. Report on capillary attraction, by Rev. James Challis, late Fellow of Trinity College, Cambridge.

6. Report on physical optics, by Prof. H. Lloyd, Univ. Dublin.

7. Report on hydraulics, as a branch of engineering, by George Rennie, F. R. S. &c.

An account of the transactions of the sections is annexed, under the heads

1. Mathematics and Physics.
2. Chemistry and Mineralogy.
3. Mathematical instruments and mechanical arts.
4. Natural History, Anatomy, and Physiology, including Botany, Zoology, and Geology.
5. Anatomy and Physiology.
6. Statistics.

We have no room for an analysis of the reports, and of the doings of the sections we gave some account in Vol. XXVIII.

The following notice, by Dr. Clark, on account of its practical bearing on our vast manufactures of iron, we copy entire.

Application of the hot blast to the production of cast iron.—In the Clyde iron works, near Glasgow, during the first six months of the year 1829, every ton of cast iron required for its production eight tons, one and one fourth hundred weight of splint coal, reduced to coke, at a loss of fifty five per cent.

During the first six months of the year 1830, after the application of Mr. Neilson's invention, when the air had been heated to about 300° Fahr., every ton of cast iron required five tons, three and one fourth hundred weight of splint coal, converted into coke. Adding eight hundred weight of coal, consumed in heating the air, the saving effected was two and a half tons of splint coal, on every ton of cast iron produced; and the same blast was found to be capable of making much more iron, the diminished requisite of air being pretty nearly proportioned to the diminished fuel required. But during the first six months of the year 1833, when the temperature of the blast had been raised to above 600°, and when the process of coaking the coal had been discovered to be superfluous, and was accordingly omitted, a single ton of cast iron was produced by only two tons, five and one fourth hundred weight of splint coal. Even when we add eight hundred weight of coal to heat the air, the quantity of splint coal required in 1833, to make a ton of cast iron, was nearly one third of what was used in 1829. The blast machinery continued the same, but the same blast made twice as much iron as in 1829. The same coal produced thrice as much cast iron; the same blast twice as much.

The iron furnaces alluded to are worked twenty three hours out of the twenty four; a half hour every evening, and another every morning, being occupied in letting off the iron produced. During every working hour, the solid materials which feed the furnace at the top, amount to two tons almost exactly, while the air forced in at the bottom, in the same time, amounts to the surprising quantity of six tons.

Since a smelting furnace must have a very elevated temperature, in order to work it favorably, when we consider the cooling effect of six tons of air an hour—two hundred weight a minute—supplied at the bottom of the furnace, and entering near the hottest part, it is easy to account for the increased energy of the furnace, when this prodigious refrigeratory is removed, by heating the air before it passes into the furnace.

We feel, however, bound to add, that Mr. Hartop made to the late scientific Association at Dublin, a communication respecting the use of hot air in iron blast furnaces in Yorkshire, in which he stated, that this mode of supplying the smelting furnaces possessed but few advantages, and also deteriorated the iron, which had, consequently, fallen much in value; but in the course of a conversation which ensued, several gentlemen stated, that the price had not so fallen in other parts of the country.

Long continued effect of heat on mineral substances.—Rev. W. V. Harcourt stated at the Edinburgh meeting in 1835, that the blast furnaces at Low Moor, are sometimes regularly worked for twelve years or more; but the average is six or seven years. The Elsecar furnace, is sometimes blown out at the end of three years. During these periods, the iron is in constant fusion on the hearths—the bottom stone is always at that temperature, and some portions of the side walls are at a still higher heat, and when the furnace is *blown out*, the walls cool with extreme slowness.

The bottom stone, about sixteen inches thick, is worn half through by the action of the melted iron, so that a pool of that metal lies in the hollow; the cracks are filled with melted metal which occasionally penetrates into the sand, on which the stone is laid, and fuses it. It is in metal thus detained within the bottom stone, that the segregation of metallic titanium takes place in the iron, or clusters of cubes in accidental vacuities.

This notice contains a detailed statement of arrangements, very ingeniously made to expose various minerals, and their elements duly mixed and arranged in hollows in the hearth stones plugged by a similar stone, or in hollows in the sand beneath, or in the back wall of the hearth, and when the furnaces are again opened we may look for some interesting and instructive results. The Elsecar furnace, in which these experiments were arranged, commenced working in October, 1833, and may be expected to blow out at the end of 1836.

Ancient race of men in the Andes.—J. B. Pentland stated, that in ancient tombs of very beautiful architecture, among the mountains of Peru and Bolivia, and in the great inter-alpine valley of Titicaca, and on the borders of the lake of the same name, are found the remains of a race, in whose crania two thirds of the entire weight of the cerebral mass is placed behind the occipital foramen, the bones of the face being very much elongated.

The tombs are probably between seven hundred and eight hundred years old, and probably belonged to a race of men, who inhabited the elevated regions between the fourteenth and the nineteenth degrees of South Latitude, before the arrival of the present Indian population, which greatly resembles the Asiatic races of the old world.

3. *Lyell's Geology, 4th London Edition, four Volumes,* 8vo. 1835.—The rapidity with which new editions of this excellent work have appeared, sufficiently evinces the estimation in which it is held. Its execution is in strict accordance with its title.—"Principles of Geology, being an enquiry how far the former changes of the earth's surface, are referable to causes now in operation."

We are indebted to the industry, good judgment and great science of Mr. Lyell, for a lucid and highly interesting exhibition of facts, and for a logical and candid discussion of principles. He has done much to recal geologists from extravagant speculations, and to allure them back to a course of strict induction; thus placing geology, side by side, with the other sciences of observation. If he has repressed the excursions of our imaginations into unknown scenes in unknown ages, he has exalted our conception of the number and magnitude of great geological events, which have happened within the historical era, and which are embraced, even within the brief span of a protracted human life. While, therefore, he does not permit us to imagine that great catastrophes were, in a sense, peculiar to the earliest periods, he proves that catastrophes and great movements have been common in all ages, and that there is an incessant onward march in physical operations, which permits not the earth to rest for one moment, without changes, the accumulation of which is constantly preparing the way for results which become great in the progress of time. As, however, there was a time when the world began to be, and its elements were called into existence, either in freedom or in combination, we do not perceive that we are prohibited from indulging in any speculations, regarding the nature or energy of early chemical and mechanical operations, which the known constitution and laws of matter may sustain by adequate evidence or high probability. Any degree of intenseness of energy in primary movements, may thus far, be admitted as a supposition, for the sake of argument.

The publication of Mr. Lyell's work forms an era in geology; it must be studied by every person who would be acquainted with the present improved state of the science, and happily the study will prove no task; for the lucid and beautiful style of the author, embellished by occasional classical flowers, gives this work almost as peculiar a character as its novel philosophy. As a mere book of elements, by which to learn geology, it cannot supersede other valuable works that have preceded it, but while the author, with so much active industry, continues to travel, observe, correspond and read; his new editions will be sure to maintain their ground.

The present edition is greatly improved by additions, corrections and embellishments, and we should be happy to see it republished in this country, in a style worthy of its great merits.

4. *Notice of a new mode of preserving Animal Bodies.—Communicated at the Editor's request*, by Mr. Henry N. Day.—The following account of an interesting discovery, recently made in Italy, is taken from a pamphlet published in Florence, during the last summer.

The author of the discovery, Sig. Girolamo Segato, is already favorably known to the scientific world, as the author and engraver of improved maps of Africa and Morocco. Ardent in the pursuit of science, he traversed the deserts of Northern Africa, and by his researches, corrected and considerably advanced the knowledge of those regions. It was while travelling in these parts, that he received the first hint of this great discovery. In the path of one of those interesting phenomena of the African deserts—a vortex of sand—which his curiosity pompted him to trace, he, one day, discovered a carbonized substance, that upon closer investigation proved to have been originally animal matter, and to have been carbonized by the scorching heat of the sand. He afterwards discovered an entire human carcass, partly black, partly of a sooty hue, about a third less than the ordinary size of man, and all perfectly carbonized. It occurred to him that this accidental process of nature, might be imitated by art, to the perfect preservation of animal substances. To discover *how*, occupied now his whole attention. At the end of some months, devoted to this pursuit, the happy thought flashed upon his mind, which was to lead him to the discovery of the desired secret. Compelled to return to Italy, by a dangerous malady brought on by nearly a week's exposure to an unwholesome atmosphere, in a pyramid of Abu-Sir, which he had entered for the purpose of extending his scientific researches, he was obliged to intermit for a time his favorite pursuit; but after regaining his health, he again gave himself to it with renewed ardor; and after a short time succeeded, to the highest degree of his most sanguine expectations.

The following are some of the results obtained by the discovery.

Entire animal bodies yield as readily to the process, as small portions. They become hard, taking a consistency entirely stony. The skin, muscles, nerves, veins, blood, &c., all undergo this wonderful change; and to effect this, it is not necessary to remove any part of the viscera. The color, forms and general characters of the parts remain the same. Offensive substances lose their smell. Putrefaction is checked at once. What is most wonderful of all, is that if the process be carried only to a given degree, the joints remain perfectly flexible. Skeletons even remain united by their own natural ligaments, which become solid, although they retain their pliancy. Moisture and insects never injure them. Their volume diminishes a little; the weight remains almost the same. Hair continues firm in its place, and retains its natural appearance. Birds and fishes lose neither their feathers, membranes, scales, nor colors. The insect preserves its minutest appendage. The eyes in most animals, sparkle as in life, and from their want of motion alone would you suppose vitality extinct.

The following are some of the objects, that have been subjected to the petrifying process, and are now exhibited in the studio of Sig. Segato. One of the first of his experiments, was performed upon a Canary bird, (Fringilla Canaria, Lin.) It is still preserved unaltered, although it is now ten years since the experiment was performed; and it has been submitted to the action of water and of insects. A parrot (Psittacus aestivus, Lin.) retains its original brilliancy of plumage, unimpaired. Eggs of the land turtle, turtles, various tarantulae, a water snake, a toad, various kinds of fish, snails and insects, are in a perfect state of preservation. To these, are added various parts of the human body. A hand of a lady, who died of consumption, preserves the emaciation of the disease and of death. Another of a man is flexible in the different phalangic articulations, and yet unalterable; a foot with the nails perfectly fast, a collection of all the intestines of a child, in their natural colors and forms, with the fecal matters unremoved; the liver of a man who died from intemperance, dark and lustrous like ebony; an entire human brain with its convolutions, of extreme hardness; the skin of a woman's breast, naturally configured; a pate of a girl perfectly flexible, from which the hair hangs in curls; the head of an infant partly destroyed, and discolored by putrefaction. There is also in the cabinet of Sig. Segato, a table constructed as follows. A spheroidal surface of wood contains a parallelogram, composed of two hundred and fourteen pieces, regularly arranged. These to the eye appear like the most beautiful pietre dure that have been produced by nature. Their various colors, polish and splendor, and their surprising hardness would leave no doubt of their stony character. The sharpest file, with difficulty, makes an impression on any of them; some it does not attack at all. These pieces, are all portions of the human body, hardened by this new process; as the heart, liver, pancreas, spleen, tongue, brain, arteries, &c., &c., all resembling the most highly polished precious marbles. An entire body has not yet been tried, principally on account of the limited resources of Sig. Segato, although the expense would be but about one tenth of that of embalming by the ordinary process.

Great advantages to science, especially to natural history and human anatomy, are expected to result from this discovery; and it is even confidently believed that the remains of friends, of men of science and of worth, may be preserved for ages in the exact form and appearance, in which the hand of death found them, with nothing offensive or revolting about them.

As vouchers for the accuracy of the statements contained in the pamphlet, the certificates of many of the ditinguished physicians, professors and men of science in Florence, where Sig. Segato resides, are appended. Among them, it is sufficient to mention the names of Sig. Betti, Professor of Physiology; Sig. Zannetti, Professor of Human Anatomy; and Dr. Gazzeri, Professor of Chemistry.

5. *Remains of birds in the strata of Tilgate Forest, Sussex, England.*—We are informed, in a letter from London, dated June 23, 1835, that Dr. Mantell had then recently communicated to the Geological Society of London, a paper on the remains of birds found in the Tilgate Grit, (ferruginous sandstone,)*—that years since, he had ventured to assert, that the thin bones found in the sandstone of Tilgate forest, belonged to birds, and not to Pterodactyles. Although this opinion has been controverted by some eminent geologists, the recent discovery of a metatarsal bone has placed the matter beyond all doubt, and although the bone is in mere fragments, yet certain characters are preserved, which prove that it belonged to some species of wader. There is an oval cavity, in such a situation in the bone, as to prove that it was intended for the attachment of the bone of the hind toe or thumb, and the high position of it shows, that the bird belonged to those which frequent marshes, and require a long hind toe.

6. *Specimens from Dr. Mantell.*—With a very ample collection of the fossils of the chalk and other connected formations, from Dr. Mantell, (which, with several previous donations from him of the same kind, afford us the means of fully understanding that portion of English geology,) we have recently received

1. A model of a tibia of the Iguanodon, from Tilgate forest.
2. Two models of teeth of the Deinotherium.
3. (The gigantic tapir of Cuvier.)
4. Model of the head of the Dodo in the Ashmolean Museum of Oxford.

