EIGHTH, NINTH AND TENTH

ANNUAL REPORTS

OF THE

GEOLOGICAL SURVEY

OF

INDIANA,

MADE DURING THE YEARS 1876–77–78,

BY

E. T. COX, STATE GEOLOGIST,

ASSISTED BY

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INDIANAPOLIS:
INDIANAPOLIS JOURNAL COMPANY, STATE PRINTERS.
1879.

OFFICE OF STATE GEOLOGIST,
INDIANAPOLIS, INDIANA.

To the Honorable President and Members of the
Indiana State Board of Agriculture:

GENTLEMEN: — I herewith submit to your honorable body my Eighth, Ninth, and Tenth Annual Reports of progress in the Geological Survey of the State, embracing detailed reports on the counties of Wayne, Crawford and Harrison, a general review of the geology of the State and special reports on the building stone, cements and clays.

Respectfully,

E. T. COX,
State Geologist.

REPORT.

The geological history of Indiana appears tame and devoid of the marvelous interest which attaches to those regions of country where the forces generated in the earth's laboratory have made themselves conspicuous by the metamorphism of the rocks, and the tilting, folding and fracturing of its crust. Here the elements concerned in the building up of strata leave no trace of violent cataclysms, and the rocks presented to view lie regularly bedded at an inclination or dip, to the westward and northward, so gentle that its existence can only be made known by observations extended to points that are far distant from one another. Not a single true fault, or upward or downward break and displacement of the strata has yet been discovered. From this, then, one might be led to suppose that the geologist would have but little trouble in tracing and making up a complete and accurate record of the geological history of the State. But this very monotony of action and uniformity of strata is, perhaps, more perplexing and defiant to deal with and read correctly, than where turbulence prevailed and marked the pages of geological time with bold and well-defined characters. There is also another great drawback to investigations in Indiana, due to an immense deposit of glacial clay, sand, gravel and boulders which spread over so large a portion of the State, and cover up the beds of stratified rock to a depth of several hundred feet in the counties north of the Wabash river, fifty to a hundred feet in the central part of the State, and twenty to sixty feet in the southern part.

The oldest and first-formed rocks in Indiana are to be seen in the southeastern part of the State, and extend along the Ohio river, from the mouth of the Fourteen-mile creek, in Clark county, to the eastern boundary line.

From the mouth of Fourteen-mile creek, the western boundary of these rocks runs in a northeasterly direction through Ripley county, keeping a little west of Versailles, nearly through the central part of Franklin, western part of Union to Cambridge and Richmond in Wayne county. It may be followed a few miles north of Richmond, on the middle fork of White Water river, and from thence east into Ohio. This group of paleozoic rocks received the name of Hudson River group in the geological reports of New York, where they were first studied and assigned to the position which they hold in geological sequence. The Hudson River group, in New York, forms the upper division of the Trenton period and the upper member of the Lower Silurian formation. Going east from the western outcrop of the Hudson River group through Ohio to its eastern boundary, the width of the exposure is about ninety miles. But by far the greater area of these beds is to be found in Kentucky, on the south, where the breadth is over one hundred miles, and the southward prolongation reaches beyond Nashville, in Tennessee. Altogether, the exposure from its northern outcrop in Ohio to its southern crop in Tennessee is about three hundred and twenty miles long. In Kentucky these rocks received the name of "Blue limestone." Professor Safford, in his geological report on the rocks of that State, gave them the name of "Nashville group." Worthen and Meek, in the geological reports of Illinois, gave them the name of "Cincinnati group," and I suppose that I might, with the same propriety, add to this confusion by applying to these beds the name of "Madison group," because we find at this city an admirable exposure of the beds, and some striking lithological peculiarities not noticed elsewhere, but I prefer rather to diminish than augment the number of synonyms which are so perplexing to the masses who are trying to acquire a fair knowledge of geological science, but become discouraged on finding so many names applied to a single epoch.

The Lower Silurian rocks being the oldest within the borders of Ohio, Indiana, Kentucky and Illinois, they must necessarily, where not brought to the surface, underlie the formations that follow them in time, so that, go in whatsoever direction you will from their surface exposure, it will be observed that they are lost beneath the drainage, and give place to newer formations. This well-known fact has led the ablest geological observers of this country to attribute their outcrop to a local disturbance, which uplifted and brought them to the surface. The axis of this disturbance was supposed to be in a northeasterly and southwesterly direction, and to pass in the vicinity of Cincinnati, Ohio. Some speak of it as the "Cincinnati axis," or "Cincinnati uplift."

Dr. John Locke and Dr. D. D. Owen believed that this line of axis in Ohio passed near to the Indiana boundary, as they found the Hudson River rocks at a greater elevation here above the Ohio river than they are at Cincinnati. Professor Orton, of the Ohio geological survey, in his very comprehensive and able report on these beds, while he did not undertake to re-examine Dr. Locke's points of observation near the borders of Indiana, finding the Cincinnati beds in Clermont county, sixty miles east of Indiana, seventy-four feet higher than at Cincinnati, and the section to include fifty feet of rocks, which are supposed to underlie the lowest stratum, exposed in the river at Cincinnati, concluded from these facts, that the axis of uplift is not a sharply-defined line, but a broad arch, and the highest point of that arch lies to the east, and not to the west, of Cincinnati, as indicated by Dr. Locke. "Cincinnati arch," and "Cincinnati dome," have long been common expressions used by geologists in speaking of the dynamics of the strata. The dip of the beds in the vicinity of Cincinnati, according to Professor Orton, is to the northward.

My own opinion is that the Lower Silurian strata in the region above alluded to were not thrust to the surface by a local disturbance, but by an elevating force which acted very slowly and extended over the entire central area of the United States. If we are to judge from the hight of the strata above the sea level, then the seat of greatest force concerned in the elevation was not confined to southwestern Ohio, but should be looked for in Kentucky, where the Lower Silurian has a greater elevation and a much more extended area than to be found in Ohio or Indiana. An examination of the hydrography of the district occupied by the Lower Silurian should at onee convince the most skeptical that instead ot Cincinnati anticlinal, it would be more proper to say Cincinnati synclinal; and instead of dome, basin. Licking river rises east of south and flows north to find the lowest level at Cincinnati. The Ohio river itself after washing the eastern border of Clermont county, has to turn almost north in order to reach the depression at Cincinnati, then turns nearly due west to the boundary of Indiana, when the general course is directed to the south. The Great Miami and the Little Miami rivers rise to the northward and flow in a southerly direction to reach the low ground at or near Cincinnati. The tributaries of the Ohio river indicate in a measure the topography of the country traveled, and we have only to point out the geological levels to prove our premises more fully. Professor Orton, in the first volume Geological Reports of Ohio, page 412, says that the heavy stratum of *Orthis biforata* found at Cincinnati four hundred and twenty-five feet above low water, are four hundred and seventy-five to four hundred and ninety feet above the river at Bethel, on the eastern side of Clermont county. Here, then, we have evidence of a dip to the northward of two to three feet to the mile.

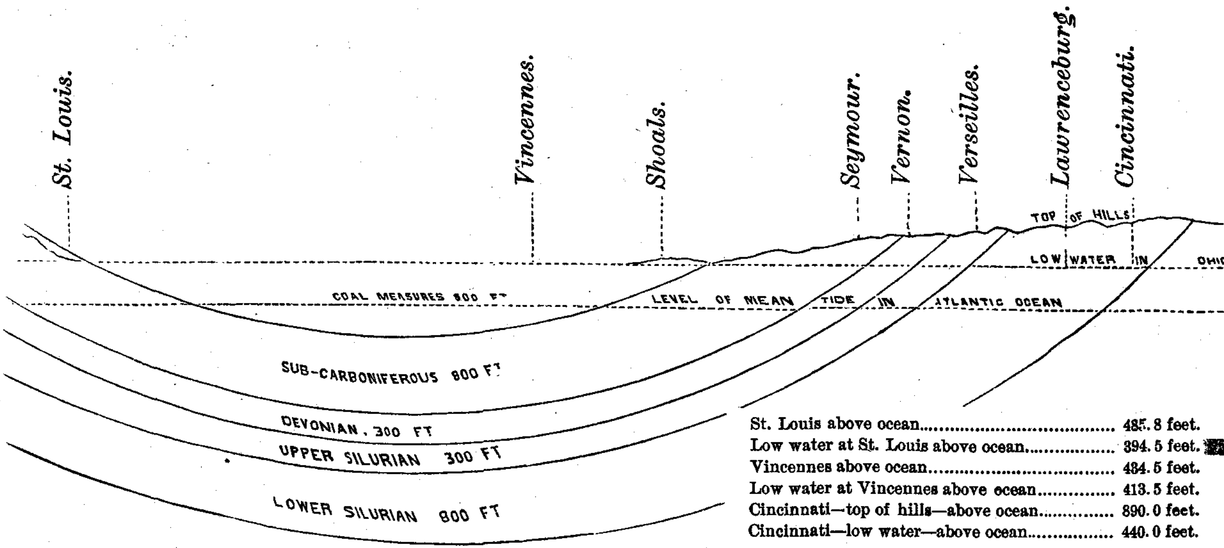
If we take the levels of Dr. John Locke near the Indiana boundary, about thirty miles west of Cincinnati, the top of the Cincinnati beds are six hundred and one feet above the river, including a dip of about two to three feet per mile to the eastward. Now my own observations in Indiana go to sustain the accuracy of Dr. Locke's levels. At Morris, on the Indianapolis, Cincinnati & Lafayette railroad, the *Orthis lynx*, or *Orthis biforata* beds, which I take to be the equivalent of the *Orthis biforata* beds at Cincinnati, have an elevation, by railroad levels, of five hundred and seventy feet above the river at the latter place; and at Pierceville, on the Ohio & Mississippi railroad, forty-four miles west of Cincinnati, the Lower Silurian is five hundred and seventy-four feet.

Take the elevation near Bethel, four hundred and seventy-five to four hundred and ninety feet, and the elevation at Morris, five hundred and seventy feet, and one would be compelled, from these levels, to place Cincinnati in a synclinal rather than an anticlinal axis. But I do not attribute the same importance to such slight variations in levels as many of my co-laborers in geology, I prefer rather to refer them to other causes such as arise from an uneven ocean bottom and the effects of subsequent denudation.

The central valley of the United States we find made up exclusively of sedimentary rocks that were laid down on an uneven bottom; of these the Lower Silurian beds are the oldest in time and were, therefore, formed first. The exposure of these beds in Indiana, Ohio, Kentucky and Tennessee, surrounded as they are on all sides by strata that follow them in regular sequence as you recede from the outcrop, have, therefore, led many geologists to believe that they were thrust up by a local disturbance, of which Cincinnati lies in or near the axis. Now, if this was the case, then we are bound to admit that in the vicinity of Cincinnati there has been a vast amount of denudation, as I have already shown that the Hudson river beds occupy a greater elevation, both on the east, south and west of that city. According to Professor Proctor, to whom I wrote for information, the Hudson river beds, twelve miles west of Frankfort, Kentucky, are eighteen hundred and eighty-five feet above the level of the sea. Immediately at Frankfort the highest points are, according to the same authority, eight hundred and ten feet, and at Lexington nine hundred and fifty feet above the sea. If Mr. Proctor is right in the elevation of the beds twelve miles from Frankfort, and that the upper beds have elsewhere been cut away and removed by denudation, we have here evidence of the exposure of a vast amount of Lower Silurian rocks far in excess of what is known in Ohio and Indiana at the present time; and as such an elevation of the Lower Silurian in Indiana or Ohio would have covered the entire area of these states, no such idea can be entertained for a moment, and their disappearance here can not be due to any very great amount of denudation, but to a northerly dip of the strata. In a paper which I read before the American Association for the Advancement of Science, at the Indianapolis meeting in 1871, I then called attention to the fact that the Lower Silurian rocks were not brought to the surface by a local uplift, but by an upward movement of the continent. The shallow parts of the ocean were first laid bare, and this

PLATE I.

Section from St. Louis, Mo., to Cincinnati, Ohio.



St. Louis above ocean	485. 8 feet.
Low water at St. Louis above ocean	394. 5 feet.
Vincennes above ocean	484. 5 feet.
Low water at Vincennes above ocean	413. 5 feet.
Cincinnati—top of hills—above ocean	890. 0 feet.
Cincinnati—low water—above ocean	440. 0 feet.

gave rise to a Lower Silurian peninsula. I shall not now undertake to give a detailed account of the filling up of the ocean basins which encompassed the Lower Silurian land, but confine myself to what followed in the area comprising the State of Indiana. As the land rose above the ocean, the succeeding strata made their appearance in regular sequence, as shown by the accompanying section (Fig. 1), which is made to scale from Cincinnati, Ohio, to the Mississippi river opposite St. Louis. The elevations are given from the grade of the Ohio & Mississippi railroad. The lower dotted line represents the level of mean tide in the Atlantic ocean. The upper dotted line, low water in the Ohio river at Cincinnati, and the top line indicates the topography. Commencing with the Lower Silurian on the right, it is succeeded near Versailles by the Upper Silurian, this by the Devonian, Sub-carboniferous and Coal-measure strata.

The subordinate strata rise again to the surface in Missouri, so that we have in Illinois and Indiana, between the eastern and western crop of the Sub-carboniferous, a vast shallow basin reaching from shore to shore of the Sub-carboniferous rocks at the close of the latter epoch. After a time this basin, being shut out from the sea, became a fresh-water marsh, and the conditions were favorable for a luxuriant growth of plants which furnished carbon for a bed of coal. To account for a succession of seams of coal, we must now admit a period of submergence.

The low ocean barriers, which protected the basin on the south, were overflowed, and a deposit of sediment gave rise to the overlying shales, sandstones and limestones. The deposit was necessarily continued over long periods, and the stoppage for a time of the movement would cause the outlet to fill up and again shut out the sea, and bring about the conditions for plant growth and the formation of another bed of coal, and so on until the basin was filled or the coal epoch terminated. This period of comparative rest and subsidence need not have been regular nor violent in its action, but must have been slow and of long duration. A similar basin, and due to like causes, existed on the eastern side of the Silurian belt, giving rise to the Appalachian coal basin; but the beds of coal which it contains need not have been formed at precisely the same time, though they must necessarily be very closely correlated in the upper part of the basins. In the eastern field the formation of coal commenced at an earlier period, and the accumulated strata are at least thicker than they are in the west. In Pennsylvania the coal measures are estimated to be eight thousand feet thick, two thousand in Ohio, seven hundred to eight hundred feet in Indiana, and about twelve hundred feet in the deepest part in Illinois.