Having heretofore, received a model of the femur and knee of the Iguanodon, with the vertebræ, ribs, teeth, spines, &c. we are in a condition to appreciate the peculiar characters, and especially the colossal dimensions of that stupendous reptile. The bones were like timber,

* Situated below the chalk; this is not so low as the Stonesfield slate, near Oxford, in which bones of birds have been found; but the geological position of the tracks described in our present No. by Professor Hitchcock, is much lower than either.—*Ed.*

and, by comparison, throw into insignificance, the largest reptiles of our present terrene crust.

7. *Recherches sur les Poissons Fossiles, par L'Agassiz, &c.*—We mentioned this splendid work, and its plan and object, in Vol. XXVIII, p. 193. We have received from the author the fourth livraison, the third not having come to hand; the first and second have been before acknowledged. We have also received four of the folio parcels of plates, containing in the whole eighty six plates.

This learned and important work is carried forward by Professor Agassiz with great spirit and energy, and we are happy to observe that he is liberally and zealously assisted by naturalists and public bodies, in different countries, and especially in the British islands. We should be gratified, if he were cheered on, from this distant country, by a liberal subscription. As yet, we are apprized of only a few copies that have been ordered for the United States, but trust that the number will be considerable in the end.

The work will be of the greatest utility, in determining the different species of fossil fishes, that have been or may be developed in our immense territory.

8. *Gradual rising of parts of Sweden, and of other countries around the Baltic.*—This fact, which has been observed for a century past, has been ably investigated by Mr. Lyell, the eminent English geologist, of whose observations there is an abstract in this Journal, Vol. XXVIII, p. 72, and the paper of Mr. Lyell, giving all the most satisfactory details, has been since published in the Transactions of the Royal Society, and received by us from the author.

We have the pleasure, also, of presenting the opinion of an eminent Swedish philosopher, whom we consulted on this point, and although the letter, dated Stockholm, July 4, 1835, in which it is contained, was not intended for publication, we do not hesitate to cite the opinion.

The fact of the gradual rising of the land, is considered by the Swedish philosopher as fully established, on the basis of observation. Mr. Lyell, in the summer of 1834, having reviewed all the marks cut in the rocks, and also other proofs of a similar nature, returned to Stockholm, with the happy results of his investigation. It is remarked by our correspondent, (than whom there is no more competent judge,) that the phenomenon in question appears to be a natural consequence of the high temperature of the interior of the globe, which being, as most geologists suppose, in a state of gradual refrigeration, the incandescent nucleus suffers contraction, and the surrounding or enveloping mass, as by its own pressure it adapts itself to the retreating nucleus, necessarily cracks, rising in some places and sinking in others, so that there will remain few points in which there will have been no alteration. In Sweden, the gradual elevation of the ground is attended by subterranean reports, with a rolling movement, apparently proceeding from north to south, perceived at different points in Sweden and Finland, but not sufficiently powerful to produce projections through the surface of the earth.

There is hardly a year, in which there are not notices in the Swedish gazettes, of one or two subterranean reports. The phenomenon in question, appears to be a necessary consequence of the contraction of the globe, and that fact being admitted, theory would lead us to expect the result, as it is observed in Sweden.

We may add then, that similar results may be expected in other countries. Subterranean noises have been long observed in the region of the Connecticut river, near Haddam, attended, at times, by considerable movements of the earth. The writer has been, for many years, in possession of statements of facts on this subject, and has been waiting for a convenient opportunity to visit and examine the region. Any authentic communications respecting these remarkable movements, would be very acceptable. These reports have been always known by the name of the "Moodus noises"—Moodus being the Indian name for Haddam.

9. *Extract of a letter to the Editor, from a gentleman in England, dated Scarborough, Oct.* 12, 1835, *with a notice of a Plesiosaurus and other fossils, and of remarkable human remains,* (not fossil,) *&c.*—I fortunately came to this place, about six weeks ago; the week after my arrival, a magnificent Plesiosaurus, measuring near sixteen feet without neck or head, was found in the alum shale, nine miles north of Whitby, which I have purchased. It will require the whole of the winter to arrange this splendid relic of ancient days; when that is completed, you shall hear more about it. This specimen was found in the alum shale, at the bottom of which are also found most curious fish, vulgarly called scale fish, (Lepidotus latissimus,) and will be properly described by M. Agassiz, in the

work he is to present to you. I merely mention this, to let you know the possibility of your finding similar remains, should you know of similar deposits.

You are aware this is a most interesting geological district, including, from the River Tees to Flamborough Head, about seventy miles, the new red sandstone, lias, and different members of the oolitic series, up to and excluding the chalks. Lately, two deposits have attracted much notice, one found reposing immediately upon the Speeton clay, containing numerous specimens of the Cardium Edule, trochus, &c. and seventy feet above the level of the present sea. This must prove the one of two things, either that the land must have been elevated by some unknown cause, or the ocean must have receded. Upon this there are now at least forty feet of diluvium. The other is at Bridlington quay, and lying npon the chalk. Mr. Phillips, now professor in the London University, and who has written the geological history of this country, is of opinion, that it may be intermediate between the London clay and the Bordeaux basin; but a Mr. Bean, who has the finest collection of British shells in the world, has already found several species, similar to the crag. Before six months are over, the fossils contained in it will probably decide this important question. Mr. Bean gave me a piece of wood he found in it, which, by slicing, I have proved to be a true dicotyledon, differing from any wood ever found below the chalk. I have sent it to Dr. Lindley, who, by his comparisons with the woods found in the tertiary deposits, may perhaps at once state its position.

In this immediate neighborhood was found, in 1834, in a large tumulus, a coffin, made of the trunk of an oak, roughly hewn at the extremities, containing a human skeleton, quite perfect. The bones were much larger and stronger than those of a more recent date. It was pronounced to be of Anglo-Saxon or Roman origin; and this week another barrow or tumulus has been opened, which, from the absence of all metals, &c. is supposed to be older than the one above mentioned.

The Dublin scientific meeting, you will perceive, has gone off well, and the next meeting is fixed to be at Bristol.

I am not aware of any other new or striking geological facts, which have very lately occurred in this country.

It is rather a singular coincidence, that whilst the inhabitants of old Ebor, (York,) are busy in forwarding plans for quick and easy communication with other places, by steamboats and railways, news should this week arrive from New York of the formation of a public company, for a similar purpose. It is expected that the passage from Liverpool to New York, will be effected in twelve days.

10. *Volcanic eruption.*—An interval of eleven days elapsed, between the appearance of the meteors in America, and the outbreak of Bochet Kaba, a volcano of Palambang, Nov. 24, 1833. The eruption was most dreadful; the whole of Java was shaken by earthquakes, with inundations from a lake on the mountain called Telaga Ketjiel, which covered several hamlets to the depth of twenty one feet, leaving a mud deposit, seven feet thick. Kaba is one hundred and fifty miles from Palambang, and yet the water of the great river Moessie was unfit to drink for weeks, owing to its mephitic mixtures. As late as February, 1834, there were floods and great rains, and Telo Mojo, a mountain of the province of Najassinar, sank down in consequence.—*Journ. de la Haye.*

11. *Diamond, matrix of, &c.*—Sir David Brewster states, (London and Edin. Jour. Oct. 1835,) that Dr. Voysey has shown that the matrix of the diamonds produced in southern India, is the sandstone breccia of the clay slate formation; and that Captain Franklin has found, that in Bundel Kund, the rocky matrix of the diamond is situated in sandstone, which he imagines to be the same as the new red sandstone of England; that there are at least four hundred feet of that rock below the lowest diamond beds, and that there are strong indications of coal underlying the whole mass. Sir David Brewster, from certain cavities observed in diamond, and from their effects in polarizing light, is led to conjecture, "that the diamond originates, like amber, from the consolidation of, perhaps, vegetable matter, which gradually acquires a crystalline form, from the influence of time, and the slow action of corpuscular forces."

12. *Proceedings of the Fifth Meeting of the British Association.*—The London Atheneum of October 31, informs us that an account of the doings above named has been published by Mr. Hardy of Dublin, in a handsome quarto, illustrated by maps, plans and drawings. We are glad to hear that this volume has appeared so early; its predecessors have not appeared until a year after the respective meetings.

13. *Collection of Saurian Remains, made by Mr. Hawkins.*—This unparaleled collection has been purchased for the British museum, on the appraisement of Prof. Buckland and Dr. Mantell, for £1400 sterling. We are much gratified to learn that so splendid an addition—unique among fossils—has been secured to the British National Museum.

14. *Some observations on a disease affecting the leaves of the vine, and on a new species of Mucedinea*, by J. E. Duby. Read before the Society de Physique et d'Histoire Naturelle de Genève, 2d October, 1834, and taken from the Memoirs of this Society, T. vii. Part i. (Bibliothèque Universelle des Sciences, &c. Fevrier, 1835. p. 128. 8vo. Geneva.)—It is certainly remarkable with what astonishing rapidity the vines along the Lake have this year been deprived of their leaves, although the fogs and rains, their usual enemies, have been quite unfrequent. On an attentive examination of these leaves, I observe on their inferior surface a greenish ferruginous down, and in so great abundance as to cover one's clothes on coming in contact with them. Examined with a lens, it presents the appearance of a woolly felt with a silvery extremity to the fibres, and it is soon recognized as a fungus of the family Mucedineæ.

It first appears here and there on the inferior surface of the leaf in small tufts of a deep green color, which by degrees extend themselves, till shortly they cover it entirely. These tufts proceed from the parenchyma, and are composed of numerous straight jointed filaments interlacing one another. Immersion in water alters much the appearance of the plant. When dry, the joints appear twisted, are contracted in some parts, and dilated in others. In water, they immediately inflate themselves, become cylindrical, and exhibit 2–5 transverse striæ, which appear to be septæ or partitions. Each filament is composed of 1–7 of these joints, quite unequal in size, and in the number of their striæ. Almost immediately on its immersion in water the joints separate from one another, and arrange themselves side by side.

These characters prove the plant to belong to the family Mucedineæ, tribe Byssineæ, and section called by me in Le Botanicon (II. pag. 30.) Cladosporiæ, whose distinctive character is that the filaments are wholly or in part moniliform, the joints separating themselves to become the stock of a new filament, and sometimes a new tuft. Although the characters of the genus *Torula* Pers. (to which, because of a want of distinctive characters, I would unite the Hormiscium of Kuntze) do not exactly apply to our Mucedinea, yet I hardly consider it advisable to form a new genus, and I would therefore name it, as it appears to be an undescribed species, *Torula dissiliens*.

After its first appearance on a leaf it rapidly extends itself, the leaf becomes crisped and variously contorted, changing to a black color as the fungus increases, and in a few days becomes completely dry, and falls in a powder. Some fields have thus been entirely deprived of their leaves, and notwithstanding the beauty of the season, the grapes deprived of the effects of the reflection of the solar rays and the circulation of the sap, have not attained the degree of perfection that was to be expected. The vineyards along the lakes were first attacked, but by degrees the disease has reached the distant heights. I have frequently met with this Mucedinea about Geneva, and have received specimens from Coppet, Nyon and Morges.

Its description in technical language is as follows:

Torula dissiliens, cespitulis fusco-virescentibus, demum confluentibus et hyphasma intertextum late expansum constituentibus, filamentis erectis strictis simplicibus aut parce ramosis pellucidis articulatis, articulis 1–9 subæqualibus cylindricis distincte 1–6 septalis utrinque obtusis humiditate secedentibus.

15. *On Mercaptan*, by M. Zeise. (Annales de Chimie, T. 56, p. 87.)—When the Sulphovinate of potassa, baryta or lime, is heated in a distilling apparatus, with a concentrated solution of protosulphuret, deutosulphuret or hydrosulphuret of Barium, the sulphovinate is changed into a sulphate, and there is formed an ethereal liquid, which is condensed with a little water in the recipient, without the disengagement of sulphuretted hydrogen. This liquid, purified and deprived of its water by means of chlorid of calcium, is lighter than water, colorless, of an odor excessively penetrating, somewhat resembling assafœtida or garlic, and has an extremely strong taste. It takes fire readily, and gives off when burning the odor of sulphurous acid. Distilled with care there are obtained two substances, the least volatile of which is *Thialic ether*, and the other *Mercaptan*.

Mercaptan is a limpid liquid even at +10°, and is destitute of color. Its odor is peculiar, and approaches that of garlic or assafœtida; its taste is sweetish and ethereal; density =0.842, boiling point +111. It is slightly soluble in water, but very much so in alcohol or ether.

It combines with Potassium, giving up its Hydrogen, and produces a saline mass, colorless and very soluble, which gives a yellow precipitate with the salts of lead, and a white with the deuto-chlorids of mercury, gold and copper. When placed in contact with the deutoxyd of mercury, the mercaptan attacks it with violence, and there is produced a colorless crystalline body, (mercaptid of mercury,) together with some water.

The mercaptid of mercury melts at 187°, commences to change its appearance at 257°, and is decomposed at 347°, with the disengagement of *thialic oil.* It is insoluble in water and alcohol, and is not acted upon by a concentrated solution of potash, and probably not by any of the acids except the nitric.

The mercaptid of Gold is colorless and destitute of lustre. The mercaptid of Platinum changes into a sulphuret by calcination. The mercaptids of Potassium, &c., have an alkaline reaction. In a dry state, no change is caused by a heat of 212°: In solution, however, the effect of heat is soon apparent.

It is very remarkable that the composition of mercaptan corresponds exactly with that of alcohol.

16. *Experiments upon the chemical action of the electrical currents produced by the influence of terrestrial magnetism and electro-dynamic magnets, &c.*, by M. Botto, of Turin. (Translated from an extract from the author's work, in the Bib. Univ. des Sciences, &c. Fev. 1835, p. 120. 8vo. Geneva.)—The apparatus by means of which M. Botto has been enabled, through the influence of terrestrial magnetism, to obtain electrical currents capable of exercising a chemical action, consists of two cylindrical bars of soft iron five feet in length and six inches in diameter, each spirally wound with copper wire, and set in motion by means of part of the apparatus of an old electrical machine. The opposite extremities of each of the bars, in their revolution, passed before and near those of two prismatic bars, also of soft iron, ten feet long, ten inches wide, and three inches thick, and placed in the direction of the dipping needle. By means of a galvanometer, the presence of two contrary cur-

rents, successively produced *by influence* was easily observed; the needle of the instrument suffering a deviation which caused it to pass through nearly an entire circumference. Two pieces of platina wire inserted into a vessel of acidulated water and placed in the route of these currents, produced no trace of chemical decomposition. A substitution of iron wire, however, gave rise to bubbles of hydrogen, resulting from the oxydation of the wire. But on putting the bars in motion, so as to cause the currents developed *by influence* to pass through the liquid, the evolution of gas was much more abundant, and increased with the acceleration of the rotation.

By a peculiar arrangement of his apparatus, M. Botto succeeded in obtaining separately the two contrary currents, and according to the one passed through the liquid, caused a development of gas at the one or the other pole. The same effects were obtained when a platina wire was substituted for one of the pieces of iron wire, except that the quantity of evolved gas was more or less considerable according as the current *by influence* coincided with that proceeding from the small voltaic battery of iron and platinum. When silver wire was used, with a solution of sulphate of copper, metallic copper was deposited on the negative wire.

After studying the effects which result from the opposition of the electro-magnetic currents, to those produced by the voltaic elements, our author paid particular attention to a fact, observed by Marianini in regard to the latter, but studied by him with respect to the former. The fact is, that if the copper arc which unites the two liquids terminates at one extremity in a point and at the other in a broad plate, the transmission of the electro-magnetic current is the most free when the current passes from the liquid through the plate, and consequently from the point into the liquid.

The reverse is the result when a non-oxydable metal, as platinum, is used.

M. De la Rive explains this phenomenon by supposing that the oxydation which takes place at the positive point of the metallic arc, facilitates the communication and compensates for the less extent of surface in contact with the liquid; a compensation which does not happen when the current passes in the contrary direction, as oxydation then takes place on that portion of the surface, which because of its greater dimensions gives the easiest passage to the current. Marianini finding that platinum produces sometimes similar phenomena with an oxydable metal, and sometimes the contrary, does not admit the explanation of the philosopher of Geneva, but is inclined to attribute the anomalies in the transmitting power of platinum, to the variation in its electro-motive force, resulting from the voltaic current, and not from the liquid conductor.

To settle this question our author has made some experiments upon platinum and some other metals with an electro-magnetic current of constant force. As he had the means of using a powerful magnet capable of supporting 40 lbs. troy, his experiments were more easily performed and more decisive.

Into a vessel containing the liquid conductor he introduced a metallic plate and a piece of wire of the same metal, each communicating with one of the extremities of the electro-magnetic spiral; and as there were in this case two contrary currents of equal intensity successively developed, the influence could not be attributed, as might be done in the experiments of Marianini to any alteration induced by the passage of the current in the electro-motive force of the metal.

He thus experimented on platinum, iron, copper and zinc, using as liquid conductors sulphuric, nitric and hydrochloric acids, sulphates of zinc, iron, soda, nitrates of zinc, copper, ammonia, soda, &c. He found that, in general, the current passed with more facility from the wire to the plate, than in the contrary direction. Platinum alone inserted in an acid or alkaline solution, presented a contrary phenomenon. These diversities of effect cannot be explained until our ideas on the propagation and distribution of the electric fluid in bodies, shall have become more extended and correct than they are at present. We can only add, that probably these phenomena are connected with the chemical action which the liquids exercise upon the portions of the metallic arc, in contact with them and with that caused by the currents themselves.

17. *New Compounds of Nitrogen*, by M. Liebig. (Ann. de Chim., T. 56, p. 5.)—When a solution of Sulphocyanid of Potassium, is boiled in nitric acid, or when a current of chlorine is passed through a solution of this salt, an orange yellow substance is deposited, which is a sulphuret of cyanogen. Heated to redness, this sulphuret is decomposed, four atoms, (8C+8N+8S) producing four atoms of sulphur, (4S) two atoms of sulphuret of carbon, (2C+4S) and six atoms of a new body, which I name *mellon*, composed of,

Carbon,	. .	0.3936	. 6 atoms.
Nitrogen,	. .	0.6064	. 8 atoms.

This substance may be more easily obtained by passing a current of dry chlorine, over the sulphocyanid of potassium, heated till it commences to melt, and washing the residue with water. There is disengaged during the process, the chlorids of sulphur and cyanogen.

Mellon is insoluble in water, and all neutral liquids. At the melting point of glass, it is decomposed into three vols. of cyanogen and two vols. of nitrogen. Heated with the oxyd of copper, it gives off three vols. of carbonic acid for two of nitrogen. With potassium it forms a transparent, fusible compound. It dissolves in potash and nitric acid with the formation of ammonia, and a deposit of a peculiar acid, crystallized in long white needles, (cyanilic acid.)

Melam.—By distilling a mixture of one part of sulphocyanid of potassium, and two of sal ammoniac, ammonia, sulphuret of carbon and of hydrogen, are disengaged, and there remains a body which when well washed, is the substance I call *Melam.*

Thus formed, it is a heavy yellow powder; it is not, however, quite pure, being mixed with a yellow substance, which is owing to the decomposition by heat of a part of it, during its formation. To purify it, it is necessary to boil it in a concentrated solution of potash, until part is dissolved. On cooling, it is then found to be a white, dull, granulous powder. Its composition is,

Carbon, . .	0.3081 .	6 atoms.
Nitrogen, . .	0.6542 .	11 atoms.
Hydrogen, . .	0.0377 .	9 atoms.

Treated with concentrated nitric acid, it is dissolved and transformed wholly into cyanuric acid and ammonia. Fused with the hydrate of potassa, it gives rise to cyanate of potassa and ammonia. The acids muriatic and sulphuric, change it into two new bodies *ammeline* and *ammelid.*

When dissolved in a moderately concentrated solution of potash, a substance which I name *melamine,* in brilliant crystalline plates, separates from the liquid on cooling, and by saturating with an acid, the liquid from which the melamine was deposited, a precipitate of ammeline is thrown down.

Melamine.—This substance crystallizes in octahedrons of a white color, slightly transparent, anhydrous, and unalterable in the air. It is insoluble in alcohol and ether, and is slightly soluble in cold, but very easily in boiling water. It combines readily with acids, and forms well characterized salts, of which the simple salts are acid, but the double, neutral. It consists of,

Carbon,	. .	0.2874	.	6 atoms.
Nitrogen,	. .	0.6657	.	12 atoms.
Hydrogen,	. .	0.0469	.	12 atoms.

Ammeline.—Ammeline is a very feeble base. It is insoluble in water, alcohol and ether, but dissolves in most of the acids and caustic alkalies. On evaporating its solution in nitric acid, it crystallizes in long, colorless, quadrangular prisms. Precipitated by ammonia, it has a silken lustre. Fused with the hydrate of potash, ammonia and cyanate of potash are formed. It is composed of,

Carbon,	. .	0.2855	.	6 atoms.
Nitrogen,	. .	0.5511	.	10 atoms.
Hydrogen,	. .	0.0389	.	10 atoms.
Oxygen,	. .	0.1245	.	2 atoms.

Two atoms of melam, and two atoms of water, give one atom of melamine, and one atom of ammeline.

Ammelid.—The addition of alcohol to a solution of melam in sulphuric acid, causes a deposit of a white powder, (*ammelid,*) resembling ammeline in all its physical characters, except that it is not basic. It may be dissolved in acids, but is separated again by water and alcohol. It consists of,

Carbon,	. .	0.2844	.	6 atoms.
Nitrogen,	. .	0.4944	.	9 atoms.
Hydrogen,	. .	0.0354	.	9 atoms.
Oxygen,	. .	0.1861	.	3 atoms.

Cyanilic acid, formed by the action of concentrated nitric acid on mellon, has a composition absolutely the same, as that of cyanuric acid. But its atomic weight is double.

Note by the Translator.—There seems to be here an unnecessary departure from the ordinary rules of nomenclature, in the formation of the names of the above compounds. By an examination of their composition, it appears that melam and melamine are composed of ammonia and mellon in different proportions, and that ammeline and ammelid contain in addition some water.

18. *Depth of mines.*—Kits pühl copper mine in the Tyrol mountains,

	Feet.
Kits pühl copper mine in the Tyrol mountains, - - - -	2764
Sampson mine at Andreasberg, in the Hartz, - -	2230
Valenciana mine, (silver,) Guanaxuato, Mexico, -	2170
Pearce's shaft, (copper,) consolidated mines, Cornwall, -	1650
Monkwearmouth colliery, Durham, - - -	1600
Wheal Abraham mine, Cornwall, - - -	1410
Eiton mine, Staffordshire, - - - -	1380

The deep mines in the Tyrol, Hartz and Andes, above described, are all in high situations—the bottom of the Mexican mine is six thousand feet higher than the top of the Cornwall shaft. The deepest perforation beneath the level of the sea, and consequently the nearest approach to the earth's centre, has been made at the Monkwearmouth colliery, which is fifteen hundred and thirteen feet below the surface of the German ocean. Pearce's shaft (thirteen hundred and thirty eight feet below the level of the sea,) was, until lately, the deepest in the world.—*Geology in* 1835, (*Mining Review.*)

19. *Topaz in Ireland.*—This mineral has been found in the mountain of Sliève Donard, which has long afforded beryl in considerable quantities.—*Trans. Dub. Geo. Soc. Vol.* I.

20. *Roasting of copper ores.*—Hitherto the copper ores of Fahlun have been roasted in rectangular spaces, but some rècent experiments have satisfactorily shown that reverbatory furnaces are the best. The ore must be reduced to the state of a coarse powder, in which condition it requires only eighty hours for completing the process.—*Ann. du comptoir des mines de fer in Sweden.*

21. *The best method of assaying the ores of Manganese,* by Zennich.—The principal pneumatic methods are—1. Calcination and measuring the quantity of oxygen gas evolved; 2. Ebullition with concentrated sulphuric acid, and measuring the quantities of oxygen; 3. Calcination with sugar, and measuring the volume of carbonic acid formed; 4. Ebullition with muriatic acid, and measuring the quantity of chlorine disengaged; 5. Ebullition with muriatic acid, and making the chlorine gas to react upon liquid ammonia, and measuring the volume of nitrogen which results from the reaction; 6. Calcination with sal-ammoniac, and measuring the gas evolved;

7. Ebullition with oxalic acid, and estimating the carbonic acid produced. The fifth method is pronounced the best; the 4th is also good, but the 6th and 7th are erroneous.—*Jour. d'Erdmann*, t. 18. p. 75.

22. *Jahresbericht der Königl. Schwedischen,* &c.*—On the progress of the science of botany during the year 1832. Translated from the Report of the Royal Academy of Sciences of Sweden, with numerous additions by C. T. Beilschmied.

The Swedish annual from which this work is translated, is undoubtedly one of the most valuable scientific periodicals of the day. The rapid advancement of the various sciences, and the scattering here and there of the discoveries that are brought to light and the results of investigations, through the various periodicals of the world, render it very desiderable that there should be published annually, collected abstracts of all the works and articles that have appeared during the past year. Such is the object of the *Arsberättelser om Vetenskapernas Framsteg*, published at Stockholm by the Royal Academy of Sciences of Sweden, of which it is a sufficient commendation to say that Berzelius is one of its contributors. The science of botany is under the charge of Joh. Em. Wikström, who is the author of the article translated in the above mentioned work. Its general divisions, are, I. Phytography, II. Botanical Geography, III. Anatomy of Plants, IV. Physiology, V. Fossil Flora, VI. Botanical Literature. Under these heads are noticed upwards of a hundred different works issued during the year, besides numerous articles from the various periodicals of Europe and America. Of the articles and works quoted, the author has given quite full abstracts, all new discoveries contained in them, or new classifications and theories proposed, being noticed in full; so that by means of it we are fully informed of the advancement of the science and of the new accessions to its literature. It is indeed, for the year, of itself a botanical library.

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* Jahresbericht der Königl. Schwedischen Akademie der Wissenchaften über die Fortschritte der Botanik im Jahre 1832. Der Akademie übergeben am 31 Marz, 1833, von Joh. Em. Wikström. Uebersetzt und mit Zusätzen versehen von C. T. Beilschmied. 8°. 186 *ss.* Mit 3 lithogr. Zeichnungen auf 2 Chärtchen. 1835. *Breslau.* Im commission bei J. Max and comp.

The titles of the works noticed are given in the most complete manner, always accompanied by dates and a statement of the size and number of volumes.

The original article has been extended nearly one third by its German translator, C. T. Beilschmied, who has made additions to many of the original notices, and introduced abstracts of a large number of omitted works, and consequently in the same or a greater ratio, has increased its original value. It is now contained in a rather closely printed octavo volume of 186 pages. To the botanists of America, who are so far distant from the great European scene of botanical investigation, and to whom all the various periodicals of that continent are not accessible, a work of this kind must be invaluable.