In quality, the coals in the respective basins, though formed under such similar conditions, are remarkably distinct when judged by their behavior when charred in ovens or burnt in furnaces or grates. The Allegheny basin coals, as a general rule, contain less water mechanically combined, and the oxygen, hydrogen and carbon are in such relations to one another that the mass is more readily melted or fused into a semi-fluid consistency under the act of combustion, and when the volatile part is expelled by dry distillation in ovens, there will remain a strong and more or less compact coke.

The coals of the Illinois basin become less fluid in burning, and make but a poor coke for metallurgical purposes. There has been much speculation in regard to the cause why coals that approach one another very closely in the amount of fixed carbon and volatile matter, and in the relative proportions of their elementary constituents—carbon, hydrogen, oxygen and nitrogen—act so very differently in the coking oven; one may make an excellent coke, while the product from the other will be very indifferent. The caking coals of Indiana swell and fuse to a pasty mass when burning, but the coke which is made from them is not strong, and is filled with large cells that give it a sort of honeycomb appearance. The Indiana block coal, on the other hand, does not swell or melt in burning, and coke made from it has the shape and structure of the original mass. Now, if we look at the analyses of fair samples of coal from the Allegheny basin, and caking coal and block coal from Indiana, one will be puzzled to know why the difference above referred to should exist when the coals are subjected to similar treatment. The volatile hydrocarbons, and the oxygen and nitrogen contained in bituminous coal are continually undergoing a change after the coal has been brought to the day. It makes no difference in this respect whether it be left exposed to the weather, or is kept under shelter and away from the direct action of the sun; the total quantity of volatile matter is diminished, and the per cent. of fixed carbon is increased.* By augmenting the temperature the change takes place more rapidly. At a temperature of 212° F. the per centage of coke will, in the laboratory, reach its maximum in about ninety hours, and if left exposed to the air at the same time will have gained in total weight from 4.75 to 5.8 per cent. A slight increase in weight of fixed carbon takes place at a temperature of 212° F. when the coal is placed in an air tight digester and excluded from the atmosphere, and when the temperature was raised in these experiments,* no change was perceived in the quality or quantity of the coal.

From the above I think it possible that time and temperature have had and continue to exert a modifying influence on the character of fossil coal. From the great thickness

*See Indiana Geological Report, 1875, pp. 18 to 29.

of the Appalachian coal basin, we may infer that the formation of beds of coal commenced then at a much earlier date—say thousands of years before their formation in the Illinois coal field began. Indeed the formation of coal beds may have ceased entirely in Pennsylvania before the conditions favorable for coal beds were reached in Indiana.

From what is said here of the physical character of coal in the two great basins, it must not be inferred that the plants themselves have had nothing to do in the matter; but their study would be foreign to the object in view which is to show the effect of time and dynamical causes in modifying and building up the strata.

With the coal measures, all marine deposits terminated within the limits of Indiana and Ohio. The Gulf of Mexico extended a little further north than the present mouth of the Ohio river. At this time, too, the Hudson River group was hardly more than five hundred feet above the sea level. The coal epoch was brought to a close by a change in the movement of the earth's crust, which now commenced to rise. The main seat of the force must have been north of either Cincinnati or Indianapolis, and a large portion of the continent beyond the great lakes was carried to an elevation which kept it clothed in perpetual ice and snow until the close of the Glacial Epoch. The grinding force of this vast field of ice, moving over mountains, valleys and plains, wore away the surface of the rocks and removed immense masses along with finer debris from a higher to a lower plain. The long continuance of a force that was cutting and wearing down the projecting mountain peaks would of itself bring about a change of temperature, and the ice belt would be moved to the north by glaciation, if not otherwise intervened to produce an equilibrium of elevation between the northern and southern portion of the continent; though it is possible that the northern part of the continent has been depressed since the Glacier Epoch closed in Indiana.

Let us again look at some of the elevations in Ohio and Indiana, and see if we can reconcile them upon the theory of a special uplift in Silurian times in the vicinity of Cincinnati. It has already been shown that Hudson River rocks are found at Bethel, twenty-six miles east of Cincinnati, at an elevation of seventy-five to ninety feet above the equivalent beds at the latter place. They are also about one hundred and fifty feet higher at the same distance northwest of Cincinnati, according to Dr. Locke; at least one hundred and ten feet higher at Sunman, in Ripley county, Indiana, on the Indianapolis, Cincinnati & Lafayette railroad; one hundred and twenty-four feet at Pierceville, on the Ohio and Mississippi railroad, and at other places which it is not necessary to cite now. At nearly all of these elevated places the Upper Silurian rocks make their appearance in thin beds, which thicken as you go to the east, north or west, and all the strata disappear in regular sequence, as shown in the diagram on page 9. Take the elevation of the upper beds of the Hudson river group at Cincinnati to be eight hundred and ninety feet, as determined by surveys, we find the country rising as we go to the north or west. Three miles northeast of Bellefontaine, Ohio, the elevation is thirteen hundred and sixty feet, and the black Devonshire shale at Bellefontaine twelve hundred and eleven feet above the level of the ocean, and four hundred and seventy feet above the hills at Cincinnati. Union City, Indiana, on the Niagara rocks, is eleven hundred and twenty-two feet above the ocean. Following a direction southwest from Bellefontaine, we have a continuation of high land, with lower geological strata, until we pass Shelbyville, when the Niagara disappears and is succeded by the Devonian. At the Weed Patch, in Brown county, the lower member of the Sub-carboniferous epoch has an elevation of eleven hundred and seventy-two feet above the sea, which is about the same as the elevation at Bellefontaine, two hundred and twenty-two miles to the northeast in an air line. The Weed Patch is about five hundred feet above the Black shale that correlates with the Black shale at Bellefontaine, which difference, without resorting to violent uplifting forces, may be accounted for by a gentle slope of the ocean bottom. The difference in altitude of this shale at the points mentioned will not exceed six hundred feet, and the horizontal distance being two hundred and twenty-two miles, will be represented by a gradient of less than three feet to the mile. From these figures, showing the elevation of the Sub-carboniferous formation in Indiana, and the Black shale at Bellefontaine, it is apparent that the central basin of the continent was elevated by a force which commenced in Silurian times and continued up to the coal epoch, and that the axis of greatest force was not in a north and south direction, passing in the vicinity of Cincinnati, but was in a northeast and southwest direction, and lay between the waters of the Wabash and Ohio rivers. In other words, these two streams run in ancient valleys. The watershed which turns the drainage to the northward and southward does not terminate in Ohio, but may be traced from Bellefontaine, in a northeast course, through Pennsylvania, and into New York to Lake Chatauqua, which forms one of the head waters of the Ohio river.

The accompanying diagram (Plate 2*) of the surface of the country, over nearly an air line from Washington, in Daviess county, Indiana, to a point three miles east of Bellefontaine, Ohio, and passing along the divide between the east and west forks of White river, is given to show the elevations of the respective places through which it passes, above the ocean, low water in the Ohio river at Cincinnati,

* See cut at end of this report.

Lake Erie, Indianapolis, and the top of the Silurian rocks in the hills back of Cincinnati. The Black shale which forms the upper member of the Devonian near Bellefontaine, is thirteen hundred and sixty feet above the ocean, or four hundred and ninety-five feet above the top of the Lower Silurian at Cincinnati. And the geological horizon is fully twelve hundred feet higher than the rocks at Cincinnati.

From Piqua, Ohio, to Centreville, Indiana, where the Hudson river rocks pass beneath the drainage of the country, the strata are nearly horizontal, and everywhere show an elevation considerably higher than at Cincinnati.

At Flat Rock or St. Paul the Niagara rocks have about the same elevation as the hills around Cincinnati. From Edinburg, which is in the same geological formation as the Black shale at Bellefontaine, the land rises rapidly to the Weed Patch, in Brown county, which is eleven hundred and seventy-two feet above the ocean, two hundred and ninety-five feet above the Hudson river rocks at Cincinnati; and more than one thousand feet higher in geological sequence, as the rocks here belong to the Sub-carboniferous sandstone group. The top of the hill is from four hundred to four hundred and fifty feet above the Black shale.

Over the entire distance, along the line of this section, the dip of the strata is so gentle, at any point visible, that one is puzzled to estimate or measure it with the clinometer, and the physical structure of the rocks and the abundance of well preserved fossils which they contain furnish evidence that they were formed in a comparatively quiet and shallow sea. Indeed, the slight inclination of the strata, and the total absence of breaks or faults, all tend to prove that the elevation of this part of the continent was the result of a force acting with remarkable uniformity over the entire basin, and could not have reached its greatest development in Silurian times.

The subsequent disturbance which elevated the Appalachian chain, and tilted and folded the Carboniferous beds of Pennsylvania, did not extend as far west as the central portion of Ohio, if it reached within the borders of that State at all. At all events no traces of it are to be found within the borders of Indiana.

We have no means of knowing the depth of the Lower Silurian beds in this State, as they have never been gone through by any of the bores yet made for Artesian water. The great well at Fort Wayne, Ind., commencing in the drift, reached the Niagara rocks at the depth of eighty feet. This rock may be seen at the crop along Little river and on the main Wabash river in Huntington and Wells counties, and is traced to within twelve or fourteen miles of Fort Wayne. It is not possible to determine the thickness of this formation in the bore by the character of the debris brought up by the sand pump, but I am satisfied from measurements made at exposures to the south that it can not exceed two hundred and fifty feet, and I question if it is so much. After passing through the Niagara* this bore continued in the Lower Silurian to a depth of three thousand feet without reaching artesian water or the bottom of the formation. Another deep bore, at Louisville, Ky., has penetrated these beds to the depth of two thousand one hundred and seventy-eight feet. While it is not possible to speak with certainty from the samples of borings, carefully preserved, of the rocks in the Fort Wayne well, as to what specific division of the Lower Silurian formation they belong, from a strong resemblance standpoint there can be but little doubt that the base of the Hudson river group has not been reached.

* I do not believe it is possible to distinguish the Clinton epoch in Indiana.

Along the Ohio river, going southwest from Cincinnati, but little change is found in the members comprising the crop of the Lower Silurian, and the upper beds maintain about the same elevation above the Ohio river at Cincinnati, until you pass west of Indian-Kentuck creek in Jefferson county. This may be seen on either side of the river. At Madison, according to W. T. S. Cornett, M. D., who has given much attention to the study of the geology of Jefferson county, and especially to the rocks at Madison, the Hudson river rocks have an exposure of three hundred and fifty-one feet above the river, only seventy-five feet less than at Cincinnati.' Now with reference to the equivalence of the Madison and Cincinnati beds I can only say the limestone and bluish gray marl with which they alternate may be followed, without losing sight of their crop, from Cincinnati to Madison, and the predominating fossils are the same. The finding of a few variations in some of the genera at the latter place is not of sufficient importance to enable one to establish a different epoch or geological horizon, and I shall therefore consider them as belonging to the same geological time.

Thirty-two feet of the upper part of the Hudson river beds at Madison is composed of a thick bedded, close grained, bluish gray rock. The following analyses show it to be an impure limestone, and closely related to the hydraulic limestone of the Niagara age at Wabash, in Wabash county.

No. 1 is the Madison specimen, and No. 2 from Wabash, which is given for comparison:

	No. 1, Madison.	No. 2, Wabash.
Silica	19.80	30.00
Alumina	15.05	16.72
Magnesia	1.55	6.05
Oxide of iron	4.45	2.48
Lime	29.19	14.34
Carbonic acid	24.61	17.91
Water (dried at 212° F.)	0.35	1.00
Water and loss	5.00	11.50
	100.00	100.00

In the Madison stone a part of the silica is replaced by lime, and there is a large per cent. of iron. This rock forms a conspicuous bench on all sides of the hills at Madison. The Madison road has been cut through it, as well as the Indianapolis & Madison railroad grade, called the "deep cut." The color is bluish gray, with numerous bands of a deeper shade of blue; hence the name of "Banded rock" applied to this number by the first State Geologist of Indiana—Dr. David Dale Owen.

It is barren of fossils of any description; hence Dr. Cornett, in his papers on the Geology of Jefferson county, calls it the non-fossiliferous bed. However, the bands form a conspicuous feature, and I think we had better retain Dr. Owen's name.

Both David Dale and Richard Owen refer the Banded rock to the Upper Silurian. Professor James Hall, of New York, also refers it to this age; and Mr. Borden, in the Indiana Geological Report for 1874, has very naturally followed in the footsteps of the eminent geologists who preceded him. It rests upon the *Tetradium fibratum* bed; contains *Favistella stellata*, locally in the upper and lower parts; and being otherwise without fossils, and more nearly resembling the overlying, unmistakable, Upper Silurian beds in lithological features, has led to the mistake of placing it in the Niagara group. Now Dr. Cornett has found, resting upon the banded rock, a thin stratum of shaly limestone, resembling the Lower Silurian beds below and carrying an abundance of Hudson river fossils: *Orthis biforata*, var. *acutilirata; Orthis retrorsa; Orthis subquadrata; Orthis insculpta; Strophomena planumbona; Strophomena sulcata; Streptelasma corniculum; Rynchonella capax; Rynchonella dentata; Zygospira headi; Ambonychia radiata.*

These are well known Hudson river fossils, and I am inclined to believe with Dr. Cornett, after a careful study of the locality, that they mark the top of the Lower Silurian at Madison, instead of the *Tetradium fibratum* bed which underlies the Banded rock. I am aware that many palæontologists will say that it is no unusual thing to find the fossils of one formation reaching upward into succeeding formations that are distant in time; and this is undoubtedly true of many species, as I have often had occasion to make public, but there can be no good reason in this case, when so large a number of Hudson River species completely terminate under the magnesio-niagara, or Cliff rock, should not be assumed as marking the true boundary line of the formations.

Dana very truly says in his Manual of Geology: "Nature does not build up walls to divide off her boundaries." So it is natural to have at some localities a difference of opinion in the assignment of a few feet more or less to a definite epoch.

From the top of the Hudson River fossil bed, that lies over the Banded rock, and extending up to the top of the hill at the toll gate, there is about one hundred feet of strata, composed for the most part of thick and thin beds of buff and light colored magnesian limestone. Portions of this member are rough-weathering, and almost worthless for building, while other portions furnish good durable stone, of which large quantities have been quarried for market. The most abundant fossil is *Calymene blumenbachi*. The lower twenty-three feet of these beds, Dr. Cornett refers to the Clinton, but I can see no good grounds for separating it from the Niagara. I have now followed the Upper Silurian beds from the Ohio river on the south, to the limits of their crop on the Wabash river in the north, without finding any well defined character by which the Clinton epoch can be recognized in Indiana.