By a letter from Mr. Beilschmied dated July 11th, 1835, to the editor of this Journal, it appears that he has translated the corresponding articles for the years 1829, '30, '31. The translation of that for '28 was soon to be ready for the press, and the same for '33 was shortly to be issued. The Swedish Report for '34 had not been received, but was expected in October or November. He writes also, that the numbers of this work, as published, may be obtained by writing to Mr. Hunnemann, Frith St., Soho, London, or to any professor or bookseller in Germany.

23. *On the cause of the Meteors of November 13th*, 1833; by Denison Olmsted, Professor of Mathematics and Natural Philosophy in Yale College.

The "Explanation," which I ventured to propose, of the meteoric phenomenon of November 13th, 1833, in the twenty sixth volume of this Journal, has occasioned various strictures, both at home and abroad, of which, from respect to the writers, as well as from a due regard to public opinion, it may seem incumbent on me to take some notice. Learning, however, that the current number of this Journal is pressed with communications, I can for the present only ask space sufficient to correct certain *erroneous impressions*, which appear to prevail respecting my "Theory of Shooting Stars."*

The leading conclusions to which I was led, after an extensive induction of facts, were the following.

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* See especially, the remarks by Mr. J. Espy in the Franklin Journal, Vol. xv, and of the Rev. W. B. Clark, in Loudon's Magazine of Natural History, Vols. vii. and viii.

1. *That the meteors of Nov. 13, 1833, had their origin beyond the limits of the atmosphere.* This inference was founded cn the fact, (confirmed by the united testimony of all who accurately noted, among the fixed stars, the position of the point whence the meteors emanated,) that the source moved along with the stars to the westward, and therefore did not partake of the earth's diurnal rotation.

2. I judged that the matter of which the meteors were constituted was *combustible*, because we saw it burn; that it was very *light*, because in its descent, it was arrested by the atmosphere, in some instances at least, at the height of many miles above the earth; and that the meteors were in many cases *large bodies*, because at some distance from the spectator they exhibited a considerable apparent magnitude, occasionally appearing as large as the full moon. Since the meteors, large and small, fell in great numbers, over a great extent of country, I inferred that, were they all collected, and restored to their original situation in space, they would occupy a large field, which might, for convenience' sake, properly enough be denominated the *meteoric cloud*,—meaning by this phrase simply the collection of meteors, as they existed before they fell to the earth.

3. As showers of meteors, very similar to each other, occurred on the morning of the 12th of November, 1799, and on the morning of the 13th of November in the years 1831, 1832, and 1833, it was inferred that effects so nearly identical had the same cause, or that the earth, at each of these periods, fell in with the "meteoric cloud." And since this meeting took place nearly in the same point of the earth's orbit, namely, at that point which it passes over on or about the 13th of November, I judged that the cloud must either have remained stationary in space, or have had a revolution, with a periodical time, which was either the same with that of the earth, or some aliquot part of it, otherwise the two bodies could not have come together the same day on two successive years. The meteoric cloud could not have remained stationary in space, for, if not attracted to some nearer body, it would have made directly for the sun. Its periodic time cannot be the same with that of the earth, for then having once moved together, they would, according to Kepler's law, always have remained together, or nearly so, for the squares of the periodical times being the same, the cubes of the distances, and of course the distances themselves, would have been constantly equal. In order, therefore, to come together at the end of a year, the supposed body must make either two, or three, or some other even

number of revolutions, while the earth makes one. But its periodic time could not be a less aliquot part than one half a year; for a less period, as one third, would, according to Kepler's law, make the whole major axis of its orbit only about ninety one millions of miles,—implying an orbit too small to permit the body ever to come near to the earth.

As the periodic time cannot be less than half a year, neither can it be greater; for then a conjunction could not take place at the same part of the earth's orbit in two successive years. Hence, I inferred that the periodic time is six months nearly.

Such a time of revolution gives, for the major axis of its orbit one hundred and nineteen millions of miles; and the orbit must evidently be one of considerable eccentricity, since one part of it is found reaching near to the earth, at a distance from the sun of about ninety five millions of miles. Hence, it is inferred that the orbit is an ellipse, the distances from the lower focus being respectively ninety five and twenty four millions of miles. That the body is near its aphelion at the time of the meteoric shower, (and consequently that the aphelion distance is nearly equal to the distance of the earth from the sun,) was inferred from the fact that the earth and the meteoric body remained so long together,—a period of at least eight hours; for had the body been merely crossing the earth's orbit, or had its direction been any other than nearly the same with the earth's, the two bodies would sooner have separated. Nor would such a shower of meteors have been equally probable at any other point of conjunction, although, during the year, two other inferior conjunctions actually occur; for, the periodic time being as it is, no other point of conjunction would take place, when the body was sufficiently near to the earth.

4. That only the "extreme portions" of the supposed nebulous body descended to the earth, is indeed to some extent matter of conjecture; but such an inference is rendered probable from the known extent of astronomical bodies, and still more from the fact, that after successive meteoric showers, the body was still able to afford so copious a shower as occurred in 1833.

5. I have thought it *possible*, that the unexplained phenomenon called the *Zodiacal Light*, is the very body in question, although the existence of a nebulous body, affording the meteoric shower, was inferred without the least reference to that light. But the following are remarkable facts.

1. The Zodiacal Light was unusually conspicuous at the time of the great meteoric shower, and for some months following; it was less conspicuous at the corresponding season in 1834, and has been still less so in 1835.

2. It changes from the morning to the evening sky about the 13th of November, (indicating that the earth passes by it or through it,) being for a considerable time after that period seen on both sides of the sun, and subtending so great an angle as to indicate that it is very near the earth.

3. At other times it varies its apparent dimensions exceedingly, sometimes expanding to a length of nearly one hundred and fifty degrees, and at other times shrinking so as to be hidden in the twilight; and there is some reason to believe, (although more accurate and multiplied observations are wanting to decide the point absolutely,) that these variations, in apparent magnitude and brightness, correspond to the appearances which the supposed nebulous body would present at the corresponding periods, being in inferior conjunction when the zodiacal light is largest, and in superior when it is smallest. Thus, the rapid changes of position which the zodiacal light undergoes about the 13th of November—its great elongation and retrograde movements, in January, when it ought to be in inferior conjunction—its rapid direct movements a few days afterwards—and its total disappearance about the middle of May, when the supposed body would be in its superior conjunction, are facts which favor the supposition that the zodiacal light is the nebulous body, whose existence and laws of revolution had been inferred from independent evidence,—evidence which will remain unimpaired, should it finally appear that the zodiacal light has no connexion with the meteoric showers.* Little or nothing has been done, to ascertain the nature and laws of this light, since the original papers of Cassini and Mairan were published, that is, for more than a century. Those great observers were undoubtedly guided by a false hypothesis, viz. that the zodiacal light was the solar atmosphere; but now since that hypothesis is exploded, it seems incumbent on astronomers to make new observations, and if it is not the solar atmosphere, to tell what it is.

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* Some, who seem to suppose that the Zodiacal Light is an imaginary body, conjured up to suit the purposes of the writer, are requested to consult the original papers of Cassini and Mairan, in the Memoirs of the French Academy for 1683 and 1731.

1. It has been objected to my "explanation," that the meteoric shower began as early as midnight, when the sun was on the opposite side of the earth, and therefore it could not have been derived from a body which lay between us and the sun.*

This is the most reasonable objection that has been alleged against the theory, as the theory is understood by the objector. But the difficulty is founded on an entire misconception of the theory itself. It assumes that the nebulous body in question, at the time of the meteoric shower, lies in a straight line, extending from the center of the earth to the sun, the circumstances being analogous to those attending an inferior conjunction of Mercury or Venus, except that the conjunction occurs very near to the earth. The body itself, also, is contemplated as so small in extent, that, in its astronomical relations it may be taken for a point.

Now as my views of this matter were propounded with extreme brevity, quite at the close of an article, extended far beyond its prescribed limits, I do not complain that I have been so imperfectly understood on this point. But the fact is, that the views here assumed, are totally different from those which I have always entertained, respecting both the extent and position of the nebulous body.

Although the part of this body which afforded the meteoric shower, must have been comparatively near the earth's orbit, yet, as this, like other astronomical bodies, is probably one of large extent, it is not possible, in the present state of our knowledge, to determine whether, at the aphelion, the *center of gravity* is within or without the earth's orbit, in respect to the sun. My views were, that the body extended to a considerable distance both interior and exterior to the earth's orbit, making (as appeared from observation) a small angle with its plane. The position which may be given to the body, to make it correspond to the facts observed, is that of a cloud, (suppose, for illustration, a thin fog,) lying across the earth's path, rising a few degrees above its plane, through or near the *skirts* of which the earth passed. If the body has the usual shape of a comet, we may place its nucleus within the earth's orbit, and let its tail spread out to a great extent over the earth. If one of the balls of an orrery represents the earth, and we place *before* it, (that is, in the line of direction in which it is moving,) and a little above the plane of its orbit, a small feather, bent at the extremity, as the tails

* Mr. Espy, Franklin Journal.

of comets usually are, it will represent a nebulous body, so situated that portions may fall from it to the earth, even at midnight. They would not, indeed, be directed towards the center of the earth; nor were the meteors; but their direction was probably the *resultant* of the force of gravity, and the relative motion occasioned by the excess of the earth's motion above that of the body. The reader will please to remark, that the source of the meteors was not between the earth and the sun, but nearly ninety degrees from that direction, that is, nearly in the line of the tangent of the earth's orbit,*—a position which is necessarily assigned to it, because it was projected towards a part of the heavens nearly ninety degrees from the sun.

2. It has been said, that had the nebulous body been within two thousand two hundred and thirty eight miles of the earth, (the computed distance of the source of the meteors,) the whole body would have fallen, even had it been twenty nine times as far off as this.† It is quite compatible with my views of the extent of the body in question, to suppose that the greatest part of it was more remote than sixty five thousand miles, the limit assigned, and that all that lay within that distance did actually fall to the earth.

The above estimate of the distance, was made before I had any conception of the true source of the meteors, and from very unsatisfactory and discordant data, as was acknowledged at the time;‡ but on arriving at the conclusion that the meteors had their source in a cometary body, (a conclusion which was formed after nearly the whole of the article was in press,) it was immediately perceived that the source of the meteors must be much farther off than the previous calculations had fixed it, and it was so remarked at the conclusion of that article.§

Nor do I consider this procedure to be at all inconsistent with the strict rules of inductive reasoning. We begin with collecting and classifying our facts; we then draw from each the most rational conclusions we are able, without any reference to a general theory. At length we unexpectedly discover the true cause on which all the phenomena depend. We are now authorized to frame our theory, and to go back and apply it to the correction of any subordinate estimates or inferences previously made, while we were ignorant of

* See the figure representing these positions, in Vol. xxvi, p. 164.
† Espy, Franklin Journal, Vol. xv.
‡ Vide Amer. Jour. Vol. xxvi, p. 145.
§ Ibid. p. 173.

the true cause. The estimate formed at the same time of the *velocity* of the meteors, required correction in a similar manner; for it proceeded on the hypothesis that the velocity was merely that which was generated by falling, by the force of gravity, from the height of two thousand two hundred and thirty eight miles; whereas, an insight into the real cause of the phenomenon, showed at once that a great *relative* velocity was to be added to that of gravity. The estimated motion of the body being 12.15 miles per second, and that of the earth about 19 miles, a relative velocity was to be reckoned of 6.85, to which if we should add any thing within the possible force of gravity, which is about seven miles per second, we may have a velocity corresponding nearly to that which, according to Mr. Twining, the meteors were observed to have, allowing much latitude for the uncertainties of observation, where fractions of a second are involved, and the observer *guesses* at the time.

3. It is said that meteors occur at other seasons of the year, and more or less at all seasons, for which this theory does not account.

According to the theory, the earth forms with the nebulous body, during the year, three inferior conjunctions,—one in November, one in January, and one in September, in each of which positions it would be favorably situated for parting with some of its "extreme portions" to the earth. Moreover, a light body moving in the contemplated orbit, would be subject, no doubt, to very great perturbations, such as to shift the places of its nodes and conjunctions, to a greater or less extent, at every revolution. We can conceive of one position of the nodes, which would be extremely favorable for producing such a phenomenon as that of Nov. 13, 1833, namely, when the line of the nodes coincides with that of the apsides.

It has been erroneously supposed essential to my theory, that the meteoric shower should return every 13th of November, and that the merits of the theory were staked on the return of the phenomenon in November, 1834. I have much less honor to claim, on the score of predictions, than some have been pleased to ascribe to me. It did, indeed, seem to me probable, that the remarkable combination of circumstances, which caused the shower of meteors to appear as early as 1831; to be repeated, to a greater extent, in 1832; and to arrive at such an unexampled degree in 1833, would continue somewhat longer, and that the showers would go off as they came on. Hence, I intimated to my *pupils*, the *possibility* of a recurrence on the morning of Nov. 13, 1834, and to a greater or less extent for a year or two afterwards. Accordingly, it is believed, that such a recurrence actually took place,—that is, that there was seen at various places, in different parts of the earth, on that morning, an extraordinary fall of meteors. Professor Bache has, indeed, labored to show, that the facts are insufficient to establish the *identity* of the phenomenon of 1834 with that of 1833 ; but he must admit an *extraordinary* occurrence of meteors on that morning; so that the question will seem to turn on this point, whether a *smaller* meteoric shower is any shower at all.

How far the morning of Nov. 13, 1835, was distinguished by any similar occurrence, *in any part of the earth*, it is too early yet to determine. Nothing uncommon was observed at New Haven, but I have testimony from the most respectable sources, that an unusual number of meteors, or shooting stars, was observed on the morning of the 14th of November, at several places in the United States, particularly in the central parts of the state of New York, and in the western parts of Maryland and North Carolina. The prescribed limits of this article, will not permit me to give the statements in detail.

Finally, I do not consider it a valid objection against the explanation proposed for the great meteoric showers, that have been several times repeated on or about the 13th of November, that it does not satisfactorily account for the ordinary single shooting stars. To render this objection good, it must be shown, that the occurrence of such shooting stars, is *incompatible* with the cause assigned for the showers, and that they depend on causes totally different. Until this is shown, we may for the present leave them to themselves.

24. *Observations upon the facts recently presented by Prof. Olmsted, in relation to the meteors, seen on the* 13*th of Nov*. 1834; by A. D. Bache, Prof. of Nat. Phil. and Chem., Univ. Penn.

Before proceeding to examine the new facts recently put forth by my friend, Prof. Olmsted, in regard to meteors seen on the 12th, and 13th of Nov. 1834, it will be well to state what is the difference of opinion between us.

I understand Prof. Olmsted to assert, that there was a recurrence of the meteoric display of Nov. 13th, 1833, in 1834; thus verifying a prediction made by him as a consequence of his peculiar theory. With that theory, further than as it is borne upon by facts in regard to the prediction founded upon it, I have not at present any concern. Independently of theory, it would be a very curious fact if it were made out, that meteoric displays of an unusual kind occurred annually, on the same night, and I was induced to observe on the night of the 13th of Nov. 1834, with reference to fact rather than theory. Prof. Olmsted states his conclusions from observations made at New Haven, in these words: "On the morning of the 13th of Nov. (1834,) there was a slight recurrence of the *meteoric shower* which presented so remarkable a spectacle on the corresponding morning of 1833."*

My views as resulting, first from observations made at Philadelphia on the morning of the 13th, are, that "there occurred the 13th of Nov. 1834, no remarkable display of meteors of the kind witnessed in 1833." To sustain this, after recording the meteors seen by me on the 13th of Nov. 1834, I undertook to show, 1. That the meteors which I saw were neither in degree, nor in their most striking peculiarity, like a portion of the meteoric phenomena of Nov. 1833. 2. That they were similar both in degree and kind to common meteors. The small number and absence of a common radiant, supports the first position. The nearness to the number frequently seen at a period of the night and a period of the year, when these meteors are less frequent than early in the morning, and late in the autumn, together with the very different points in which their paths, if produced, would have intersected, show the second.

The new facts presented by my friend, Prof. Olmsted, and upon which I now proceed to remark, are classified by him as "foreign testimonies" and "domestic testimonies." The first are somewhat particular, but the latter quite general. The foreign testimonies alluded to are those of the Rev. W. B. Clark, A. M., F. G. S. &c., and W. H. White, Esq. both of England. These gentlemen saw meteors on the morning of the 13th of Nov. 1834.

The opinion of Mr. Clark, in relation to the meteors which he saw, is to be found in the same paragraph from which Prof. Olmsted has quoted his observation. It is thus expressed: "the coincidence between these and those seen in America and Europe on this day of the month is curious, *but those which I now mention were*

* Am. Jour. of Science, Vol. XXVII, p. 417. Jour. Frank. Inst. Vol. XVI. p. 368. In an article headed *Zodiacal Light*, between which and the meteors Prof. Olmsted's theory leads him to infer a connexion.

electrical, and of no uncommon character.*"† In a subsequent paper, after reviewing the observations made by Prof. Olmsted, Mr. Twining, and myself in America, and by Mr. White and himself in England, the Rev. Mr. Clark thus concludes,‡ "one fact is at least established by these seeming contradictions, viz. that *common electrical*§ meteors did appear both in England and in America on the same night, whilst there is no direct evidence to show that any others also appeared."

I have considered the opinion of Mr. Clark, of what he saw, as the more important, because his description of the direction of the meteors is not very precise. He says they were in the direction of a line from Leo to the star Mizar. This may mean that their paths coincided with this line, or merely, that they were parallel to it. Taking the former statement as most favorable to the similarity of this phenomenon to that of 1833, it would still however be very different from that, however remarkable in itself. That fifteen meteors should fall precisely in the same line is certainly a curious fact, but as certainly a very different one from the apparent convergence to a single point of the paths of more than two hundred and seven thousand, falling in different parts of the heavens.

The Rev. Mr. Clark further states, that he saw one meteor which appeared to pass to the south of Ursa Major and between Cor Caroli and Arcturus, the most northern of these stars, being about 17° greater in north polar distance than Mizar. If this was one of the fifteen meteors before alluded to, Mr. Clark probably intended his description to apply to the general direction and not to the precise position of their paths. This, however, is not important as far as the inference in regard to the question between Prof. Olmsted and myself is concerned.

The greatest number of meteors which Mr. Clark saw was fifteen in fifteen minutes, or else he only observed fifteen minutes: which is the correct supposition, his account leaves doubtful. The portion of the heavens which his view embraced is also doubtful, he merely states that he observed from a window. To make the hypothesis as

* This term, which I used to denote the peculiarity in regard to the paths of the meteors of 1833, has, I find, been misunderstood. I did not mean by its use to express an opinion, that those meteors had a different physical cause from ordinary "shooting stars."

† Loudon's Mag. Nat. Hist. Vol. VII, p. 655.

‡ Loudon's Mag. Nat. Hist. Vol. VIII, pp. 420, 421.

§ This term electrical is in allusion to his theory.

favorable as possible to the number of meteors, we may suppose that he observed but for fifteen minutes, and saw fifteen meteors; that his range of vision embraced not more than one tenth of the visible heavens, and that meteors fell in equal numbers over an equal space in other quarters. All these assumptions, and they are for the most part gratuitous, would make the number over the whole sky six hundred in one hour, while, during the display in 1833, six hundred and fifty meteors* were counted in about one fourth part of the sky in fifteen minutes, making upwards of thirty six thousand in one hour; and this only one hour and a quarter before sunrise.

The observations of Mr. White do not seem to me, any more than they do to Mr. Clark, to support the idea of a recurrence of the meteoric phenomenon of 1833. The number of meteors which he saw, was ten in half an hour, being less than the number seen in fifteen minutes by Mr. Clark. The observations where made from windows which commanded a view of the north and east, and supposing that they commanded but one sixth part of the heavens, and that the meteors were of the same frequency in every part, we should have one hundred and twenty meteors for the whole sky in one hour; one three hundredth part of the probable number visible in 1833 at Boston in one hour. During the display of 1833, ninety eight meteors were seen in fifteen minutes, the rate being three hundred and ninety two per hour, within three quarters of an hour before sunrise.

Neither does it appear that the meteors seen by Mr. White had an apparent radiant. One of the meteors of which he speaks, "glided almost perpendicularly towards the earth: this was succeeded by another of a more brilliant appearance, which took a westerly direction."

The ten meteors to which I have before referred, are said to have appeared between Leo, Virgo, and Ursa Major. This place as assigned in a general description, is a matter of course, since these were the principle constellations within view from the north and east windows from which Mr. White observed. Nothing is said about a radiant, too remarkable a fact to have been overlooked had it existed.

But the number of these meteors has frequently been equalled and even exceeded, in cases between which, and the meteors of 1833, no connexion has been claimed. I need only quote a few

* Am. Jour. Science, Vol. XXV, p. 367.

cases. On August 8th, 1823, Prof. Brandes noticed sixty five in two hours; on August 10th "one hundred and fifty were noticed in less than two hours, and Prof. Brandes remarks, that they were obliged to leave many unrecorded.* During August, 1833, Mr. Espy and myself noted, over one fifth of the visible heavens, thirty seven meteors in one hour. We have noted eight in fifteen minutes, six in nine and a half minutes, five in ten minutes, and this at a time of the evening, and at a season, when meteors are comparatively unfrequent. At other times one meteor only would be seen in half an hour, showing the variable nature of the occurrence even on the commonest occasions.

Prof. Olmsted himself refers to *showers* of meteors seen in *April*, 1803, in Virginia; in England on the 19th of *November;* in France, in *April*, 1833; in *August*, 1833, in England, &c.

There is no connexion, in point of time, between the English observations and those made in America. The meteors seen by both Mr. White and the Rev. Mr. Clark, occurred at a time when meteors were not unfrequent even at New Haven.

The "*American testimonies*" given by Prof. Olmsted, would determine the question, if it were, *did meteors occur on Nov. 13th*, 1834, but upon the one really at issue they do not bear. The authorities, a member of the Theological Seminary at Andover, an anonymous writer in the St. Louis Observer, and a female servant at Zanesville, give no particulars on which to found an opinion as to the nature of the meteors which they saw, the St. Louis Observer merely states loosely that he saw at 5 A. M. in fifteen or twenty minutes thirty or forty meteors. The accounts want the precision necessary to form an opinion in the cases.

In regard to the remarks which my friend Prof. Olmsted appends to his facts, it is necessary to observe, First, that in addition to the indirect evidence of no meteoric display having been seen at eleven military posts from Maine to Florida, six western posts and five on the northern frontier and which he notices, I presented *other indirect evidence*, not noticed by him, derived from scientific friends at Wilmington, Baltimore, the University of Virginia, and the University of North Carolina, and *direct evidence*, also unnoticed by him from observations at New York, Philadelphia, and Nashville. Further, that a sentinel at Mackinac, where meteors *did* fall in con-

* On shooting stars, by E. Loomis, Am. Jour. Vol. XXVIII, p. 96.

siderable numbers, saw and remembered the fact. My friend states his preference for the testimony of nautical men, and yet of all those who navigate between this and England, on the night in question, not one has recorded observations of any extraordinary meteoric occurrence like that of 13th of Nov. 1833.

In the second remark, allusion is made to a record on the minutes of the American Philosophical Society. This record is there entered as a "verbal communication in relation to the result of observations on the recurrence of the remarkable meteoric display of Nov. 13th, 1833."* This record rests not on the responsibility of that learned body, but on my own, and I believe I have shown full warrant for it. Records are made of all verbal communications presented to the society, and among them will be found a reference to the new facts presented by my friend, Prof. Olmsted, as the substance of another verbal communication made by me.

In conclusion, I think the examination of those of the new facts, which are susceptible of such a course, has conclusively shown, that the meteors referred to in them, were of ordinary character. And a comparison of this result, with the inference which I have elsewhere drawn from my own observations, and that of others, leads to the conclusion, that no satisfactory evidence has yet been presented of the occurrence, in 1834, of a meteoric display, which in numbers, in peculiarities, or in connexion (as parts of the same phenomenon) and extent combined, was such as to connect it with the meteoric display of Nov. 13th, 1833.

25. *Aurora Borealis of Nov.* 17, 1835.—The evening of Nov. 17th, was rendered memorable by the occurrence of a remarkable Aurora Borealis. Both in extent and magnificence, it is believed to have been one of the grandest forms of this mysterious phenomenon, resembling in its features the great Aurora Borealis of August 19th, 1726, which was seen in France and other parts of Europe, and which furnished the occasion of the celebrated work of M. Mairan on the Aurora Borealis.†

The present Aurora exhibited itself, in nearly equal magnificence, though with features somewhat varied, at points very remote from

* This quotation from the minutes, which are not published, is made by the permission of the society.

† Memoires of the French Academy for 1726 and 1731.

each other, as at Montreal and Dartmouth College, at New York, at Cincinnati, and on the waters of the Mississippi. By the kindness of our correspondents, we have been furnished with numerous detailed and interesting descriptions of the phenomenon, which we are obliged reluctantly to postpone for want of room. The facts deserve to be fully collated and compared with the accounts of similar occurrences, (of which there are a great number recorded in history,) with the hope and expectation of arriving at the true cause of the Aurora Borealis. For the present, however, we are compelled to confine ourselves to a statement of the leading facts, as observed by Professor Olmsted, at this place, (Yale College,) and published in the New Haven Daily Herald of Nov. 18th.

"Last night, our northern hemisphere was adorned with a display of auroral lights remarkably grand and diversified. It was first observed at 15 minutes before 7 o'clock, (mean time,) when an illumination of the whole northern sky, resembling the break of day, was discernable through the openings in the clouds. About 18 degrees east of north, was a broad column of shining vapor tinged with crimson, which appeared and disappeared at intervals. A westerly wind moved off the clouds, rendering the sky nearly clear by 8 o'clock, when two broad white columns which had for some time been gathering between the stars Aquila and Lyra on the west, and the Pleiades and Aries on the east, united above, so as to complete a luminous arch, spanning the heavens a little south of the prime vertical. The whole northern hemisphere, being more or less illuminated, and separated from the southern by this zone, was thrown into striking contrast with the latter, which appeared of a dark slate color, as though the stars were shining through a stratum of black clouds. The zone moved slowly to the south until about 9 o'clock, when it had reached the bright star in the Eagle in the west, and extended a little south of the constellation Aries in the east.—From this time, it began to recede northward, at a nearly uniform rate, until 20 minutes before 11, when a vast number of columns, white and crimson, began to shoot up, simultaneously, from all parts of the northern hemisphere, directing their course towards a point a few degrees south and east of the zenith, around which they arranged themselves as around a common focus. The position of this point was between the Pleiades and Alpha Arietis, and south of the Bee, having a right ascension of 42° and a declination of 24°, as nearly as could be determined without the aid of instruments; but this comes so near to the pole of the *dipping needle* and to the magnetic meridian, that we need not hesitate to conclude that, agreeably to what has been observed of similar phenomena before, the columns arranged themselves exactly in obedience to the laws of terrestrial magnetism.