Of course one may go to work and make indefinite divisions of any formation, however small the space it occupies in vertical range. The bottom will be the oldest and each succeeding division will follow in regular sequence; but a classification, based upon such a system, could never be maintained over a large area of country, and the attempt in that direction would lead to the greatest confusion and interminable disputes. In New York and Pennsylvania, where the entire Upper Silurian formation is from fifteen hundred to three thousand two hundred and seventy feet thick, it is possible to establish well defined boundaries of subdivision; but here, where the formation has dwindled to from fifty to two hundred and fifty feet, the attempt is fraught with mischief, and should, in my judgment, be abandoned.

From Madison to the mouth of Fourteen-mile creek the Lower Silurian dips in a southerly direction, and passes beneath the Ohio river at the latter place, which is fourteen miles above Louisville, Kentucky, and has an elevation of four hundred and four feet above the ocean—a dip of three hundred and fifty-nine feet in about thirty miles, or a little over ten feet to the mile. Taking the elevation at Madison to be seven hundred and sixty-five feet above the ocean. Fourteen-mile creek, in Clark county, is the most westerly crop of the Lower Silurian rocks known in the State.

Mr. A. S. Miller, of Cincinnati, author of a recent work on American Palæozoic Fossils, has very obligingly, at my request, furnished a complete catalogue of all the fossils which have been found in the Lower Silurian rocks over a portion of Ohio, Indiana and Kentucky.

Mr. Miller's work on the American Palæozoic Fossils, has very justly won for him the reputation of the very highest authority on American fossils, and this list, coming as it does first from his pen, can not fail to be of incalculable value to collectors of Lower Silurian fossils.

CATALOGUE OF FOSSILS

FOUND IN THE

Hudson River, Utica Slate and Trenton Groups,

AS EXPOSED IN THE

SOUTHEAST PART OF INDIANA, SOUTHWEST PART OF OHIO, AND NORTHERN PART OF KENTUCKY.

BY S. A. MILLER, ESQ., OF CINCINNATI, O.

In 1842* Professor James Hall, of New York, stated that the shale at Newport, Kentucky, containing *Triarthrus becki*, is of the age of the Utica Slate of New York, and that the rocks below in Kentucky are the equivalent of the Trenton Group of New York.

In 1865 Professor F. B. Meek proposed to substitute the name Cincinnati Group for the older and well understood Hudson River group of the New York and Canadian geologists. As this could not be done, other geologists have tried to substitute the name "Cincinnati Group" for rocks of the age of the Hudson River, Utica Slate or Trenton Groups wherever found in the Western States. The attempt to substitute the name of the "Cincinnati Group" for one or

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Am. Jour. Sci. and Arts, vol. 42.

more of these well-defined and clearly characterized groups of New York and Canada has caused a great deal of useless discussion and no small amount of confusion in the nomenclature of these rocks.

The Cincinnati geologists, neglecting the study of the Trenton Group of Kentucky, and overlooking the evidences pointing to the Utica Slate age of the small exposures in the banks of the Ohio, near Cincinnati, contented themselves, with the study of the richer fields, in the exposures of the Hudson River group in Ohio and Indiana, and permitted geologists from abroad, who knew little or nothing of the rocks in question, to flatter them with a local name until the absurdity of the position became so manifest and the injury to science so apparent that they resolved, notwithstanding their local pride, to abandon the worse than useless synonym, and to raise their voice in behalf of exact science and the well established law of priority in geological nomenclature.

The action taken will be best understood by quoting the proceedings at the special meeting of the Cincinnati Society of Natural History, as follows, to-wit:

*"SPECIAL MEETING OF THE CINCINNATI SOCIETY OF NATURAL HISTORY TO CONSIDER QUESTIONS OF GEOLOGICAL NOMENCLATURE.

"At a special meeting of the Cincinnati Society of Natural History, called to consider questions of geological nomenclature, held at the rooms of the society, on the 23d day of January, 1879, at 3 o'clock P. M.—L. S. Cotton, vice-president, in the chair—on motion of S. A. Miller, Esq., it was

"*Resolved*, That a committee of ten, who take a special interest in the study of the Lower Silurian rocks of southwestern Ohio, southeastern

*My own views on the Lower Silurian rocks, in this report, were written in 1877. So far as Indiana is concerned, I see no cause to make any changes, but in view of the ability of the committee of the Natural History Society of Cincinnati, their long acquaintance with, and fine opportunities to study the rocks at Cincinnati, leads me to agree with them in placing the lower part of the group in Ohio in the Utica slate.

E. T. C.

Indiana and Kentucky, be appointed by the chair to report to this society upon what seems to them to be the correct nomenclature of these rocks.

"Whereupon the chair appointed as such committee, S. A. Miller, Esq., Prof. A. G. Wetherby, Fred. Braun, Esq., Prof. Geo. W. Harper, Prof. John Mickleborough, Paul Mohr, Esq., Prof. John W. Hall, Jr., C. B. Dyer, Esq., E. O. Ulrich, Esq., and Dr. R. M. Byrnes.

"The committee thereupon reported as follows:

"*To the Cincinnati Society of Natural History:*

"Your committee, appointed to report upon what seems to be the correct nomenclature of the Lower Silurian rocks of southwestern Ohio, southeastern Indiana, and Kentucky, represent:

"That the fossils found in the strata, for twenty feet or more above low water mark of the Ohio river, in the first ward of the city of Cincinnati, and on Crawfish creek, in the eastern part of the city, and in Taylor's creek, east of Newport, Kentucky, at an elevation of more than fifty feet above low water mark in the Ohio river, indicate the age of the Utica Slate Group of New York. A fauna is represented in these rocks that is not found above or below them. Within this range we find the *Triarthrus becki, Leperditia byrnesi, Leptobolus lepis, Buthotrephis ramulosa,* and several species of Graptolites, Crinoids, Bryozoans, and Brachiopods that seem to be confined within its limits. Moreover, the brown slates and greenish-blue shales and concretionary nodules give a lithological character to the strata which distinguish them from the strata both above and below. From the evidences thus furnished by the lithological character of the strata, and the distinct character of the fossil remains, we refer all the strata containing the *Triarthrus becki* to the age of the Utica Slate Group of New York.

"Above the range of the *Triarthrus becki*, the fossils, as well as the position of the rocks, indicate the age of the Hudson River Group of New York, and we have no hesitation in so referring them, and entertain no doubt of the correctness of the reference.

"The fossils from Paris, Lexington, the High Bridge over the Kentucky river, and from other places in Kentucky, as well as the lithological character of the strata, furnish abundant evidence of the existence of the Trenton Group over an extensive tract of country in that State. In the State of Kentucky, we have the Trenton, Utica Slate and Hudson River Groups well represented, and the rocks have a northerly dip from Paris and Lexington toward the Ohio river, but at what rate per mile we are not advised.

"In Southeastern Indiana neither the Trenton nor Utica Slate appear, and, consequently, we refer all the Lower Silurian rocks of that State to the Hudson River Group.

"The Trenton Group is not exposed at Cincinnati, nor at any point in Ohio west of the city, but we think it is probable that it may be represented in the banks of the Ohio river a few miles east of the city. The Utica Slate is represented in Ohio only in the banks of the river, at the city of Cincinnati, and east of the city, and in the excavations near the mouths of the streams which enter the river east of the city. Consequently all the Lower Silurian rocks in Southwestern Ohio belong to the Hudson River Group, except those represented by the small exposures in the banks of the river at Cincinnati, and east of the city, in the immediate vicinity of the river.

"The conclusion to which we have come is, that all the Lower Silurian rocks which we have had under consideration, are to be referred to the Trenton, Utica Slate and Hudson River Groups, and that the name 'Cincinnati Group' should be dropped, not only because it is a synonym, but because its retention can subserve no useful purpose in the science, and because it will, in the future, as in the past, lead to erroneous views and fruitless discussion. And we would add that so far as any investigations of these rocks have been made, they have not led to any other or further subdivisions than those which we have adopted, and which have been so thoroughly and firmly established by the geologists of the State of New York.

"S. A. MILLER,	A. G. WETHERBY,
"FRED. BRAUN,	GEO. W. HARPER,
"JNO. MICKLEBOROUGH,	PAUL MOHR,
"JOHN W. HALL, JR.,	C. B. DYER,
"E. O. ULRICH,	R. M. BYRNES.

"After some discussion and remarks in favor of the report, by R. B. Moore, Esq., and others, the report was received, and the committee discharged; and there being no other business before the society, on motion, it adjourned."

It will be observed that only a few fossils in the following catalogue are referred to the Trenton Group of Kentucky. This is to be accounted for on the Ground that this Group is to the Cincinnati geologists a comparatively unexplored field. As long as all the rocks were referred to the "Cincinnati Group," collectors would naturally seek the richest grounds for hunting and neglect the less exposed and more difficult places. Ohio and Indiana furnished the finest exposures and those most favorable, because composed of shales and thin limestones. The beautiful plains in the Blue-grass region of Kentucky offer but few exposures of the underlying Trenton rocks, and those are generally confined to displays of massive stone in the banks of the streams where fossils are collected under difficulties.

The rocks having been correctly subdivided, we may expect, in the future, to find the Trenton Group quite thoroughly explored and a more accurate knowledge of its fossils in the possession of our collectors, as well as a definite determination of the fossils which are limited in their range to the Utica Slate.

PLANTÆ.

Aristophycus—Miller & Dyer, 1878. Cont. to Pal., No. 2. [Ety. *aristos*, best of its kind, excellent; *phukos*, a sea plant.]
" **ramosum**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Hud. Riv. Gr. [Sig. branchy.]
" **ramosum** *var.* **germanum**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Hud. Riv. Gr. [Sig. near of kin.]

Arthraria—Billings, 1874. Pal. Foss. Vol. 2. [Ety. *arthron*, a joint.]
" **biclavata**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Sig. double-clubbed.]

Blastophycus—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. [Ety. *blastos*, a bud; *phukos*, sea weed.]
" **diadematum**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Lower part Hud. Riv. Gr. [Sig. diademed.]

Buthotrephis—Hall, 1847. Pal. N. Y., Vol. 1. [Sig. growing in the depths of the sea.]
" **gracilis**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. slender.]
" **gracilis** *var.* **intermedia**—Hall, 1852. Pal. N. Y., Vol. 2. Hud. Riv. Gr. [Sig. intermediate.]
" **ramulosa**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Utica Slate Gr. [Sig. full of little branches.]

Chlœphycus—Miller & Dyer, 1878. Cont. to Pal., No. 2. [Ety. *chlœ*, young grass; *phukos*, a sea plant.]

" **plumosum**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Lower part of Hud. Riv. Gr. [Sig. feathered.]

Dactylophycus—Miller & Dyer, 1878. Cont. to Pal., No. 2. [Ety. *dactylos*, a finger; *phukos*, a sea plant.]

" **quadripartitum**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Lower part Hud. Riv. Gr. [Sig. four-parted.]

" **tridigitatum**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Lower part Hud. Riv. Gr.. [Sig. three-fingered.]

Dystactophycus—Miller & Dyer, 1878. Cont. to Pal., No. 2. [Ety. *dystaktos*, hard to arrange; *phukos*, a sea plant.]

" **mamillanum**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Upper part Hud. Riv. Gr. [Sig. having breasts, or protuberant.]

Heliophycus—Miller & Dyer, 1878. Cont. to Pal., No. 2. [Ety. *helios*, the sun; *phukos*, a sea plant.]

" **stelliforme**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Hud. Riv. Gr. [Sig. star-shaped.]

Licrophycus—Billings, 1862. Pal. Foss., Vol. 1. [Ety. *Likros*, a fan; *phukos*, a sea plant.]

" **flabellum**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. a fan.]

Lockia—James, 1879. Palæontologist. [Ety. proper name.]

" **siliquaria**—James, 1879. Palæontologist, Utica Slate Gr. [Sig. pod-like.] Mr. James has published a number of names with brief descriptions in a paper called the "Palæontologist." This species can be readily identified, and is found in abundance in the bank of the Ohio river, below Covington, Ky. I have admitted into this catalogue, from his "Palæontologist," only such species as I have identified.

Protostigma—Lesquereux, 1877. Trans. Am. Phil. Soc. [Ety. *protos*, first; *stigma*, a dot or puncture.]

" **sigillarioides**—Lesquereux, 1877. Trans. Am. Phil. Soc. Upper part of Hud. Riv. Gr. [Sig. like a fossil of the genus *sigillaria*.] I regard this as a sea plant, though Prof. Lesquereux has published it as a land plant.

Psilophytum—Dawson, 1859. Quar. Jour. Geo. Soc., Vol. 15. [Ety. *psilon*, smooth; *phyton*, stem.]

" **gracillimum**—Lesquereux, 1877. Trans. Am. Phil. Soc. Utica Slate and lower part Hud. Riv. Gr. Professor Lesquereux published this as a land plant, but I think it is a Graptolite, and have referred it to *Dendrograptus gracillimus.*

Rusophycus—Hall, 1852. Pal. N. Y., Vol. 2. [Ety. *rusos*, rugose; *phukos*, a sea plant.]

" **asperum**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Lower part Hud. Riv. Gr. [Sig. rough.]

" **bilobatum**—Vanuxem, 1842. (*Fucoides bilobatus.*) Geo. Rep. N. Y. Hud. Riv. Gr. [Sig. two-lobed.]

" **pudicum**—Hall, 1852. Pal. N. Y., Vol. 2. Hud. Riv. Gr. [Sig. shame-faced.]

Sphenophyllum—Brongniart, 1828. Prodr. Hist. Veg. Foss. [Ety. *sphen*, a wedge; *phyllon*, a leaf.]

" **primævum**—Lesquereux, 1877. Trans. Am. Phil. Soc. Hud. Riv. Gr. (?) Prof. Lesquereux published this as a land plant. I do not think it is. If it is a fossil, it is a Graptolite.

Trichophycus—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. [Ety. *trichos*, hair; *phukos*, sea plant.]

" **lanosum**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Upper part of Hud. Riv. Gr. [Sig. woolly.]

" **sulcatum**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Lower part of Hud. Riv. Gr. [Sig. furrowed.]

ANIMAL KINGDOM.

SUB-KINGDOM PROTISTA.

CLASS RHIZOPODA.

Pasceolus—Billings, 1857. Rep. of Prog. Can. Sur. [Ety. *pasceolus*, a leather money bag.]