"Soon after 11 o'clock, commenced a striking display of those undulatory flashes, denominated in the northern regions *Merry Dancers*. They consist of thin waves or sheets of light, coursing each other with immense speed. Those undulations which play upon the surface of a field of rye, when gently agitated by the wind, may give to the reader a faint idea of these auroral waves. One of these crimson columns, the most dense and beautiful of all, as it ascended towards the common focus, (the vanishing point of perspective for parallel lines,) crossed the planet Jupiter, then at an altitude of 36 degrees. The appearance was peculiarly interesting, as the planet shone through the crimson cloud, with its splendor apparently augmented rather than diminished.

"A few *shooting stars* were seen at intervals, some of which were above the ordinary magnitude and brightness. One that came from between the feet of the Great Bear, at eight minutes after one o'clock, and fell apparently near to the earth, exhibited a very white and dazzling light, and as it exploded, scattered shining fragments, very much after the manner of a sky rocket.

"As early as 7 o'clock, the *magnetic needle* began to show unusual agitation, and it has been since carefully observed by Mr. Loomis. Near 11 o'clock, when the streamers were rising, and the corona forming, the disturbance of the needle was very remarkable, causing a motion of 1° 5′ in five minutes' time. This disturbance continued until 10 o'clock this morning, the needle having traversed an entire range of one degree and 40 minutes, while its ordinary diurnal deflection is not more than 4 minutes.

"The thermometer at 11 o'clock was at 33°; it shortly fell to 31, and remained nearly at this point during the remainder of the night, a degree of cold considerably below that of the few preceding nights. The ground this morning was covered with a copious white frost, indicating an unusual deposition of watery vapor.

"At about 3 o'clock, the sky grew cloudy, and the moon rising shortly afterwards, farther observations were prevented; but the continued disturbance of the magnetic needle would induce the belief, that the aurora continued through the night, and even to a late hour this morning."

26. *Transactions of the Geological Society of Pennsylvania,* Vol. I, Part II.—In Vol. xxvii p. 347, we gave a notice of the first part of this valuable work. The second part is still more valuable, being replete with papers important alike to science and practical utility. This part contains two hundred and fifty seven pages, and is amply illustrated by plates: the entire volume contains four hundred and twenty seven pages, and the execution is beautiful. We are obliged to defer to another occasion, a particular notice of the facts and views exhibited in this work, which does so much credit to our science, that we hope and trust it will be continued; notwithstanding the difficulties, which (in common with all similar things in this country,) we understand it encounters.

27. *Mr. Conrad's new work on American conchology.**—The natural history of the family of the Naiades of North America, illustrated by colored plates of each species; by T. A. Conrad, member of the Academy of Natural Sciences of Philadelphia, honorary member of the Geological Society of Pennsylvania.

The author has made the *Naiades* the study of many years, and it is his intention in this important work, to fix the names of the species, in which he will be assisted by several able conchologists.

All the figures will be drawn on stone by himself, from the best and most characteristic specimens; and the plates will be very carefully colored under his own immediate inspection.

It may not be improper to state, that this is the only work of the kind hitherto attempted, those species heretofore described being scattered through various journals and other works.

The work will be printed in royal octavo, on a new type, and very superior paper. It will be issued in parts, each containing not less than five finely colored plates, with accompanying descriptions of the species.

The price per part, colored, will be one dollar. As some persons may wish to obtain the work with the plates uncolored, it will be

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* To be published by subscription, by J. Dobson, Philadelphia.

furnished without coloring at seventy five cents per part, payable on delivery.

Any person obtaining five subscribers, and paying for that number, shall receive the sixth copy gratis.

The work will be published monthly, and the first part will appear early in December, containing figures of eight species, viz: *Unio ovatus*, *U. fasciatus*, *U. reflexus*, *U. foliatus*, *U. scalenius*, *U. retusus*, *U. subrotundus*, *U. decisus*.

Remark.—Mr. Conrad's name is a pledge, amply sufficient, for the accuracy of this work; and we feel assured, that his very respectable publisher will fully co-operate with him in giving it all requisite finish and beauty.—*Ed.*

P. S. We have just seen No. I, of Mr. Conrad's work, which justifies our expectations.

28. *Valuable cabinet of minerals for sale.*—The collection of foreign minerals of Baron L. Lederer, the Austrian consul general, will be sold at public auction on the first days of May, 1836,* if not previously disposed of at private sale. This collection consists of upwards of two thousand and six hundred specimens of foreign minerals, nearly all crystallized or polished, and a great many of them are very valuable and rare. It probably contains a greater number of handsome and rare specimens than any other collection of the same kind in this country. It is arranged according to Cleaveland, in four glass cases at Holbrook & Arnolds', where it may be examined. Each specimen has a black and red number referring to a catalogue, that gives the names under which they were received, those of Werner and Cleaveland, with annotations. Any person wishing to acquire by private sale, is requested to apply to Mrs. Lederer, No. 21, St. Mark's place, New York.

From some acquaintance with the collection of Baron Lederer, we take the liberty to recommend it as eminently worthy of the attention of scientific individuals and of public institutions, in this country. The respected proprietor, for many years resident in the United States, while he has been constantly enriching the cabinet of Vienna with the choicest American specimens, has enjoyed the best

* At the auction store of Messrs. Holbrook & Arnold, No. 92, Broadway.

opportunities of obtaining select specimens of foreign minerals, and especially those of the rich mining districts of Germany, Hungary, &c., and we have no doubt that the opportunity now presented of obtaining, in this country, so valuable a cabinet of minerals, is one that will rarely, perhaps never, occur again.—*Ed.*

On inquiry we are informed, that this collection contains all the species, sub-species, and varieties; and the minerals of the appendix of Mr. Cleaveland's edition of 1822, with the exception of about thirty—but it has a greater number than that, of minerals not mentioned by Cleaveland. A great number of them are described. The minerals of this cabinet were selected by men well acquainted with the science, and who had extensive opportunities for selecting; on this account, the collection may justly claim a pre-eminence. There are perhaps, between forty and fifty geological specimens, but such as belong in the same time to mineralogy, as marl containing petrifactions.

29. *Botanical specimens wanted.*—Prof. Rafinesque of Philadelphia, having begun to publish a *Supplemental Flora* of North America, wishes to procure all the plants omitted by former authors. He will be much obliged to any botanists who will furnish him with their discoveries, or plants omitted by Michaux, Pursh, Nuttall, Bigelow, Torrey, Beck, Eaton, De Candolle, Elliott, &c. and other botanists.

He wants, also, to procure the doubtful plants of these writers; although he has collected already, during twenty years, from 1815 to 1835, many thousand species, and more than five hundred new species: he is chiefly in want of southern plants, and he offers to buy from collectors or botanists, plants of Carolina, Georgia, Florida, Alabama, Tennessee, Mississippi, Louisiana, and Arkansas, at a fair rate, according to value, either labelled or unlabelled.

If a botanist is inclined to visit those states as a collector, he will insure him the sale of plants to the amount of $100. Apply to him for terms. Other plants or books given in exchange when desired.

30. *Fossil Flora of North America.*—Prof. Rafinesque has been collecting, for a long while, materials for a Fossil Flora of North America. He has already one hundred and twenty five species, well ascertained and named, collected from Missouri to the At-

lantic. He offers to purchase or exchange specimens of fossil plants and trees, and give their true names. Specimens must be accompanied with their geological station. Apply to him at Philadelphia.

31. *History of the Americas.*—In March, 1836, will be published the first volume of the *History of the Earth and Mankind in North and South America, or Annals of the ancient and modern nations of both Americas;* by Prof. RAFINESQUE, of Philadelphia. He has been engaged in this work since 1818, and has announced it since 1825. This first volume will contain the *original traditions of the Linapis,* translated from the glyphic manuscripts mentioned by Loskiel, from the creation until the year 1600; also, the traditions of the Haytians omitted by Irving. Each volume will sell for one dollar.

32. The *Prodromus herbarium Rafinesquianum,* published in 1833, has been continued, and contains the *Autiken Botanikon Index, the Florula Texensis, Florula Oregonensis, Nova Sylva Americana, Florula Alleghaniensis, &c. Florula Apalachiensis,* Monographs of *Dodecatheon, Kuheria, Helichna, &c. New Orchidea, &c.*

33. The AUTIKEN BOTANIKON of Prof. Rafinesque, is the original type of his botanical discoveries in North America. The plates are replaced by original specimens of two thousand six hundred plants, whereof five hundred are new, or described by him. This work consists of a single copy, to be disposed of only for a public institution.

34. *Diamonds in North America.*—The "Transactions of the Geological Society of Pennsylvania, 2d part," contains a notice of a diamond, weighing one carat and a half, recently found in the washings of a stream in North Carolina; a more particular account of it, is soon to be given.

35. *Obituary.*—It has often been our painful duty to record the departure of eminent friends to our labors—friends in our personal relations, and friends to the cause of science and of mankind. Such were the two distinguished men, for a short notice of whom we are indebted to the recent daily journals. Our limits of time and space do not permit us to obtain a more extended and appropriate notice, which we would fain look for from their friends.

Death of BENJAMIN VAUGHAN, LL. D. aged 81, of Hallowell, Me.—Mr. V. was a man of great and varied learning, and his personal knowledge of the literati of Europe for fifty years past was uncommonly extensive. He had one of the largest and most valuable private libraries in the country. Mr. V. was formerly a member of the British Parliament, and was of the Whig party headed by Mr. Fox and Lord Lansdowne. In 1793–4 he was so much in favor of the French revolution, that he incurred the displeasure of the British ministry. He was useful to Dr. Franklin and the other American envoys in Europe, in 1781–2, when negotiations were going on for peace between England and the United States. Mr. V. was a most benevolent character, and of patriotic and liberal views, but a zealous friend of order, morality and religion. He favored all efforts for the enlightening of mankind. In religion he was of the school of Priestley, and in politics, of that of Fox, Franklin, and Jefferson. But he was not like many Englishmen who come to reside among us, or to visit us, and who find fault with the government, and endeavor to excite the prejudices of the lower classes amongst us. He came to this country, and settled at Hallowell, in 1795, on land belonging to the family; and no man has done more to improve the people, to encourage the means of education, and introduce new modes of agriculture, than Mr. V. His memory will be held precious, and his good deeds long remembered with gratitude.—*Boston Gazette.*

Death of Dr. HOSACK, of New York.—A great man in the profession has fallen. Few men enjoyed more uninterrupted health than Dr. H. We met him only the day before his attack, and were remarking to him that we never saw him look better—his reply was, he was in the perfect enjoyment of health. We learn that he was rather unwell on Friday morning, but took his breakfast, went out a short distance, transacted some business, and returned to ride out in his wagon, which was at the door. He however was seized with a faintness, sunk on the sofa—was soon attacked with a shock of apoplexy, attended by paralysis, from which he lingered until Tuesday night, and expired, at the age of sixty six.

Dr. H. was one of the last of the old school, who have been at the head of the profession in this city for the last forty years. He received his medical honors at Edinburgh—enjoyed a most extensive practice—was a most eloquent teacher as professor of the theory and practice of physic. He early took a stand in relation to yellow fever, which he maintained to the last. He was a most liberal promoter of the sciences and the arts. Few individuals have a richer collection of rare works in store than Dr. H. His History of the Erie Canal, and the life of his friend De Witt Clinton, belong to the times. We trust some talented gentleman will write a biography of Dr. Hosack, which will be most acceptable to the public.—*N. Y. Daily Advertiser.*

It would be difficult to name two men, who shone in their appropriate sphere, with a brighter and more steady lustre, than Mr. Vaughan and Dr. Hosack. In both we have found warm friends of our humble labors, and Mr. Vaughan not unfrequently contributed to our pages, but his singular modesty would never permit his name to appear, or any allusion to escape him by which he might be known.

36. LIST OF NEW PUBLICATIONS.

American.

The Naturalist's Own Book; comprising Descriptions and authentic Anecdotes of Quadrupeds, scientifically arranged according to the system of Cuvier. By the author of the "Young Man's Own Book." 1 vol. 12mo. 1835. *Philadelphia.* (Key & Biddle.)——Turner, (Edward,) M. D. F. R. S. &c.: *Elements of Chemistry, including the recent discoveries and doctrines of the science.* Fifth American, from the fifth London Edition; with Notes and Emendations, by Franklin Bache, M. D. 12mo. xix, and 682 pp. *Philadelphia.* 1835. $2 50.——Conrad, (T. A.) Curator of the Academy of Natural Sciences of Philadelphia: *Monography of the Family Unionidæ or Naiades of Lamarck of North America,* illustrated by Figures drawn on stone from nature. No. 1. 12 pp. 8vo. Philadelphia. 1835. Contents, Unio fasciatus (plate 1), ovatus (plate 2), slava (3), decirus (3), reflexus (4), flexuosus (4), Phillipsii (5), metaneura (5.)——*Transactions of the Geological Society of Pennsylvania.* vol. 1. part 2., x. and 177—247 pp. 8vo. Philadelphia. 1835.