" **claudei**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Hud. Riv. Gr. [Ety. proper name.]

" **darwini**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Hud. Riv. Gr. [Ety. proper name.]

CLASS PORIFERA.

Brachiospongia—Marsh, 1867. Am. Jour. Sci. and Arts, 2d Ser., Vol. 44. [Ety. *brachium*, an arm; *spongia*, sponge.

" **digitata**—Owen, 1857. (Scyphia digitata.) Geo. of Ky., Vol. 2. Trenton Gr. of Ky. [Sig. fingered.]

" **lyoni**—Marsh, 1867. Am. Jour. Sci. and Arts, 2d Ser., Vol. 44. Trenton Gr. of Ky. [Ety. proper name.]

" **roemerana**—Marsh, 1867. Am. Jour. Sci. and Arts, 2d Ser., Vol. 44. Trenton Gr. of Ky. [Ety. proper name.]

Microspongia—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. [Ety. *mikros*, small; *spongia*, sponge.]

" **gregaria**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. gregarious.]

SUB-KINGDOM RADIATA.

CLASS POLYPI.

Aulopora—Goldfuss, 1826. Germ. Petref. [Ety. *aulos*, a pipe; *poros*, a pore.

" **arachnoidea**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. like a cobweb.]

Chetetes—Fischer, 1837. Oryct. du Gouv. Moscow. [Ety. *chaite*, hair.] Following the best authors, I refer the species usually referred to this genus, from the Lower Silurian rocks, to the genus Monticulipora.

Climacograptus—Hall, 1865. Can. Org. Rem. Decade 2. [Ety. *climax*, a small ladder; *grapho*, to write.]

" **bicornis**—Hall, 1847. (Graptolithus bicornis.) Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. two horned.]

" **typicalis**—Hall, 1865. Can. Org. Rem. Decade 2. Hud. Riv. Gr. [Sig. type of the genus, though the genus was founded upon *G. bicornis*.]

Columnopora—Nicholson, 1874. Lond. Geo. Mag. N. S., Vol. 1. [Ety. *columna*, a column; *porus*, a pore.]

" **cribriformis**—Nicholson, 1874. Lond. Geo. Mag. N. S., Vol. 1. Upper part Hud. Riv. Gr. [Sig. seive-formed.]

Constellaria polystomella—Nicholson. Syn. for Stellipora antheloidea; or, at most, a mere variety.

Dendrograptus—Hall, 1865. Can. Org. Rem. Decade 2. [Ety. *dendron*, a tree; *grapho*, to write.]

" **gracillimus**—Lesquereux, 1877. (Psilophytum gracilimum.) Trans. Am. Phil. Soc. Utica Slate and lower part of Hud. Riv. Gr. [Sig. very slender.]

Favistella—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *favus*, honey comb; *stella*, a star.]

" **stellata**—Hall, 1847. Pal. N. Y., Vol. 1. Upper part of Hud. Riv. Gr. [Sig. starred.]

Megalograptus—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. [Ety. *megale*, great; *grapho*, to write.]

" **welchi**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]

Monticulipora—D'Orbigny, 1850. Prodr. de Palæont. [Ety. *monticulus*, a hillock; *porus*, a pore.]

" **approximata**—Nicholson, 1874. (Chetetes approximatus.) Quar. Jour. Geo. Soc., Vol. 30. Hud. Riv. Gr. [Sig. near to—from its near approach to *M. dalei*.]

Monticulipora—**attrita**—Nicholson, 1874. (Chetetes attritus, and later Dekayia attrita) is merely a weathered form of different species.

" **briareus**—Nicholson, 1875. (Chetetes briareus.) Ohio Pal., Vol. 2. Utica Slate Gr. [Ety. mythological name.]

" **calceolus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. a little shoe.]

" **caliculus**—James, 1875. (Chetetes calicula.) Catalogue Cin. Foss. Utica State Gr. [Sig. a little cup.]

" **clathratula**—James. (Chetetes clathratulus). Syn. for Cyclopora jamesi.

" **clavacoidea**—James, 1875. (Chetetes clavicoideus.) Catalogue Cin. Foss. Hud. Riv. Gr. [Sig. club-shaped.]

" **corticans**—Nicholson. (Chetetes corticans.) Syn. for Monticulipora tuberculata.

" **dalei**—Edwards & Haime, 1851. (Chetetes dalei.) Pol. Foss. des Terr. Palæoz. Hud. Riv. Gr. [Ety. proper name.]

" **decipiens**—Rominger, 1866. (Chetetes decipiens.) Proc. Acad. Nat. Sci. Phil. Hud. Riv. Gr. [Sig. doubtful.] This may be a syn. for *Cyclopora jamesi.*

" **delicatula**—Nicholson, 1874. (Chetetes delicatulus.) Quar. Jour. Geo. Soc., Vol. 30. Upper part Hud. Riv. Gr. [Sig. quite slender.]

" **discoidea**—Nicholson, 1875. (Chetetes discoideus.) Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. disc-like.]

" **fibrosa**—Goldfuss, 1826. (Calamopora fibrosa.) Germ. Petref. Trenton and Hud. Riv. Gr. [Sig. fibrous.]

" **fletcheri**—Edwards & Haime, 1851. (Chetetes fletcheri.) Pol. Foss. des Terr. Palæoz. Hud. Riv. Gr. [Ety. proper name.]

" **frondosa**—D'Orbigny, 1850. Prodr. de Palæont. Hud. Riv. Gr. [Sig. branchy.]

" **gracilis**—Nicholson, 1874. (Chetetes gracilis.) Quar. Jour. Geo. Soc., Vol. 30. Hud. Riv. Gr. [Sig. slender.]

" **jamesi**—Nicholson, 1874. (Chetetes jamesi.) Quar. Jour. Geo. Soc., Vol. 30. Lower part Hud. Riv. Gr. [Ety. proper name.

Monticulipora—lycoperdon—Say, 1847. (Favosites lycoperdon.) Hall in Pal. N. Y., Vol. 1. Trenton and Hud. Riv. Gr. [Sig. puff-ball-shaped.]

" **mammulata**—D'Orbigny, 1850. Prodr. de Palæont. Hud. Riv. Gr. [Sig. mammillated.]

" **newberryi**—Nicholson, 1875. (Chetetes newberryi.) Ohio Pal., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

" **nodulosa** — Nicholson, 1874. (Chetetes nodulosus.) Quar. Jour. Geo. Soc., Vol. 30. Upper part Hud. Riv. Gr. [Sig. covered with small knots.]

" **onealli**—James, 1875. (Chetetes onealli.) Catalogue Sil. Foss. Lower part Hud. Riv. Gr. [Ety. proper name.]

" **ortoni**—Nicholson, 1874. (Chetetes ortoni.) Quar. Jour. Geo. Soc., Vol. 30. Hud. Riv. Gr. [Ety. proper name.]

" **papillata**—McCoy, 1850. Ann. and Mag. Nat. Hist., 2d Ser., Vol. 6. Hud. Riv. Gr. [Sig. covered with papilli.]

" **pavonia**—See Cyclopora pavonia.

" **petechialis**—Nicholson, 1875. (Chetetes petechialis.) Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. spotted.]

" **pulchella** as identified by Nicholson (chetetes pulchellus) is M. fibrosa.

" **quadrata**—Rominger, 1866. (Chetetes quadratus.) Proc. Acad. Nat. Sci. Upper part Hud. Riv. Gr. [Sig. four-cornered.]

" **rhombica**—Nicholson. (Chetetes rhombicus.) Syn. for M. quadrata.

" **rugosa**—Edwards & Haime. (Chetetes rugosus.) It is merely a form of M. dalei. Moreover, the name was pre-occupied.

" **sigillarioides**—Nicholson, 1875. (Chetetes sigillarioides.) Ohio Pal., Vol. 2. Utica Slate and lower part Hud. Riv. Gr. [Sig. like a sigillaria.]

" **subpulchella**—Nicholson, 1875. (Chetetes subpulchellus.) Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. somewhat like *M. pulchella.*] This is a variety of M. fibrosa.

" **tuberculata**—Edwards & Haime, 1851. (Chetetes tuberculatus.) Pol. Foss. des Terr. Palæoz. Hud. Riv. Gr. [Sig. tuberculated.]

Monticulipora—undulata—Nicholson, 1875. Pal. Province of Ontario. Hud. Riv. Gr. [Sig. undulated.] This is the large, irregular form which is usually regarded as a variety of M. lycoperdon.

Palæophyllum—Billings, 1858. Rep. of Progr. Can. Sur. [Ety. *palaios*, ancient; *phyllon*, a leaf.]

" **divaricans**—Nicholson, 1875. Ohio Pal., Vol. 2. Upper part Hud. Riv. Gr. [Sig. wide apart.]

Protarea—Edwards & Haime, 1849. Pol. Foss. des Terr. Palæoz. [Ety. *protos*, first; *araios*, spongy.]

" **vetusta**—Hall, 1847. (Porites vetustus.) Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. ancient.]

Stellipora—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *stella*, a star; *porus*, a pore.]

" **antheloidea**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. like a coral of the genus *Anthelia*.]

Streptelasma—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *streptos*, twisted; *elasma*, lamella.]

" **corniculum**—Hall, 1847. Pal. N. Y., Vol., 1. Upper part Hud. Riv. Gr. [Sig. a little horn.]

Tetradium—Dana, 1848. Zooph., Vol. 8. [Ety. *tetras*, four.]

" **fibratum**—Safford, 1856. Am. Jour. Sci. and Arts, 2d Ser., Vol. 22. Upper part Hud. Riv. Gr. [Sig. threaded.]

CLASS ECHINODERMATA.

Agelacrinus—Vanuxem, 1842. Geo. Rep. 3d Dist. N. Y. [Ety. *agele* a herd; *krinon*, a lily.]

" **cincinnatensis**—Roemer, 1857. Verh. Naturh. Rhein. Westph., Vol. 8. Hud. Riv. Gr. [Sig. proper name.]

" **pileus**—Hall, 1866. Pamphlet Hud. Riv. Gr. [Sig. a cap.]

" **septembrachiatus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. having seven arms.]

" **vorticellatus**—Hall, 1866. Pamphlet Hud. Riv. Gr. [Sig. whorled.]

Anomalocrinus—Meek & Worthen, 1868. Geo. Sur. Ill., Vol. 3. [Ety. *anomos*, irregular; *krinon*, a lily.]

" **incurvus**—Meek & Worthen, 1865. (Heterocrinus incurvus.) Proceedings Acad. Nat. Sci. Hud. Riv. Gr. [Sig. incurved—from an incurved arm.]

Anomalocystites—Hall, 1859. Pal. N. Y., Vol. 3. [Ety. *anomos*, irregular; *kustis*, a bladder.]

" **balanoides**—Meek, 1872. Am. Jour. Sci. and Arts, 3d Ser., Vol. 3. This species is referred by Prof. A. G. Wetherby to the crustacea under the name *Enopleura balanoides*.

Cyclocystoides—Billings & Salter, 1858. Can. Org. Rem. Decade 3. [Ety. *kuklos*, a circle; *kustis*, a bladder; *eidos*, form.]

" **bellulus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Supposed to be from the Utica Slate, but possibly from the lower part of the Hud. Riv. Gr. [Sig. beautiful.]

" **magnus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. large.]

" **minus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. small.]

" **mundulus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. neat, trim.]

" **parvus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. little.]

Dendrocrinus—Hall, 1852. Pal. N. Y., Vol. 2. [Ety. *dendron*, a tree; *krinon*, a lily.]

" **caduceus**—Hall, 1866. Pamphlet.* Upper part Hud. Riv. Gr. [Sig. the herald's staff.]

" **casei**—Meek, 1871. Am. Jour. Sci. and Arts, 3d Ser., Vol. 2. Upper part of Hud. Riv. Gr. [Ety. proper name.]

" **cincinnatensis**—Meek, 1872. Proc. Acad. Nat. Sci. Hud. Riv. Gr. [Ety. proper name.]

" **dyeri**—Meek, 1872. Proc. Acad. Nat. Sci. Hud. Riv. Gr. [Ety. proper name.]

*[NOTE.—I have used the word "Pamphlet" as an abbreviation for advance sheets of the Reports of the New York State Museum of Natural History.]

Dendrocrinus polydactylus—Shumard, 1857. (Homocrinus polydactylus.) Trans. St. Louis Acad. Sci. Upper part Hud. Riv. Gr. [Sig. many-fingered.]

" **posticus**—Hall, 1866. Pamphlet. Hud. Riv. Gr. [Sig. posterior.]

Glyptocrinus—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *glyptos*, sculptured; *krinon*, a lily.]

" **angularis**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. angular.]

" **baeri**—Meek, 1872. Am. Jour. Sci. and Arts, 3d Ser., Vol. 3. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **decadactylus**—Hall, 1847. Pal. N. Y., Vol. 1. Middle part Hud. Riv. Gr. [Sig. ten-fingered.]

" **dyeri**—Meek, 1872. Proceedings. Acad. Nat. Sci. Middle part Hud. Riv. Gr. [Ety. proper name.]

" **dyeri** *var.* **subglobosus**—Meek, 1873. Ohio Pal. Vol. 1. Middle part Hud. Riv. Gr. [Sig. subglobose.]

" **dyeri** *var.* **sublævis**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Middle part Hud. Riv. Gr. [Sig. somewhat smooth.]

" **fornshelli**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **nealli**—Hall, 1866. Pamphlet. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **parvus**—Hall, 1866. Pamphlet. Lower part Hud. Riv. Gr. [Sig. little.]

" **shafferi**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Middle part Hud. Riv. Gr. [Ety. proper name.]

Hemicystites—Hall, 1852. Pal. N. Y., Vol. 2. [Ety. *hemi*, half; *kustis*, a bladder.]

" **granulatus**—Hall, 1852. Pal. N. Y., Vol. 2. Middle part Hud. Riv. Gr. [Sig. granulated.]

" **stellatus**—Hall, 1866. Pamphlet. Middle part Hud. Riv. Gr. [Sig. star-shaped.]

Heterocrinus—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *heteros*, irregular; *krinon*, a lily.]

" **constrictus**—Hall, 1866. Pamphlet. Middle part Hud. Riv. Gr. [Sig. constricted.]

" **constrictus** *var.* **compactus**—Meek, 1873. Ohio Pal., Vol. 1. Lower part Hud. Riv. Gr. [Sig. compact.]

Heterocrinus exilis—Hall, 1866. Pamphlet. Upper part Hud. Riv. Gr. [Sig. slender.]

" **exiguus**—Meek. Syn. for H. exilis.