GENERAL NATURAL HISTORY.

Foreign.

Nouvelles Annales du muséum d'histoire naturelle, tome iv; 1re livraison de 1835; in 4° de 95 p. *Paris,* Roret.——*Analyse des* *travaux de l'Académie des sciences, etc., de Besançon*, pendant 1834; 115 p. in 8°. *Besançon.*——*Analyse des travaux de la Soc. d'agriculture, etc., de Mende;* 200 p. in 8°. *Mende.* 1835.——*The West of England Journal of Science and Literature*, edited by Geo. T. Clark. No. 1. January, 1835. 8vo. 88 pp. on Science, and 36 pp. on Literary subjects. To be continued.——Moffatt, (John F.): *The Book of Science*, 2d series, comprising a treatise on Chemistry, Metallurgy, Mineralogy, Crystallography, Geology, Oryctology, Meteorology, adapted to the comprehension of young people. 16mo. 480 pp. with numerous plates. *London.* (Chapman & Hall.) 1835.——Mudie, (Robert): *British Naturalist.* 2 vols. 8vo. *London.* 1835. 12*s.*——*The Naturalist's Library*, vols. ix. x. foolscap. 8vo. *London.* 1835. 6*s.* each.——*Popular Illustrations of Natural History*, foolscap. 8vo. *London.* 1835. 6*s.* 6*d.*——Mudie, (Robert): *The Air.* foolscap. *London.* 1835. 5*s.*

MINERALOGY AND GEOLOGY.

Omalius d'Halloy, (J. J. d'): *Elémens de géologie*, ou deuxième partie des élémens d' histoire naturelle inorganique; 2nd ed.; in 8° de 742 p. *Paris.* Levrault. 1835.——Nyst, (H.): *Recherches sur les coquilles fossiles de la province d'Anvers;* broch. in 8°. *Bruxelles.* 1835.——Berthelot, (S.): *Description orographique de l'île de Ténériffe;* 13 p. in-8°. 1835.——Higgins, (W. M.), F. G. S.: *The Earth, its Physical History and most Remarkable Phenomena. London.* (Orr & Smith.) 1835.——Necker: *Le règne minéral ramené aux méthodes de l'histoire naturelle;* 2 vols. in 8° de 400 et quelques pages chacun. *Paris.* Levrault. 1835.——Gras, (Scipion), ingénieur des mines: *Statistique Minéralogique du département de la Drôme;* 300 pages in 8°. *Grenoble.* 1835.——Thomson, (Thomas), M. D., F. R. S.; Regius Professor of Chemistry in the University of Glasgow: *Geology and Mineralogy*, forming the third portion, or the fourth and fifth volumes of his System of Chemistry. 2 vols. 8vo. *London.* 1835.

ZOOLOGY.

The Natural History of Man. 18mo. *London.* 1835. 3*s.* 6*d.* ——Bell, (Thomas) Esq., F.R.S. &c.; Lecturer on Comparative Anatomy in Guy's Hospital: *A History of British Quadrupeds.*

1835.——Morris, (Rev. F. O.) B. A.: *A Guide to an Arrangement of British Birds;* being a Catalogue of all the species hitherto discovered in Great Britain and Ireland. 8vo. 18 pp. *London.* 1835. 10*s.* 6*d.*——Comte, (Ach.): *Tableaux méthodiques du règne animal de M. le Baron Cuvier;* crustacés décapodes; poissons acanthoptérygiens; 2f. in fl°. *Paris.* Crochard. 1835.——Webb et Berthelot: *Mémoire sur une nouvelle espèce de Mollusque de la famille des Limacinées, le Cryptella Canariensis;* 8 p. in–8°. *Paris.* 1835.——Kiener: *Species général et iconographie des coquilles vivantes comprenant le musée Masséna, etc.;* 10e livraison; in 4°. 1835.——*Catalogue of Recent Shells in the Cabinet of John C. Jay,* M. D. 12mo. 55 p. *New York.* 1835.——Roberts, (Mary): *The Sea-side Companion, or Marine Natural History.* 12mo. *London.* 1835. 6*s.* 6*d.*

BOTANY.

Hooker, (Wm. J.): *Companion to Curtis's Botanical Magazine.* Dr. Hooker has discontinued his *Botanical Journal,* under this name, and has begun to communicate the kind of information which has been supplied in the *Botanical Journal,* in the Magazine above noticed, which he edits. The first number appeared on August 1, 1835: it is to be continued monthly, in numbers, each of 2 sheets and 2 partially colored plates, 1*s.* 6*d.*; if taken stitched with the *Magazine,* 1*s.*——Macgillivray, (W.): *Withering's Systematic Arrangement of British Plants.* 3d edition. *London.* Scott, Webster & Geary. 1835.——Baxter: *Illustrations of the Genera of British Flowering Plants.* 2nd edition. 1835.——Bohler, (J.): *Lichenes Britannici;* or Specimens of the Lichens of Britain, with Descriptions and Occasional Remarks. In monthly fasciculi. 8vo. No. I. June, 1835. *Sheffield* and *London.* 3*s.* 6*d.* each number.——Stewart, (R. B.): *Outlines of Botany;* a Sketch of the Linnæan Arrangement of Plants, with Tables to illustrate the distinctions of Genera and Species; to which are added, Hints for the Management of a small Garden. 8vo. 72 pp. *London.* 1835. 2*s.* 6*d.*——Deakin, (R.) F. R. C. S. E.; and (Marnock R.) Curator of the Sheffield Botanical and Horticultural Gardens: *Florigraphia Britannica;* or Engravings and Descriptions of the Flowering Plants and Ferns of Britain. In monthly numbers, demy 8vo., each to contain figures and descriptions of twelve species of plants. Price per number, figures colored, 1*s.*; figures uncolored, 1*s.* 6*d.* *Sheffield* and *London*, 1835.——Lindley, (J.), Ph. Dr., F. R. S., Professor of Botany in the London University; and Hutton, (W.) F. G. S., Member of the Geological Society of France: *The Fossil Flora of Great Britain;* or Figures and Descriptions of the Vegetable Remains; found in a Fossil state in this country. No. xvii.; July, 1835. 8vo. 9 pl. *London.* 5*s.* 6*d.*——Caisne, (J. de): *Herbarii Timorensis descriptio*, 4° de 170 pag., avec 6 pl. *Paris*, Roret: 1835.——Montagne: *Description de plusieurs espéces de Cryptogames découvertes par M. Gaudichand dans l'Amérique méridionale;* 12 p. in–8, avec une planche. (Extrait des Annales des Sciences naturelles.) 1835.——*Flore Batave;* 100e et 101e livraisons (en français et hollandais) in–4. Amsterdam, Sep. et fils. 1835. ——Saint-Hillaire (Auguste de): *Mémoire sur la structure et les anomalies de la fleur des Résédacées.* (Extrait du t. xiii. des Annales de la Société royales des Sciences d'Orleans) in–4, de 20 pages. 1835.——Reid, (Hugo): *Outlines of Medical Botany*, comprising Vegetable Anatomy and Physiology; the characters and Properties of the Natural Orders of Plants; an Explanation of the Linnæan system of classification; and Tables of Medicinal Plants, arranged in their Linnæan and Natural orders. 12mo. *London.* 1835. 9*s.* ——Toase, (W. K.): Botanical Tables and Tables of Materia Medica. 4to. *London.* 1835. 4*s.*——Francis, (G.): *A Catalogue of the Species of British Flowering Plants and Ferns that are described in the third edition of Dr. Hooker's British Flora;* published to facilitate Botanical correspondence, as an Index to Herbariums, &c. In one sheet. *London.* 1835. 6*d.*——Jacob, (Rev. J.), L.L. D.: *West Devon and Cornwall Flora.* In monthly numbers. 1*s.* each. *London.* 1835.——Halsted (Caroline A.): *The Little Botanist*, or steps to the attainment of Botanical Knowledge. 2 parts. 243 and 271 pp. 16mo. *London.* 1835.——*Sowerby's English Botany.* Plates, 8vo. Nos. lxxxix. to xciv. *London.* 1835. 1*s.* each.——Turnbull, (A.), M. D.: *On the Medical Properties of the Natural Order Ranunculaceæ*, &c. *London.* 1835.

CHEMISTRY.

Dumas & Peligot: *Mémoire sur l' esprit de bois, et sur les divers composés éthérés qui en proviennent.* (Mémoire lu à l' Académie en October, 1834.) 8vo. *Paris.*——Van Mons: *Abrégé de Chimie, à l' usage des leçons;* t. v; in—12. *Louvain.* 1835.——Valerius: *Analyse chimique*; tableau in fol. *Bruxelles.* 1835.——Reid, (D.

B.) M. D.: *Elements of Practical Chemistry.* 2nd edition. 1 vol. 8vo. *London*, 1835. 15*s.*——Ure, (Andrew): *Dictionary of Chemistry.* 4th edition. 8vo. *London*, 1835. 21*s.*——Rose, (Henry): *Manual of Analytical Chemistry*, by Griffin. *London*, 1835. 16*s.* boards.——Davy, (Edward), M. R. C. S.: *An experimental guide to Chemistry. London*, 1835. 5*s.* 6*d.*——Accum, (F.): *Chemical Reagents or Tests, and their application in analyzing Waters, Earths, Soils, Ores, Metallic alloys, &c. &c.* Improved and brought down to the present state of Chemical Science, by William Maugham, Surgeon, Lecturer on Chemistry and Materia Medica, &c. Plates. *London*, 1835. 6*s.* boards.

NATURAL PHILOSOPHY, &C.

Becquerel: *Traité expérimental de l' électricité et du magnétisme, et de leurs rapports avec les phénomènes naturels;* tome III, comprenant la fin de l' électro-dynamique, les théories électro-chimiques et les piles thermo-électriques; in—8 de 450 p. *Paris*, 1835. Firmin Didot.

MATHEMATICS AND ASTRONOMY.

Pontecoulant, (G. de): *A History of Halley's Comet, with an account of its return in* 1835, *and a Chart showing its situation in the Heavens.* Translated from the French, by Col. Charles Gold, C. B. 8vo. *sewed. London*, 1835. 1*s.* 6*d.*——Baily, (Francis) Esq.: *An account of the Rev. John Flamsteed, the First Astronomer Royal*, compiled from his own MSS. and other authentic documents, never before published; to which is added, his British Catalogue of Stars; corrected and enlarged. *London*, 1835.——Poisson, (S. D.): *Théorie mathématique de la chaleur;* in 4° de 532 pages, avec une planche. *Paris*, Bachelier. 1835.——Larrony: *Essai d' une nouvelle théorie de la similitude des figures géométriques;* 62 pages in 8°. *Paris*, Bachelier. 1835.——*Feuilles* 13 *et* 14, *des Cartes célestes publiées sous les auspices de l' Académie des Sciences de Berlin.* 1835.——Sturm: *Theorem on the Solution of Numerical Equations*, by means of which the Determination of the Number and Situation of all the real Roots of a Numeral Equation, is completely and Satisfactorily effected with comparative simplicity. This remarkable theorem has just been published by order of the Académie Royale des Sciences de l' Institut de France. Translated by W. H. Spiller. 4to. *London*, 1835. 7*s.* 6*d.*

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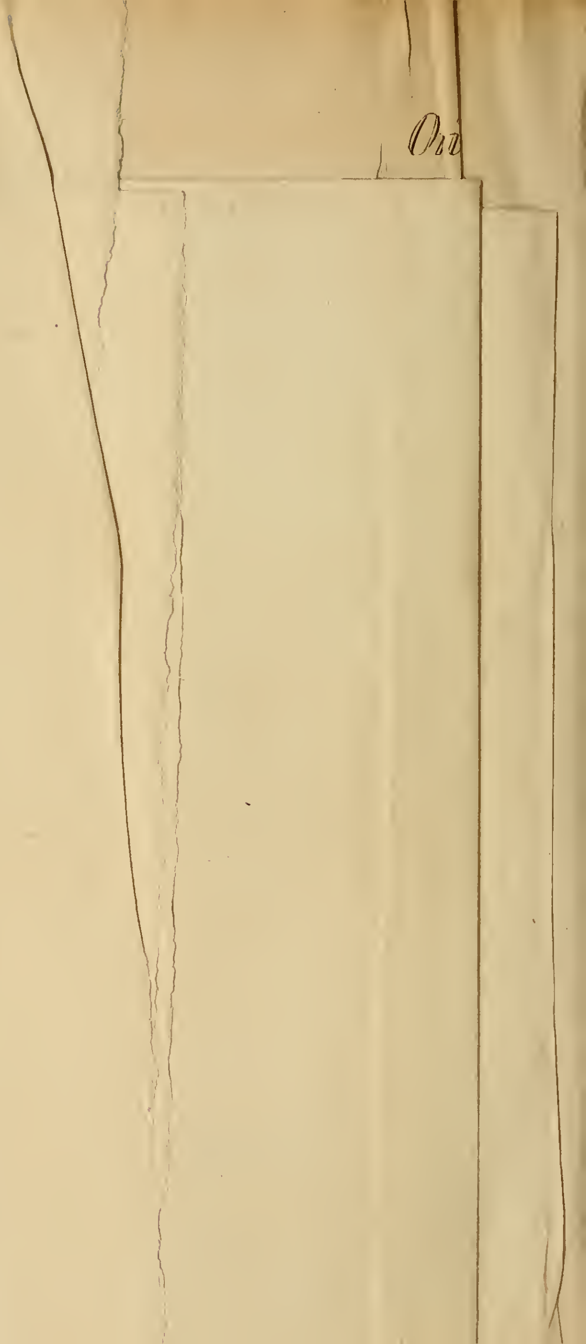
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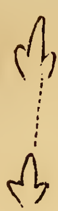

Fgs. 1

Ornithichnites giganteus. (Natural size)

Fig: 21

Fig. 22.