" **heterodactylus**—Hall, 1847. Pal. N. Y., Vol. 1. Utica Slate and Hud. Riv. Gr. [Sig. irregular-fingered.]

" **isodactylus**—Syn. for H. constrictus *var* compactus.

" **juvenis**—Hall, 1866. Pamphlet. Hud. Riv. Gr. [Sig. young.]

" **laxus**—Hall, 1866. Pamphlet. Hud. Riv. Gr. [Sig. loose.]

" **simplex**—Hall, 1847. Pal. N. Y., Vol. 1. Utica Slate and Hud. Riv. Gr. [Sig. simple.]

" **simplex** *var.* **grandis**—Meek, 1873. Ohio Pal., Vol. 1. Hud. Riv. Gr. [Sig. grand.]

" **subcrassus**—Meek & Worthen, 1865. Proc. Acad. Nat. Sci. Upper half of Hudson Riv. Gr. [Sig. somewhat like *H. crassus*.

Lepadocrinus—Conrad, 1840. Ann. Rep. N. Y. [Ety. *lepas* the Barnacle *Anatifa; krinon*, a lily.]

" **moorei**—Meek, 1871. Am. Jour. Sci. and Arts, 3d Ser. Vol. 2. Upper part Hud. Riv. Gr. [Ety. proper name.]

Lichenocrinus—Hall, 1866. Pamphlet. [Ety. *lichen*, a moss; *krinon*, a lily.]

" **crateriformis**—Hall, 1866. Pamphlet. Utica Slate and lower part of Hud. Riv. Gr. [Sig. having the form of a cup.]

" **dyeri**—Hall, 1866. Pamphlet. Middle part Hud. Riv. Gr. [Ety. proper name.]

" **tuberculatus**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Sig. tuberculated.]

Palæaster—Hall, 1852. Pal. N. Y., Vol. 2. [Ety. *palaios*, ancient; *aster*, a star.]

" **antiquatus**—Locke, 1846. (Asterias antiquata) Proc. Acad. Nat. Sci., Phil. Hud. Riv. Gr. [Sig. ancient.]

" **clarkei**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Ety. proper name.]

" **dubius**—Miller & Dyer, 1878. Contribution to Palæontology, No. 2. Hud. Riv. Gr. [Sig. doubtful.]

Palæaster dyeri—Meek, 1872. Am. Jour. Sci. and Arts, 3d Ser., Vol. 3. Hud. Riv. Gr. [Ety. proper name.]

" **granulosus**—Hall, 1868. 20th Reg. Rep. N. Y. Hud. Riv. Gr. [Sig. granular.]

" **incomptus**—Meek, 1872. Am. Jour. Sci. and Arts, 3d Ser., Vol. 3. Hud. Riv. Gr. [Sig. unadorned.]

" **jamesi**—Dana, 1863. (Palæasterina (?) jamesi.) Am. Jour. Sci. and Arts, 2d Ser., Vol. 35. Hud. Riv. Gr. [Ety. proper name.]

" **longibrachiatus**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. long-armed.]

" **shafferi**—Hall, 1868. 20th Reg. Rep. N. Y. Utica Slate, and possibly lower part Hud. Riv. Gr. [Ety. proper name.]

" **simplex**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. simple.]

" **spinulosus**—Miller and Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. full of spines.]

Palæasterina—McCoy, 1851. Brit. Pal. Foss., but first defined by Salter, 1857. Ann. Mag. Nat. Hist. [Ety. *palaios*; ancient; *aster*, a star; *inus*, resemblance.]

" **approximata**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. approximate; from its resemblance to *P. speciosa*.]

" **speciosa**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. beautiful.]

Protaster—Forbes, 1849. Mem. Geo. Sur. Great Britain. [Ety. *protos*, first; *aster*, star.]

" **flexuosus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Lower part of Hud. Riv. Gr. [Sig. full of turnings.]

" **granuliferus**—Meek, 1872. Am. Jour. Sci. and Arts, 3d Ser., Vol. 3. Hud. Riv. Gr. [Sig. granule-bearing.]

Protasterina fimbriata—Syn. for Protaster flexuosus.

Stenaster—Billings, 1858. Can. Org. Rem. Decade 3. [Ety. *stenos*, narrow; *aster*, a star.]

" **grandis**—Meek, 1872. Am. Jour. Sci. and Arts, 3rd Ser., Vol. 3. Upper part Hud. Riv. Gr. [Sig. grand.]

SUB-KINGDOM MOLLUSCA.

CLASS BRYOZOA.

Alecto—Lamouroux, 1821. Expos. Method. [Ety. mythological name.]
" **auloporoides**—Nicholson, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. like *Aulopora*.]
" **confusa**—Nicholson, 1875. Ohio Pal., Vol. 2. Utica Slate and lower part Hud. Riv. Gr. [Sig. confused.]
" **frondosa**—Nicholson, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. branchy.]
" **inflata**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. inflated.]
" **nexilis**—James, 1875. Catalogue, Cin. Foss. Hud. Riv. Gr. [Sig. wreathed together.]

Bythopora—Miller & Dyer, 1878. Cont. to Pal., No. 2. [Ety. *buthos*, the depths of the sea; *poros*, a pore.]
" **arctipora**—Nicholson, 1875. (Ptilodictya (?) arctipora.) Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. having narrow pores.]
" **fruticosa**—Miller & Dyer, 1878. Cont. to Pal. No. 2. Hud. Riv. Gr. [Sig. shrubby.]

Callopora—Hall, 1852. Pal. N. Y., Vol. 2. [Ety. *kallos*, beautiful; *poros*, a pore.]
" **cincinnatensis**—Ulrich. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Ety. proper name.] I am by no means certain that this species belongs to the genus Callopora.

Ceramopora--Hall, 1852. Pal. N. Y., Vol. 2. [Ety. *keramis*, imbricated; like roof tile; *poros*, a pore.]
" **nicholsoni**—James, 1875. Catalogue Cin. Foss. Hud. Riv. Gr. [Ety. proper name.]
" **ohioensis**—Nicholson, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

Cyclopora—Prout, 1860. Trans. St. Louis Acad. Sci. [Ety. *kuklos*, a circle; *poros*, a pore.]
" **jamesi**—Prout, 1860. Trans. St. Louis Acad. Sci. Hud. Riv. Gr. [Ety. proper name.]
" **pavonia**—D'Orbigny, 1850. (Ptilodictya (?) pavonia.) Prodr. de Palaeont, Hud. Riv. Gr. [Ety. *Pavonia*, a genus of polyps.]

Intricaria—Defrance, 1823. Dict. des Sci. Nat. [Ety. *intrico*, to entangle.]
" **clathrata**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Hud. Riv. Gr. [Sig. latticed, cross-barred.]
" **reticulata**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. reticulated.]

Ptilodictya—Lonsdale, 1839. Murch. Sil. Syst. [Ety. *ptilon*, a wing; *dictyon*, a net.] All the species referred to this genus belong to Stictopora, which is regarded, generally, as only a subgenus.
" **emacerata**—Nicholson, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. thin, lean.]
" **falciformis**—Nicholson, 1875. Ohio Pal., Vol. 2. Hud. Gr. [Sig. sword-shaped.]
" **fenestelliformis**—Nicholson, 1875. Ohio Pal., Vol. 2. Upper part Hud. Riv. Gr. [Sig. like the genus *Fenestella*.]
" **flagellum**—Nicholson, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. a small whip.]
" **hilli**—James, 1878. Palæontologist. Supposed to be from the Trenton Gr. [Ety. proper name.]
" **internodia**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Hud. Riv. Gr. [Sig. between knots.]
" **maculata**—Ulrich, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. spotted.]
" **magnifica**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. magnificent.]
" **perelegans**—Ulrich, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. very elegant.]
" **shafferi**—Meek, 1872. Proc. Acad. Nat. Sci. Hud. Riv. Gr. [Ety. proper name.]

CLASS BRACHIOPODA.

Crania—Retzius, 1781. Schrift. Berl. Gesell. Natur. [Ety. *kranion*, the upper part of the skull.]
" **dyeri**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. (?) Gr. [Ety. proper name.]
" **lælia**—Hall, 1866. Pamphlet. Hud. Riv. Gr. [Ety. proper name.]
" **multipunctata**—S. A. Miller. Hud. Riv. Gr. [Sig. many dotted.]
" **reticularis**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Upper part Hud. Riv. Gr. [Sig. reticulated.]

Crania scabiosa—Hall, 1866. Pamphlet. Hud. Riv. Gr. [Sig. scabby.]
" **socialis**—Syn. for C. scabiosa.

Discina sublamellosa and **D. tenuistriata** are, as I think, founded upon very poor specimens of Trematis dyeri.

Leptæna—Dalman, 1827. Kongl. Vet. Acad. Handl. [Ety. *leptos*, thin.]
" **sericea**—Sowerby, 1839. Murch. Sil. Syst. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. silky.]
Leptobolus—Hall, 1871. Pamphlet. [Sig. minute *obolus*.]
" **lepis** — Hall, 1871. Pamphlet. Utica Slate Gr. [Sig. a scale.]

Lingula—Bruguire, 1792. Encyc. Meth. [Ety. *lingula*, a little tongue.] All the species referred to this genus belong to *Lingulella*.

Lingulella—Salter, 1861. Mem. Geo. North Wales. [Ety. diminutive of *lingula*.]
" **cincinnatensis**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]
" **covingtonensis**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Utica Slate Gr. [Ety. proper name.]
" **norwoodi**—James, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]
" **vanhornei**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

Orthis—Dalman, 1827. Kongl. Vet. Acad. Handl. [Sig. straight—straight hinge line.]
" **acutilirata**—Conrad, 1842. Jour. Acad. Nat. Sci., Vol. 8. Upper part Hud. Riv. Gr. [Sig. sharp-ridged.]
" **bellula**—Meek, 1873. Ohio. Pal., Vol. 1. Hud. Riv. Gr. [Sig. pretty.]
" **borealis**—Billings, 1859. Can. Nat. and Geo., Vol. 4. Trenton Gr. of Ky. [Sig. northern.]
" **clytie**—Hall, 1861. Fourteenth Reg. Rep. N. Y. Trenton Gr. of Ky. [Ety. mythological name.]
" **ella**—Hall, 1860. Thirteenth Reg. Rep. N. Y. Hud. Riv. Gr. [Ety. proper name.]
" **emacerata**—Hall, 1860. Thirteenth Reg. Rep. N. Y. Utica Slate and lower part of Hud. Riv. Gr. [Sig. made lean.]
" **fissicosta**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. having divided costae.]

Orthis insculpta—Hall, 1847. Pal. N. Y., Vol. 1. Upper part of Hud. Riv. Gr. [Sig. engraved.]

" **jamesi**—Hall, 1861. Fourteenth Reg. Rep. N. Y. Hud. Riv. Gr. [Ety. proper name.]

" **lynx**—Eichwald, 1830. Nat. Kizze von Podol. Trenton and Hud. Riv. Gr. [Sig. the name of a quadruped of the genus *Felis.*]

" **lynx** *var.* **crassa**—James, 1874. Cin. Quar. Jour. Sci., Vol. 1. Hud. Riv. Gr. [Sig. thick.]

" **lynx** *var.* **laticostata**—Meek, 1873. Ohio Pal., Vol. 1. Hud. Riv. Gr. [Sig. broad-ribbed.]

" **occidentalis**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. western.]

" **pectinella**—Conrad 1840. Ann. Rep. N. Y. Trenton Gr. of Ky. [Sig. a little comb.]

" **plicatella**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. a little fold.]

" **plicatella** *var.* **triplicatella**—Meek, 1873. Ohio Pal. Vol. 1. Hud. Riv. Gr. [Sig. having three plications.]

" **retrorsa**—Salter, 1858. Geo. Sur. of Great Britain. Hud. Riv. Gr. [Sig. turned backward.]

" **sinuata**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. waved.]

" **subquadrata**—Hall, 1847. Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. somewhat quadrate.]

" **testudinaria**—Dalman, 1827. Vet. Acad. Handl. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. arched like a tortoise shell.]

" **testudinaria** *var.* **meeki**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

" **testudinaria** *var.* **multisecta**—Meek, 1873. Ohio Pal., Vol. 1. Utica Slate and lower part of Hud. Riv. Gr. [Sig. having many paths.]

" **tricenaria**—Conrad, 1843. Proceedings Acad. Nat. Sci., Vol. 1. Trenton Gr. of Ky. [Sig. of or belonging to thirty.]

Pholidops—Hall, 1859. Pal. N. Y., Vol. 3. [Ety. *Pholidos* a scale.]

" **cincinnatensis**—Hall, 1872. Pamphlet. Lower part of Hud. Riv. Gr. [Ety. proper name.]

Rhynchonella—Fischer, 1809. Mem. Soc. Imp. Moscow. [Ety. *rhynchos*, a beak; *ella*, diminutive.]

Rhynchonella capax—Conrad, 1842. (Atrypa capax.) Jour. Acad. Nat. Sci., Vol. 8. Upper part Hud. Riv. Gr. [Sig. large.]

" **dentata**—Hall, 1847. (Atrypa dentata.) Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. having teeth.]

Schizocrania—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. [Ety. *schiza*, a cleft; *Crania*, a genus of shells.]

" **filosa**—Hall, 1847. (Orbicula filosa.) Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. thready.]

Streptorhynchus—King, 1850. Monograph Permian Fossils. [Ety. *streptos*, twisted; *rhynchos*, beak.]

" **filitextum**—Hall, 1847. (Strophomena filitexta.) Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. woven like thread.]

" **hallianum**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Lower part Hud. Riv. Gr. [Ety. proper name.]

" **nutans**—Meek, 1873. (Hemipronites nutans.) Ohio Pal., Vol. 1. Upper part Hud. Riv. Gr. [Sig. bent over.]

" **planoconvexum**—Hall, 1847. (Leptæna planoconvexa.) Pal. N. Y., Vol. 1. Middle part Hud. Riv. Gr. [Sig. level-convex.]

" **planumbonum**—Hall, 1847. (Leptæna planumbona.) Pal. N. Y., Vol. 1. Upper part of Hud. Riv. Gr. [Sig. flat on the umbo.]

" **sinuatum**—Emmons, 1855. (Strophomena sinuata.) Am. Geol. Upper part Hud. Riv. Gr. [Sig. waved.]

" **subtentum**—Conrad, 1847. (Strophomena subtenta.) Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. somewhat bent.]

" **sulcatum**—Verneuil, 1848. (Leptæna sulcata.) Bull. Geol. Soc. France, Vol. 5. Upper part Hud. Riv. Gr. [Sig. furrowed.]

Strophomena—Rafinesque, 1825. Manuel de Malacologie. [Ety. *strophos*, bent; *mene*, a crescent.]

" **alternata**—Conrad, 1838. (Leptæna alternata.) Ann. Rep. N. Y. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. alternating.]

Strophomena alternata *var.* **alternistriata**—Hall, 1847. Pal. N. Y., Vol. 1. Utica Slate and Hud. Riv. Gr. [Sig. alternately striated.]

" **alternata** *var.* **fracta**—Meek, 1873. Ohio Pal., Vol. 1. Hud. Riv. Gr. [Sig. broken.]

" **alternata** *var.* **loxorhytis**—Meek, 1873. Ohio Pal., Vol. 1. Upper part Hud. Riv. Gr. [Sig. oblique-wrinkled.]

" **alternata** *var.* **nasuta**—Conrad, 1842. Jour. Acad. Nat. Sci., Vol. 8. Trenton and Hud. Riv. Gr. [Sig. having a prominent nose.]

" **squamula**—James, 1874. Cin. Quar. Jour. Sci., Vol. 1. Hud. Riv. Gr. [Sig. a little scale.]

" **tenuistriata**—Sowerby, 1839. (Leptæna tenuistriata.) Murch. Sil. Syst. Utica Slate and Hud. Riv. Gr. [Sig. fine-lined.]

Trematis—Sharpe, 1847. Quar. Jour. Geo. Soc., Vol. 13. [Ety. *trema*, an opening.]

" **dyeri**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Lower part Hud. Riv. Gr. [Ety. proper name.]

" **millepunctata**—Hall, 1866. Pamphlet. Hud. Riv. Gr. [Sig. many-dotted.]

" **punctostriata**—Hall, 1873. Twenty-third Reg. Rep. N. Y. Hud. Riv. Gr. [Sig. punctured and striated.]

" **quincuncialis**—Miller & Dyer, 1878. Cont. to Pal. No. 2. Upper part Hud. Riv. Gr. [Sig. in the form of a quincunx.]

Trematospira—Hall, 1859. 12th Reg. Rep. N. Y. [Ety. *trema*, an opening; *spira*, a spire.]

" (?) **granulifera**—Meek, 1872. Proceedings Acad. Nat. Sci. Hud. Riv. Gr. [Sig. bearing granules.]

" (?) **quadriplicata**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Trenton Gr. of Ky. This species does not belong to the genus *Trematospira*. It belongs to an undefined genus of which *Rhynchonella cuneata* should be made the type.

Zygospira—Hall, 1862. 15th Reg. Rep. N. Y. [Ety. *zygos*, a yoke; *spira*, a spire.]

Zygospira headi—Billings, 1862. (Athyris headi.) Pal. Foss., Vol. 1. Upper part Hud. Riv. Gr. The fossil referred to this species by Prof. Meek is quite distinct from it, and should bear a separate specific name.

" **modesta**—Say, 1847. (Atrypa modesta.) Pal. N. Y., Vol. 1. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. not large.)

" **modesta** *var.* **cincinnatensis**—Meek, 1873. Ohio Pal.,Vol. 1. Hud. Riv. Gr. This variety is founded on no other distinction than its large size.

CLASS PTEROPODA.

Conularia—Miller, 1818. Sow. Min. Conch., Vol. 3. [Ety. *conulus*, a little cone.]

" **formosa**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. beautiful.]

" **trentonensis**—Hall, 1847. Pal. N. Y., Vol. 1. Trenton and Hud. Riv. Gr. [Ety. proper name.]

Tentaculites—Schlotheim, 1820. Petref. [Ety. *tentaculum*, a feeler; *lithos*, stone.]

" **richmondensis**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **tenuistriatus**—Meek & Worthen, 1865. Proceedings Acad. Nat. Sci. Hud. Riv. Gr. [Sig. fine-striated.]

CLASS GASTEROPODA.

Bellerophon—Montfort, 1808. Conch. Syst., Vol. 1. [Ety. mythological name.]

" **bilobatus**—Sowerby, 1839. Murch. Sil. Syst. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. two-lobed.]

" **mohri**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv Gr. [Ety. proper name.]

" **morrowensis**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Upper part Hud. Riv. Gr. [Ety. proper name.]

Bucania—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *bukane*, a trumpet.]

" **costata**—James, 1872. (Cyrtolites costatus.) Am. Jour. Sci. and Arts, 3rd Ser., Vol. 3. Hud. Riv. Gr. [Sig. ribbed.]

" **expansa**—Hall, 1847. Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. expanded.]

Carinaropsis—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *Carinaria*, a genus of shells; *opsis*, appearance.]

" **patelliformis**—Hall, 1847. Pal. N. Y., Vol. 1. Utica Slate Gr. [Sig. like *Patella*, limpet-shaped.]

Cyclonema—Hall, 1852. Pal. N. Y., Vol 2. [Ety. *kuklos* a circle; *nema* a thread.]

" **bilix**—Conrad, 1842. (Pleurotomaria bilix.) Jour. Acad. Nat. Sci., Vol. 8. Hud. Riv. Gr. [Sig. woven like a thread.]

" **bilix** *var.* **fluctuatum**—James 1874. Cin. Quar. Jour. Sci., Vol. 1. Hud. Riv. Gr. [Sig. waved.]

" **conicum**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Sig. conical.]

" **percarinatum**—Hall, 1847. (Pleurotomaria percarinata.) Pal. N. Y., Vol. 1. Utica Slate and lower part Hud. Riv. Gr. [Sig. very much carinated.]

" **pyramidatum**—James, 1874. Cin. Quar. Jour. Sci., Vol. 1. Hud. Riv. Gr. [Sig. pyramidal.]

" **varicosum**—Hall, 1870. 24th Reg. Rep. N. Y. Hud. Riv. Gr. [Sig. varicose.]

Cyclora—Hall, 1845. Am. Jour. Sci. and Arts, Vol. 48. [Ety. *kuklos*, a circle.]

" **hoffmani**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Lower part Hud. Riv. Gr. [Ety. proper name.]

" **minuta**—Hall, 1845. Am. Jour. Sci. and Arts, Vol. 48. Utica Slate and Hud. Riv. Gr. [Sig. minute.]

" **parvula**—Hall, 1845. Am. Jour. Sci. and Arts, Vol. 48. Hud. Riv. Gr. [Sig. very small.]

Cyrtolites—Conrad, 1838. Ann. Rep. N. Y. [Ety. *kurtos*, curved; *lithos*, stone.]

" **carinatus**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Utica Slate and lower part Hud. Riv. Gr. [Sig. keeled.]

" **dyeri**—Hall, 1871. Pamphlet. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **elegans**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Middle part Hud. Riv. Gr. [Sig. elegant.]

" **magnus**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. great.]

" **ornatus**—Conrad, 1838. Ann. Rep. N. Y. Hud. Riv. Gr. [Sig. ornamented.]

Fusispira Hall, 1871. Pamphlet. [Ety. *fusus*, a spindle; *spira*, a spire.]
" **subfusiformis**—Hall, 1847. (Murchisonia subfusiformis.) Pal. N. Y., Vol. 1. Trenton Gr. [Sig. somewhat spindle-shaped.]
" **terebriformis**—Hall, 1871. Pamphlet. Lower part Hud. Riv. Gr. [Sig. auger-shaped.]

Microceras — Hall, 1845. Am. Jour. Sci. and Arts, Vol. 48. [Ety. *mikros*, small; *keras*, a horn.]
" **inornatus**—Hall, 1845. Am. Jour. Sci. and Arts., Vol. 48. Utica Slate and Hud. Riv. Gr. [Sig. not ornamented.]

Murchisonia—D'Archiac & Verneuil, 1841. Bull. Soc. Geo. France, Vol. 12. [Ety. proper name.]
" **bellicincta**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. beautifully banded.]
" **gracilis**—Hall, 1847. Pal. N. Y., Vol. 1. Lower part Hud. Riv. Gr. [Sig. slender.]
" **milleri**—Hall, 1877. Am. Pal. Foss. Hud. Riv. Gr. [Ety. proper name.]
" **multigruma**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. much heaped up.]
" **uniangulata**—Hall, 1847. Pal. N. Y., Vol. 1. Trenton, Utica Slate and lower part Hud. Riv. Gr. [Sig. having one angular line.]

Pleurotomaria—Defrance, 1826. Dict. Sci. Nat., Vol. 41. [Ety. *pleura*, side; *tome*, notch.]
" **halli**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Lower part Hud. Riv. Gr. [Ety. proper name.]
" **subconica**—Hall, 1847. Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. somewhat conical.]
" **tropidophora**—Meek, 1872. Am. Jour. Sci. and Arts, 3d Ser., Vol. 4. Upper part Hud. Riv. Gr. [Sig. keel bearing.]

Raphistome—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *raphe*, a seam or suture; *stoma*, mouth.]
" **lenticulare**—Emmons, 1842. (Pleurotomaria lenticularis.) Geo. Rep. N. Y. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. lens-shaped.]

CLASS CEPHALOPODA.

Crytoceras—Goldfuss, 1832. Handbuch der Geog. [Ety. *kurtos*, curved; *keras*, horn.]

" **amœnum**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. pleasant, welcome.]

" **magister**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Lower part Hud. Riv. Gr. [Sig. the chief.]

" **vallandighami**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Middle part Hud. Riv. Gr. [Ety. proper name.]

" **ventricosum**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Lower part Hud. Riv. Gr. [Sig. ventricose.]

Endoceras—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *endos*, within; *keras*, horn.]

" **proteiforme**—Hall, 1847. Pal. N. Y., Vol. 1. Trenton and Hud. Riv. Gr. [Sig. having many shapes.]

Gomphoceras—Sowerby, 1839. Murch. Sil. Syst. [Ety. *gomphos*, a club; *keras*, a horn.]

" **eos**—Hall & Whitfield, 1875. Pal. Ohio, Vol. 2. Upper part Hud. Riv. Gr. [Sig. the dawn.]

Orthoceras—Breynius, 1732. Dissert. Polyth. [Ety. *orthos*, straight; *keras*, horn.]

" **byrnesi**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

" **carleyi**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

" **cincinnatense**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

" **duseri**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Upper part Hud. Riv. Gr. [Ety. proper name.] Probably a syn. for *O. fosteri*.

" **dyeri**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

" **fosteri**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **hallanum**—S. A. Miller, 1877. American Palæozoic Fossils. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **harperi**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

Orthoceras meeki—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

" **mohri**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **ortoni**—Meek, 1872. Proceedings Acad. Nat. Sci. Hud. Riv. Gr. [Ety. proper name.]

" **transversum**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Lower part Hud. Riv. Gr. [Sig. transverse.]

" **turbidum**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Sig. disordered.]

Trochoceras—Hall, 1852. Pal. N. Y., Vol. 2. [Ety. *trochos*, a hoop; *keras*, a horn.]

" **baeri**—Meek & Worthen, 1865. Proceedings Acad. Nat. Sci. Upper part Hud. Riv. Gr. [Ety. proper name.]

Trocholites—Conrad, 1838. Ann. Geo. Rep. N. Y. [Ety. *trochos*, a hoop; *lithos*, stone.]

" **ammonius**—Conrad, 1838. Ann. Geo. Rep. N. Y. Trenton Gr. [Ety. mythological name.]

" **circularis**—Miller & Dyer, 1878. Cont. to Pal. No. 2. Upper part Hud. Riv. Gr. [Sig. round.]

" **minusculus**—Miller & Dyer, 1878. Cont. to Pal. No. 2. Utica Slate Gr. [Sig. rather small.]

CLASS LAMELLIBRANCHIATA.

Ambonychia—Hall, 1847. Pal. N. Y. Vol. 1. [Ety. *ambon*, the boss of a shield; *onyx*, a claw.]

" **bellistriata**—Hall, 1847. Pal. N. Y., Vol. 1. Utica Slate and Hud. Riv. Gr. [Sig. beautifully striated.]

" **carinata**—Goldfuss, 1826. (Pterina carinata.) Petref. Germ. Hud. Riv. Gr. [Sig. heeled.]

" **casei**—Meek & Worthen, 1866. Proceedings Acad. Nat. Sci. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **costata**—Meek, 1873. Ohio Pal., Vol. 1. Hud. Riv. Gr. [Sig. ribbed.]

" **radiata**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. radiated.] This may be a syn. for A. carinata.

" **retrorsa**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. turned back.]

Angellum—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. [Ety. *angos*, a pail; *ellus*, diminutive.]

" **cuneatum**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. wedge-shaped.]

Anodontopsis—McCoy, 1851. Ann. and Mag. Nat. Hist., 2d Ser., Vol. 7. [Ety. *Anodonta*, a genus of shells; *opsis*, appearance.]

" **milleri**—Meek, 1871. Am. Jour. Sci., 3d Ser., Vol 2. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **unionoides**—Meek, 1871. Am. Jour. Sci. and Arts, 3rd Ser., Vol. 2. Hud. Riv. Gr. [Sig. like a *Unio*.]

Anomalodonta—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. [Sig. anomalous toothed.]

" **alata**—Meek, 1872. (Ambonychia alata.) Proceedings Acad. Nat. Sci. Upper part Hud. Riv. Gr. [Sig. winged.]

" **gigantea**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Sig. very large.]

Avicula—See Pterinea.

Cardiomorpha—DeKoninck, 1844. Anim. Foss. Carb. Belg. [Ety. *kardia*, heart; *morphe*, form.]

" **(?)obliquata**—Meek, 1872. Proceedings Acad. Nat. Sci. Lower part Hud. Riv. Gr. [Sig. oblique.]

Cleidophorus—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. *kleidos*, a clavicle; *phoros*, bearing.]

" **fabula**—Hall, 1845. (Nucula fabula.) Am. Jour. Sci. and Arts, Vol. 48. Hud. Riv. Gr. [Sig. a little bean.]

Cuneamya—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. [Ety. *cuneus*, a wedge; *Mya*, a genus of shells.]

" **curta**—Whitfield, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Sig. cut off.]

" **miamiensis**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **neglecta**—Meek, 1872. (Sedgwickia (?) neglecta.) Proceedings Acad. Nat. Sci. Upper part Hud. Riv. Gr. [Sig. neglected.]

" **scapha**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Upper part Hud. Riv. Gr. [Sig. skiff or boat.]

Cycloconcha—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. [Ety. *kuklos*, a circle; *concha*, a shell.]