Ornithichnites diversus a clarus

(Natural size)

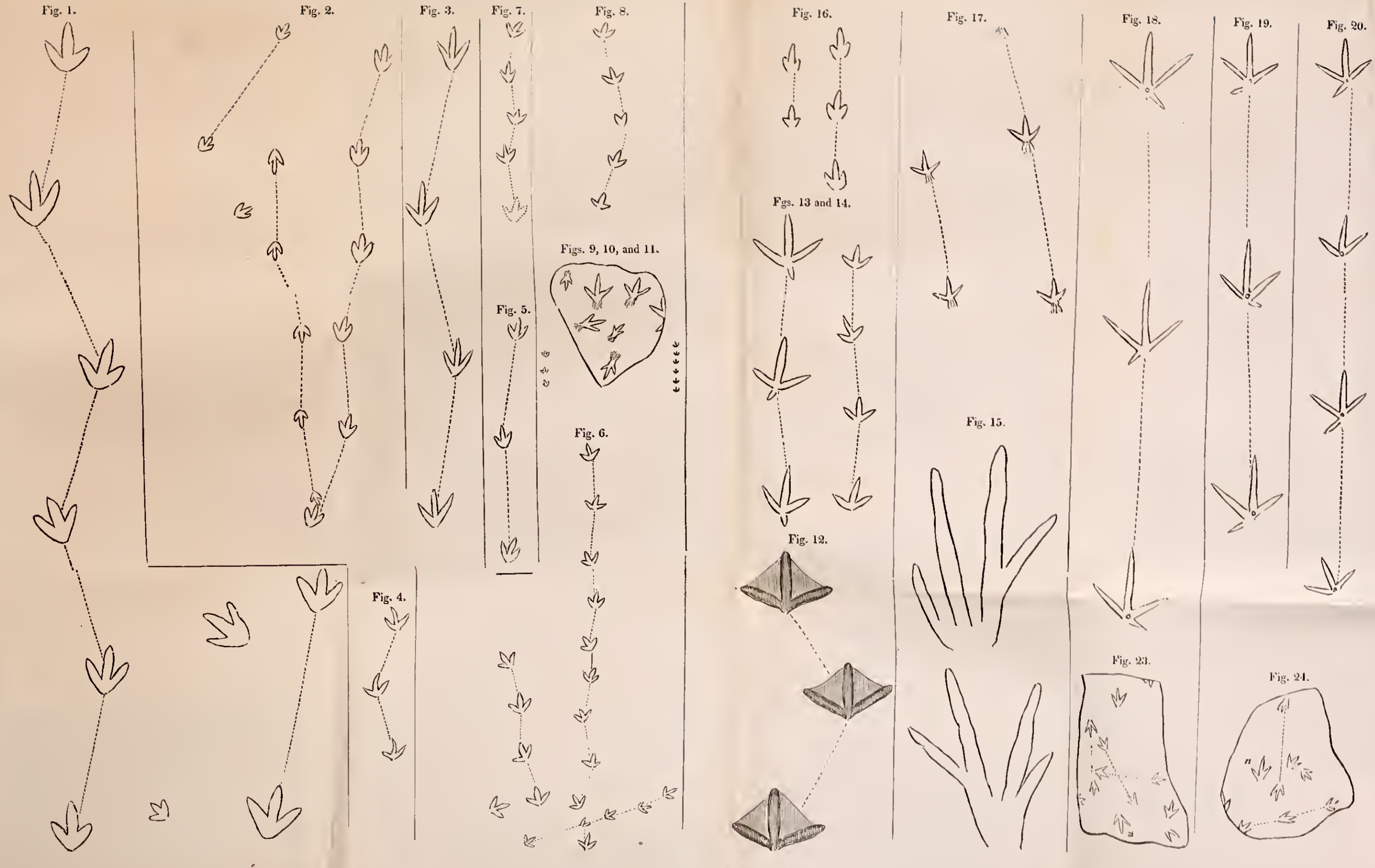
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Fig. 23.
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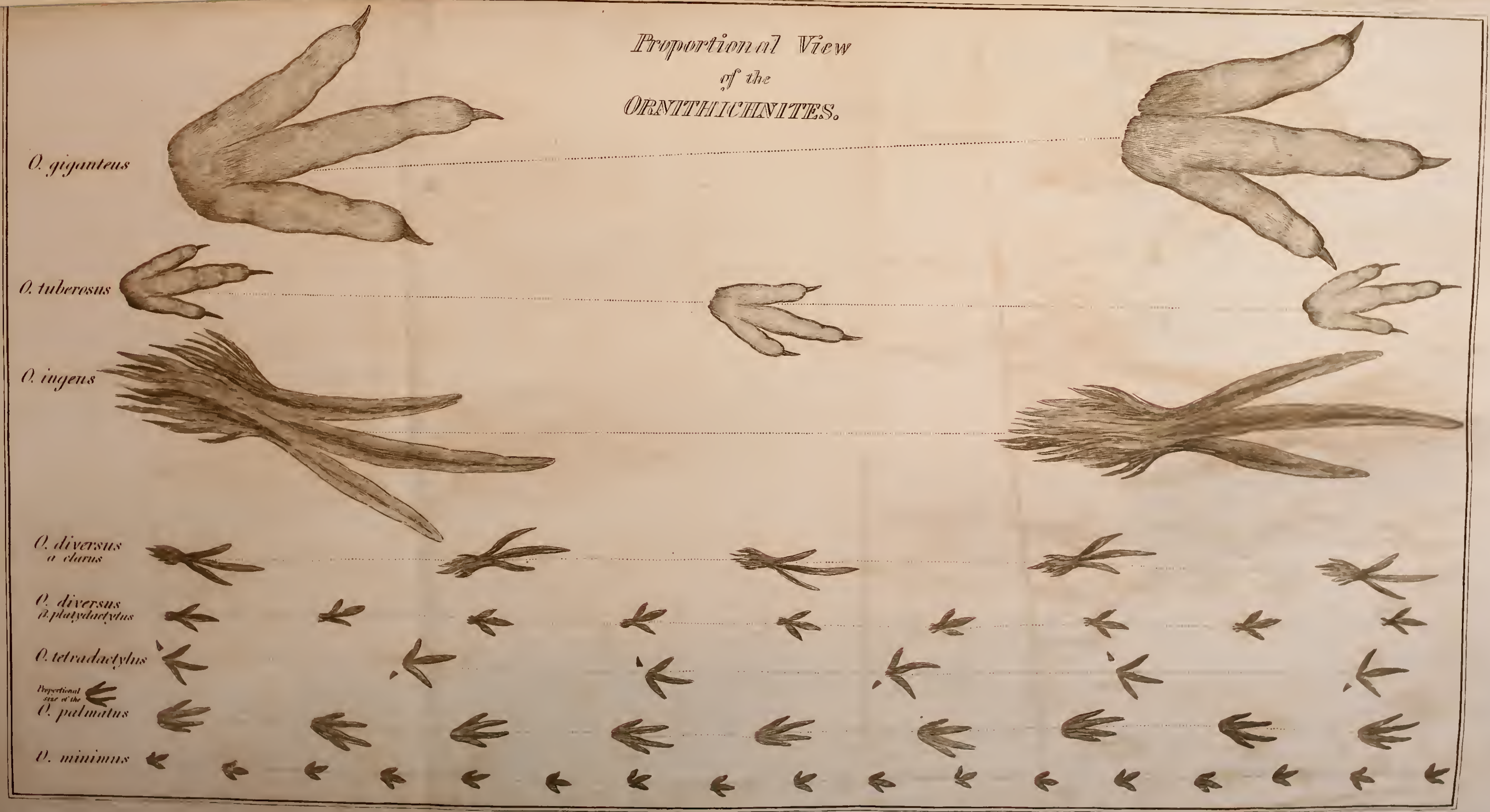
Proportional View
of the
ORNITHICHNITES.
O. giganteus
O. tuberosus
O. ingens
O. diversus
α clarus
O. diversus
β platydactylus
O. tetradactylus
Proportional size of the
O. palmatus
O. minimus

PROSPECTUS.

In 1810, 11 and 12, the late Dr. Bruce, of New York, published his Journal of Mineralogy and Geology in one volume of four numbers.

The American Journal, was, however, the first, that in this country, embraced in its plan, *the entire circle* of the Physical Sciences, and their applications to the arts. It was begun in July, 1818, and has completed its twenty ninth volume.

While it has prompted original American efforts, it has been sustained by them, and being devoted to important national interests, in a great measure common also to all mankind, it is, in that character, known and accredited, both at home and abroad. It has elicited many valuable researches and discoveries, and its miscellaneous department, in particular, has presented a great variety of topics, of general interest. The Foreign Journals, (many of them sent in exchange,) often quote from its pages, which are in turn, enriched by theirs; and it has thus, become identified with the science and arts of the present day.

Terms.—For four quarterly Nos., of not less than 200 pages each, fully illustrated by plates, making, together, two annual volumes, of at least 800 pages; six dollars—*in advance.*

The quarterly *literary* journals, escape the heavy expense incurred by this, for plates and for difficult technical composition; and as they enjoy, from obvious causes, a far more extended circulation, they can be much better afforded at $5 per ann. than this at $6. *Without a greatly increased patronage, this Journal could not be sustained at five dollars, as the actual receipts would not pay for the paper and the mechanical labor.*

Postmasters are, occasionally, patrons of the Journal, when of course their communications are franked.

A number will be sent gratis, as a sample, when requested, especially to editors of newspapers who republish this appeal and prospectus, and transmit the paper containing it to the editor. Names may be lodged with any of the agents, or sent to the Editor or publishers, and the work may be obtained through all booksellers, or from the editor.

Complete sets are furnished to individuals, and to the trade, at a suitable discount.

The Editor will draw on his agents semi-annually, (that is, on or near the time of the publication of No. 2, of each volume,) in all cases where payment is not otherwise provided for; the drafts will be usually payable April 1, and Oct. 1. An annual payment in advance is, in all cases, expected from the individual subscribers, and the bills are accordingly forwarded with the Journal; *their numbers will be stopped, if payment is one year in arrears.*

For single subscribers, the mail is, decidedly, the best mode of conveyance: the postage is about that of a twice weekly newspaper, that is, from $1.10 to $1.32 per annum.

New Haven, Jan. 1, 1836.

Remark.—Not being willing to keep in the view of the world the painful facts, that were disclosed in an appeal, not long since, prefixed to this prospectus, we repose, for a season, upon the aid brought to our cause by zealous and kind friends, in various places, but especially in Boston and Salem; and which, although honorable to those by whom it was offered or obtained, still falls short of the full security which the case requires; this aid secures us from immediate catastrophe, but not from a gradual decline.

Our cause has been warmly espoused abroad, especially by the Mining Journal of London—which has often honored us with more than merited commendation. On the present occasion, (omitting what is personal to the editor,) we beg leave to quote from that work, a passage relating to this Journal. "The character of the American Journal is too highly appreciated on this side of the Atlantic, to need our testimony, and it is with feelings of deep regret and astonishment, we learn that a nation professing a regard for literature and philosophy, should have been so indifferent to the success of a periodical [work] which has materially contributed to raise America to the rank she now holds in the scientific world." It is then stated, that although the appeal is made to Americans, the cause belongs to mankind.

ACKNOWLEDGMENTS TO FRIENDS, CORRESPONDENTS AND STRANGERS.

Remarks.—This method of acknowledgment has been adopted, because it is not always practicable to write letters, where they might be reasonably expected; and still more difficult is it to prepare and insert in this Journal, notices of all the books and pamphlets which are kindly presented, even in cases, where such notices, critical or commendatory, would be appropriate; for it is often equally impossible to command the time requisite to frame them, or even to read the works; still, judicious remarks, from other hands, would usually find both acceptance and insertion.

In public, it is rarely proper to advert to personal concerns; to excuse, for instance, any apparent neglect of courtesy, by pleading the unintermitting pressure of labor, and the numerous calls of our fellow-men for information, advice, or assistance, in lines of duty, with which they presume us to be acquainted.

The apology, implied in this remark, is drawn from me, that I may not seem inattentive to the civilities of many respectable persons, authors, editors, publishers, and others, both at home and abroad. It is still my endeavor to reply to all letters which appear to require an answer; although, as a substitute, many acknowledgments are made in these pages, which may sometimes be, as now, in part, retrospective.—*Ed.*

DOMESTIC.

A System of Modern Geography for Schools and Academies, by Nathaniel G. Huntington, A. M. Hartford, Conn., 1835. From the publishers.

Report of the Engineer upon the preliminary Surveys for the Hartford and New Haven Rail Road. From A. C. Twining, Esq. Civil Engineer.

Details of the American Revolution from a manuscript obtained by Ithiel Town, Esq., in London, in the year 1830. New York, 1835. From Mr. Town.

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