" **mediocardinalis**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Lower part Hud. Riv. Gr. [Sig. in allusion to the position of the teeth near the middle of the hinge line.]

Cypricardites—Conrad, 1841. Ann. Rep. N. Y. [Ety. from its resemblance to *Cypricardia*.]

" **carinatus**—Meek, 1872. (Dolabra carinata.) Proceedings Acad. Nat. Sci. Lower part Hud. Riv. Gr. [Sig. carinated.]

" **hainesi**—S. A. Miller, 1874. Cin. Quar. Jour. Sci. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **hindi**—Billings, 1862. (Cyrtodonta hindi.) Pal. Foss., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **quadrangularis**—Whitfield, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. quadrangular.]

" **sterlingensis**—Meek & Worthen, 1866. (Dolabra sterlingensis.) Proceedings Acad. Nat. Sci. Upper part Hud. Riv. Gr. [Ety. proper name.]

Lyrodesma—Conrad, 1841. Ann. Rep. N. Y. [Ety. *lyra*, a harp; *desma*, a ligament.]

" **cincinnatense**—Hall, 1871. Pamphlet. Utica Slate and lower part Hud. Riv. Gr. [Ety. proper name.]

" **planum**—Conrad, 1841. Ann. Rep. N. Y. Hud. Riv. Gr. [Sig. flat.]

Megambonia—Hall, 1859. Pal. N. Y., Vol. 3. [Ety. *mega*, great; *ambon*, the boss of a shield.]

" **jamesi**—Meek, 1872. Proceedings Acad. Nat. Sci. Hud. Riv. Gr. [Ety. proper name.]

Modiolopsis—Hall, 1847. Pal. N. Y., vol. 1. [Ety. *Modiola*, a genus of shells; *opsis*, appearance.]

" **cincinnatensis**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Utica Slate Gr. [Ety. proper name.]

" **concentrica**—Hall & Whitfield, 1875. Ohio. Pal., Vol. 2. Hud. Riv. Gr. [Sig. concentric.]

" **modiolaris**—Conrad, 1838. (Pterinea modiolaris.) Ann. Rep. N. Y. Hud. Riv. Gr. [Sig. like a *Modiola*.]

Modiolopsis pholadiformis—Hall, 1857. Lake Sup. Land Dist., Vol. 2. Upper part Hud. Riv. Gr. [Sig. like the *Pholas*.]

" **terminalis**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv Gr. [Sig. terminating.]

" **truncata**—Hall, 1847. Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. cut short.]

" **versaillesensis**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]

Orthodesma—Hall & Whitfield, 1875. Ohio. Pal., Vol. 2. [Ety. *orthos*, straight; *desma*, a ligament.]

" **contractum**—Hall, 1847. (Orthonota contracta.) Pal. N. Y., Vol. 1. Upper part Hud. Riv. Gr. [Sig. contracted.]

" **curvatum**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Upper part Hud. Riv. Gr. [Sig. curved.]

" **mickelboroughi**—Whitfield, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Ety. proper name.]

" **parallelum**—Hall, 1847. (Orthonota parallela.) Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. parallel.]

" **rectum**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Upper part Hud. River Gr. [Sig. straight.]

Orthonota—Conrad, 1841. Ann. Rep. N. Y. [Ety. *orthos*, straight; *notos*, back.]

" **pholadis**—Conrad, 1838. Ann. Rep. N. Y. Hud. Riv. Gr. [Sig. like a *Pholas*.]

Pterinea—Goldfuss, 1826. Germ. Petref. [Ety. *pteron*, a wing.]

" **corrugata**—James, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Sig. corrugated.]

" **demissa**—Conrad, 1842. Jour. Acad. Nat. Sci., Vol. 8. Hud. Riv. Gr. [Sig. hanging down.]

" **insueta**—Emmons, 1842. Geo. Rep. N. Y. Hud. Riv. Gr. [Sig. unusual.]

" **welchi**—James, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]

Sedgwickia—McCoy, 1844. Synop. Carb. Foss., Ireland. [Ety. proper name.]

" **compressa**—Meek, 1872. Proceedings Acad. Nat. Sci. Upper part Hud. Riv. Gr. [Sig. compressed.]

Sedgwickia divaricata—Hall & Whitfield, 1875. Ohio Pal., Vol. . Upper part Hud. Riv. Gr. [Sig. divaricated.]

" **fragilis**—Meek, 1872. Proceedings Acad. Nat. Sci. Hud. Riv. Gr. [Sig. frail.]

" **lunulata**—Whitfield, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. a small moon.]

Tellinomya—Hall, 1847. Pal. N. Y., Vol. 1. [Ety. from a resemblance to *Tellina* and *Mya*.]

" **hilli**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **levata**—Hall, 1847. (Nucula levata.) Pal. N. Y., Vol. 1. Hud. Riv. Gr. [Sig. smoothed.]

" **obliqua**—Hall, 1848. (Nucula obliqua.) Am. Jour. Sci. and Arts, Vol. 48. Hud. Riv. Gr. [Sig. oblique.]

" **pectunculoides**—Hall, 1871. Pamphlet. Hud. Riv. Gr. [Sig. like *Pectunculus*.]

SUB-KINGDOM ARTICULATA.

CLASS ANNELIDA.

Cornulites—Schlotheim, 1820. (Petrefactenkunde.) [Ety. *cornu*, horn; *lithos*, stone.]

" **corrugatus**—Nicholson, 1872. (Conchicolites corrugatus.) Lond. Geo. Mag., Vol. 9. Hud. Riv. Gr. [Sig. corrugated.]

" **flexuosus**—Hall, 1847. (Tentaculites flexuosus.) Pal. N. Y., Vol. 1. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. flexuous.]

" **intermedius**—Nicholson, 1874. (Ortonia intermedia.) Lon. Geo. Mag., N. S., Vol. 1. Hud. Riv. Gr. [Sig. intermediate.]

" **minor**—Nicholson, 1873. (Ortonia minor.) Lond. Geo. Mag., Vol. 10. Hud. Riv. Gr. [Sig. less.]

Nereidavus—Grinnell, 1877. Am. Jour. Sci. and Arts, 3d Ser., Vol. 14. [Ety. *Nereidæ*, a family of annelids; *avus*, grandfather.]

Nereidavus varians—Grinnell, 1877. Am. Jour. Sci. and Arts, 3d Ser., Vol. 14. Hud. Riv. Gr. [Sig. variable.] I regard this species as representing part of the masticatory apparatus of a Crustacean, since it so closely resembles the masticatory organs of the carboniferous genera, Dithyrocaris aud Ceratiocaris. Prof. Grinnell refers it to similar organs of an Annelid, notwithstanding that we have no knowledge of an Annelid, in the Palaeozoic rocks, capable of bearing such organs.

Scolithus—Haldeman, 1840. Supp. to Monograph of Limniades. [Ety. *scolex*, a worm; *lithos*, stone.]

" **tuberosus**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. bumping out.]

Spirorbis—Lamarck, 1801. Syst. An. Sans. Vert. [Sig. spiral whorl.]

" **cincinnatensis**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Ety. proper name.]

Walcottia—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. [Ety. proper name.]

" **cookana**—Miller & Dyer, 1878. Cont. to Pal., No. 2. Hud. Riv. Gr. [Ety. proper name.]

" **rugosa**—Miller & Dyer, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. rugose.] In addition to these, Mr. Ulrich has described some fossils under the names of *Eotrophonia setigera, Protoscolex covingtonensis, P. ornatus, P. tenuis,* and *P. simplex;* the latter of which is a synonym for *Walcottia cookana.*

CLASS CRUSTACEA.

Acidaspis—Murchison, 1839. Sil. Syst. [Ety. *akis*, a spear-point; *aspis*, a shield.]

" **anchoralis**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Below the middle of the Hud. Riv. Gr. [Sig. anchor-like.]

" **cincinnatensis**—Meek, 1873. Ohio, Pal., Vol. 1. Middle part Hud. Riv. Gr. [Ety. proper name.]

" **crossota**—Locke, 1843. Am. Jour. Sci. and Arts, Vol. 44. Utica Slate and lower part of Hud. Riv. Gr. [Ety. *crossotus*, fringed.] Usually misspelled *crosotus.*

" **onealli**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Upper part Hud. Riv. Gr. [Ety. proper name.]

Asaphus—Brongniart, 1822. Hist. Nat. Crust. [Ety. *asaphus*, obscure.]
" **gigas**—DeKay, 1825. Ann. Lyc. Nat. Hist. N. Y. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. a giant.]
" **megistos**—Locke, 1841. Proceedings Am. Ass. Geol. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. very large.]

Beyrichia—McCoy, 1850. Synop. Sil. Foss. Ireland. [Ety. proper name.]
" **chambersi**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Throughout Hud. Riv. Gr. [Ety. proper name.]
" **ciliata**—Emmons, 1855. Am. Geol. Utica Slate and lower part of Hud. Riv. Gr. [Sig. haired on the margin.]
" **cincinnatensis**—S. A. Miller, 1875. Cin. Quar. Jour. Sci., Vol. 2. Upper part of Hud. Riv. Gr. [Ety. proper name.]
" **duryi**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Middle part of Hud. Riv. Gr. [Ety. proper name.]
" **oculifera**—Hall, 1871. Pamphlet. Middle part Hud. Riv. Gr. [Sig. eye-bearing.]
" **quadrilirata**—Syn. for Beyrichia regularis.
" **regularis**—Emmons, 1855. Am. Geol. Upper part Hud. Riv. Gr. [Sig. formed in bars.]
" **richardsoni**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Ety. proper name.]
" **striato-marginata**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Upper part Hud. Riv. Gr. [Sig. having a striated margin.]
" **tumifrons**—Syn. for Beyrichia ciliata.

Calymene—Brongniart, 1822. Hist. Nat. Crust. [Ety. *kekalymenos*, concealed.]
" **callicephala**—Green, 1832. Monograph of Trilobites. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. having a beautiful head.]
" **christyi**—Hall, 1860. Thirteenth Reg. Rep. N. Y. Upper part Hud. Riv. Gr. [Ety. proper name.]
" **senaria**—Conrad. Syn. for C. callicephala.

Ceraurus—Green, 1832. Monograph of Trilobites. [Ety. *keras*, a horn; *oura*, a tail.]
" **icarus**—Billings, 1850. Can. Nat. and Geol., Vol. 5. Upper part of Hud. Riv. Gr. [Ety. mythological name.] I regard the identification of this species with the Canadian as doubtful.

Ceraurus pleurexanthemus—Green, 1832. Monograph of Trilobites. Hud. Riv. Gr. [Ety. *pleura*, side; *exanthemata*, breaking out.]

Cythere—Müller, 1785. Entomostraca sue Insecta, etc. [Ety. proper name.]

" **cincinnatensis**—Meek, 1872. Proceedings Acad. Nat. Sci. Middle part Hud. Riv. Gr. [Ety. proper name.]

" **irregularis**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Hud. Riv. Gr. [Sig. irregular.]

Dalmanites—Emmrich, 1845. (Dalmania.) Barrande, 1852. Sil. Syst. Boh. [Ety. proper name.]

" **breviceps**—Hall, 1866. Pamphlet. Upper part of Hud. Riv. Gr. [Sig. short-headed.]

" **carleyi**—Meek, 1872. Am. Jour. Sci. and Arts, 3rd Ser., Vol. 3. Middle part Hud. Riv. Gr. [Ety. proper name.]

Enoploura—Wetherby, 1879. Jour. Cin. Soc. Nat. Hist. [Ety. *enoplos*, armed; *oura*, tail.] Proposed for Anomalocystites balanoides.

" **balanoides**—Meek, 1872. (Anomalocystites balanoides.) Am. Jour. Sci. and Arts, 3rd Ser., Vol. 3. Hud. Riv. Gr. [Sig. resembling *Balanuis.*]

Leperditia—Rouault, 1851. Bull. Soc. Geo. France. [Ety. *lepis*, a scale; *dittos*, double.]

" **byrnesi**—S. A. Miller, 1874. Cin. Quar. Jour. Sci., Vol. 1. Utica Slate Gr. [Ety. proper name.]

" **cylindrica**—Hall, 1871. Pamphlet. Trenton, Utica Slate and Hud. Riv. Gr. [Sig. cylindrical.]

" **minutissima**—Hall, 1871. Pamphlet. Utica Slate and Hud. Riv. Gr. [Sig. very small.]

Lichas—Dalman, 1826. Monograph of Trilobites. [Ety. mythological name.]

" **harrisi**—S. A. Miller, 1878. Jour. Cin. Soc. Nat. Hist. Upper part Hud. Riv. Gr. [Ety. proper name.]

" **trentonensis**—Conrad, 1842. Jour. Acad. Nat. Sci., Vol. 8. Hud. Riv. Gr. [Ety. proper name.]

Plumulites—Barrande. [Ety. *plumula*, a feather.]

" **jamesi**—Hall & Whitfield, 1875. Ohio Pal., Vol. 2. Hud. Riv. Gr. [Ety. proper name.]

Prœtus—Steininger, 1830. Versteinerungen, etc. [Ety. mythological name.]

" **parvlusculus**—Hall, 1866. Pamphlet. Hud. Riv. Gr. [Sig. very small.]

" **spurlocki**—Meek, 1872. Am. Jour. Sci. and Arts, 3d Ser., Vol. 3. Hud. Riv. Gr. [Ety. proper name.] C. D. Walcott has suggested that this is the young of *Asaphus megistos.*

Triarthrus—Green, 1832. Monograph of Trilobites. [Ety. *triarthrus*, three-jointed.]

" **becki**—Green, 1832. Monograph of Trilobites. Utica Slate. [Ety. proper name.] J. G. Anthony in 1846 [Quar. Jour. Geo. Soc., Vol. 3,) said he found *Triarthrus becki* below the Cincinnati Observatory at an elevation of 200 feet above low water mark in the Ohio. I have never found this species more than 125 feet above low water mark; but it is quite likely that the Utica Slate will include a thickness of 200 feet, and that some of the fossils referred to the lower part of the Hudson River Group will be found to be confined to the Utica Slate.

Trinucleus—Lhwyd, 1698. Phil. Trans., Vol. 20. [Ety. *trinucleus*, three-kerneled.]

" **concentricus**—Eaton, 1832. Geo. Text Book. Utica Slate and lower part Hud. Riv. Gr. Probably Trenton, also [Sig. concentric.]

" **bellulus**—Synonym for T. concentricus.

Rocks of Upper Silurian age may be traced from Clarke county, Indiana, through all the river border counties to Butler county, Ohio, where, according to Dr. Locke, they are six hundred and one feet above the Ohio river at Cincinnati, or one thousand and forty-one feet above the ocean. Over this entire distance the Niagara presents great uniformity of lithological features and rests upon strata of Lower Silurian age that are alike marked in their lithological characteristics, while at the same time the two horizons are so distinct that they may be readily recognized without the aid of fossils. The only exception to this uniformity of lithological character is that mentioned in the Banded rock at Madison, and this may only be from a more compact crystallization of the marl-like shale, which at other localities occupies the same horizon.

The upper members of the Hudson River group, or Cincinnati beds, may prove to be locally somewhat thicker in Indiana than at the immediate neighborhood of Cincinnati; but this is not of sufficient importance to warrant one in establishing a different epoch for the beds at Richmond or Madison, as I have endeavored to prove by the above stratigraphical deductions.

The Niagara rocks in Indiana for the most part, especially in the southeastern part of the State, have lost none of the characters by which they are distinguished in New York. There they form the mural face of Niagara Falls, Genesee Falls, as well as a multitude of smaller falls and precipitous bluffs. The scenery in Indiana is alike marked by this epoch, and hence the name given to it in Ohio by Dr. Locke of "Cliff Rock." It caps the hills over a large portion of Jefferson county, and all the streams that cut their way through it have more rapidly removed the soft, marly Hudson River beds from beneath, and the superincumbent, massive Niagara breaks loose and tumbles to the foot of the ravine, where it is often seen in large blocks.

In this way cliffs are formed over which the streams pour their waters in beautiful cascades. Indeed, it is impossible to find any scenery in the State more beautiful and grand than is to be found in the vicinity of Madison and Hanover College. As we follow the crop of the Niagara limestone to the northeast, we find the character of some of the beds changed to a light, grayish buff, close-grained, magnesian limestone, forming flagstone and building stone of great value. Extensive quarries are opened in the vicinity of Greensburg, at St. Paul on Flat Rock creek; and, in fact, the stone is of excellent quality for a great distance both up and down the creek. Near Waldron, on Conns creek, there is, close to the top of the beds and over the flagstone, four or five feet of bluish shale and thin bands of limestone that abound in fossils. The bed is not persistent, and becomes thinner and disappears as you go either north or south of this place. It is very near to the corniferous limestone which crops further up the creek. Prof. James Hall, State Geologist of New York, has made a special study of the fossils of this locality and St. Paul, commencing as far back as 1862, and the results have been publised, so far as accurate drawings of the specimens are concerned, in the Twenty-eighth Regent's Report. No less than one hundred and twenty-six species have been recognized, and the locality has become one of the most noted in the world for the variety and beauty of its fossils. I am under obligations to Dr. R. R. Washburn, who lives at Waldron, for a number of very fine crinoid and brachiopod shells which he took from his large collection, all of which he obtained from the fossiliferous shales of Conns creek, one mile to the west of Waldron. The doctor is an enthusiast in the study of paleontology, and an intelligent, generous-hearted gentleman. His gratuitous labors in the cause of science are alike creditable to himself and an honor to the State. Among the most interesting objects found on Conns creek are the roots of Eucalyptocrinus. Some specimens are seen which preserve the base of the column, and show the ramification of the rootlets through the calcareous shale in every direction, and in such a manner as to indicate that they were imbedded in it during their growth at the bottom of the ocean. Numerous forms of Bryozoa cover some of the layers of stone with their net-like markings, and have even found lodgment upon the shells of mollusca. There could have been no want of life in palæozoic times. Then, as now, it would appear as though every available space was occupied by living matter.

Passing northwest, the Niagara rocks may be traced through portions of Rush, Hancock, Henry, Madison, Hamilton and Howard to Cass county on the upper Wabash river. To the east of Cass the Niagara is seen along the Wabash and Salamonie rivers in Miami, Wabash, Huntington, Blackford and Wells counties. There are crops along the Mississinewa river in Grant county, and in the bed of White river in Delaware county. In all the above counties the Niagara beds are quarried for flagging stone and architectural purposes. The layers are for the most part thin, and the stone refractory, variable in color and wanting in durability. The average composition may be seen from the following analyses of specimens from Randolph county, taken at the localities named:

	Macksville.	Ridgeville.
Water at 212° F	1.18	0.90
Silicic acid	1.20	0.70
Ferric oxide	1.30	2.70
Alumina	4.40	3.75
Lime	45.45	45.08
Magnesia	4.01	4.36
Carbonic anhydride	40.12	39.21
Sulphuric acid	0.27	0.44
Combined water and loss	2.07	2.86
	100.00	100.00

These stones are porous, open-grained, light buff colored. They make excellent lime. The specimens were collected and analyzed by Dr. Levette. It will be seen by the subjoined analysis of Huntington stone, which is celebrated for the quality of lime which it yields, that the Randolph county beds are not only equivalent in geological time, but are almost identical in chemical composition.

HUNTINGTON STONE, BEST FOR LIME.

Water at 212°	0.50
Silicic acid	1.50
Lime	31.92
Magnesia	7.58
Alumina and ferric oxide	8.25
Carbonic anhydride	49.52
Sulphuric acid	0.34
Loss	0.39
	100.00

The Niagara rocks in this part of the State carry locally a thin bed of sandstone which belongs to the Corniferous epoch. In Huntington county it forms the upper fifteen inches, is pure white, coarse-grained and loosely coherent.

In Madison county, at Pendleton, we have the following section extending from the bed of Fall creek to the top of the drift, all belonging to the Corniferous epoch:*

Drift with large bowlders of granite and other crystalline rocks strewed over the surface	50 feet.
Ash colored, rough weathering, cherty, magnesian limestone, alternating with soft, sandy, greenish colored, pyritiferous layers, in all, about	4 feet.
Buff, sandy, magnesian limestone, Pleurotomaria and coral bed	4 feet.
Heavy bedded and soft, white sandstone, upper part fossiliferous	15 feet.
Bed of Fall creek	

*A letter received from Prof. James Hall, State Geologist of New York, since this report was written, informs me that after a study of the Pendleton fossils he refers the sandstone to the "Schoharie Grit." He says: "My own convictions are that it is the equivalent of our own Schoharie Grit, being the western prolongation of beds that are generally well developed in Canada West, but making no conspicuous figure in the geology. Several of the fossils are identical with those of our own Schoharie Grit, and lately I had placed in my hands, for drawing, by Mr. Rogers, of Pendleton, a specimen of *Cyrtoceras eugeniana*, which is a common and characteristic fossil of the grit, and is the first specimen I have seen from beyond Central New York."

The sandstones may be had in blocks five feet thick; it is soft when first quarried, but hardens on exposure to the weather, and has a good reputation as a building stone, both for beauty and durability. This stone furnished the sand for the Indianapolis Glass Works, when they first started, and proved to be well adapted for this branch of manufacture. The fossils found at this locality are *Spirifer fimbriata*, *S. subumbonata*, *Conocardium trigonale*, *Zaphrentis gigantea*, *Pleurotomaria?*, *Diphyphyllum cæspitosum?*, *Cladopora fibrosa?*, and *Tentaculites scalariformis.*

These arenaceous beds have, so far, only been noticed in Huntington and Madison counties; at the former locality the thickness of the stratum is only a few inches, without organic remains, and its area quite limited. At Pendleton the exposure is, in all, about twenty-three feet, of which fifteen feet is sandstone. The layers all contain fossils, many of which correspond specifically with those found in the rocks at the Falls of the Ohio; I have, therefore, concluded to place them in the same epoch. I do this for the same reasons that I have placed all the rocks lying between the Corniferous and the Hudson River group, in Indiana, in the Niagara. The deposits are too thin and without well-defined characters, either lithological or fossiliferous, that will serve for lines of undisputed subdivisions. Of course every deposit has its top, middle and bottom parts, and at each locality these may be marked by the prevalence of specific forms of life or lithological variations; but I maintain that the absence of these forms, and a change in lithological features at another locality, is not unmistakable evidence of a difference in geological time. It is the duty of the geologist to make careful sections of all exposures of the rocks, to note the character of each stratum, and give with great minuteness the record of the fossils; but he will find himself involved in inextricable difficulties if he under-takes to make its features the standard by which to measure the age of other outcrops. Sandstone beds may be traced along the exposed face until the sand is replaced by lime, and the bed actually becomes a limestone. It may be without fossils at one part of the exposure and fossiliferous at another; so it is with the forms of life—they will vary in a remarkable degree along the same horizon in different parts of the stratum. I do not wish to be understood as ignoring the study and use of organic remains in determining geological sequence, but I simply deny their infallibility for the identity of minute subdivisions of strata over widely separated districts of country.

The Pendleton sandstone rests immediately on magnesian limestone belonging to the Niagara, which crops in considerable force on property owned by Hon. William Crim, one and a half miles west of the court house, in Anderson, and close to the bank of White river. It is opened up for quarrying, and presents a face several hundred feet in length, and contains as many as eleven workable layers of stone, varying from four to twelve inches in thickness. The section at the west end of the quarry is:

	Ft.	In.
Earth stripping	4	00
Buff argillaceous, magnesian limestone in uneven layers	4	06
Bluish colored layer, good stone	0	08
Bluish colored layer, good stone	0	06
Bluish colored layer, good stone	1	00
Bluish colored layer, good stone	0	08
Bluish colored layer, good stone	0	04
Bluish colored layer, good stone	0	06
Bluish colored layer, good stone	0	04
Bluish colored layer, good stone	0	04
Bluish colored layer, good stone	0	06
Bluish colored layer, good stone	0	06
Bluish colored layer, good stone	0	09
	14	07

At the east end of the quarry the stripping averages from two to four and a half feet. The thickness of the layers here is about the same as at the west end. The stone from Crim's quarry meets with a very ready sale and bears a good reputation for durability. Quarries have been opened in the vicinity of Marion, in Grant county, at a number of localities to the northwest of the city and along the Mississinewa river. The character of the stone is the same as at Crim's, near Anderson, and, like the latter, belongs to the Niagara epoch. It is a magnesian limestone; has an exposure of twelve feet and upwards, and is in layers varying from two to eighteen inches in thickness.

The city of Marion is situated in the valley of the Mississinewa river, at a point where the stone has been removed by denudation, or, mostly, by glaciation.

With a view to supply the city with water a well was dug on the east side of the river. It was commenced twenty-five feet in diameter, and carried to a depth of twenty-seven feet and walled with brick. It started in swampy ground, and passed through:

	Ft.
Black muck	1
Blue clay	2
Gravel and sand	9
Blue clay	15
	27

No water was found in this part of the well after passing below the seeps from the clay which formed the bed of the old swamp. A bore was started in the bottom of the digging, and, after passing through forty-one feet of gravel and clay, reached a stream of water which flowed to the surface with considerable force, and in twelve hours filled the body of the great well and flowed over the top. Here was an abundant supply of good potable water. Dean Bro.'s, of

Indianapolis, had been engaged to put up water works for distributing the water over the city, and at the time of my visit their admirable pump was at work emptying the main well, so that an additional and larger bore could be made for the purpose of increasing the flow of water, and thus insure an ample supply for all possible wants of the city. The people of Marion were very anxious to know the quality of the water for drinking and other household uses, and some bottles were filled and taken to the laboratory for chemical examination. The result of this analysis was reported to Mr. D. S. Hogan for publication in the local papers, but as a matter of general information it is repeated here:

ANALYSIS OF MARION ARTESIAN WELL WATER.

This water comes from a depth of sixty-eight feet, and has a temperature of 51½° F. It is colorless and odorless, has a slight chalybeate taste, and a small deposit of ferric oxide settled to the bottom of one of the bottles after standing a few days.

An imperial gallon (10 pounds) contains 28.2 grains of solid mineral matter, composed of:

	Grains.
Silica, insoluble in acids	1.610
Alumina	0.350
Magnesia	3.705
Lime	9.319
Ferrous oxide	0.849
Soda	0.154
Potash	0.022
Carbonic acid, combined	9.314
Sulphuric acid	2.298
Chlorine	0.236
Loss	0.343
	28.200

These substances are probably combined as follows:

	Grains.
Silica	1.610
Alumina	0.350
Sulphate of magnesia (Epsom salts)	4.061
Proto sulphate of iron	1.790
Carbonate of lime	16.800
Carbonate of magnesia	2.814
Carbonate of potash	0.042
Chloride of sodium (common salt)	0.390
	27.857

The free carbonic acid, which exists in considerable quantity, together with nitrogen and oxygen, was not determined. It is a sulphate, chalybeate and carbonated water, and may be said to have tonic and alterative properties, though 28.2 grains in 70,000 grains (10 pounds) of water must be looked upon as a homœopathic dilution, and an excessive drinker would scarcely receive into his system more than three grains of solid mineral matter from the water, by its free use, in twenty-four hours.

The total mineral constituents of the Marion artesian water corresponds very closely in quantity with what is found in most natural spring and well waters that are obtained from the drift deposit of Indiana.

The water analyzed from the spring at the "Mound," in Madison county, contained 24.101 grains of solid mineral matter in an imperial gallon, as follows:

	Grains.
Silica	1.658
Alumina	trace
Magnesia	trace
Lime	8.161
Ferrous oxide	1.041
Sulphuric acid	2.750
Carbonic acid	6.411
Undetermined and loss	4.080
	24.101

The Hawkins chalybeate spring, situated in the edge of Richmond, Wayne county, contains 32.2 grains of solid matter in an imperial gallon.

The chalybeate spring at Rochester, Fulton county, 24.5 grains.

Indianapolis well water, upper seam, 36 to 40, and the lower seams 23 to 28 grains per gallon.

So far as tested, all the water in the State which is obtained from the drift contains a considerable amount of iron, and in many localities the quantity is sufficiently large to give it decided tonic and alterative properties.

The Niagara beds in Delaware and Randolph counties have been quarried for building stone and for lime. Indeed, this stone is noted for the excellent quality of lime which it makes, and the operation of burning lime forms a large industry wherever the layers beneath the cherty beds which belong at the top of this formation can be reached. In Randolph county the stone is cream colored, porous and coarse-grained, which renders it inferior for masonry where durability is a matter to be considered, but the following analyses show that it is in no way inferior to the celebrated Huntington stone for the manufacture of lime. For comparison, the analysis is also given of the Huntington stone, which has given the best results in making quicklime for masonry.

No. 1 is quarried in White river bottom, near Macksville, seven miles west of Winchester, Randolph county.

No. 2 is found near Ridgeville, in the north part of Randolph county, and crops out in the bed of Mississinewa river for some miles east and west of that town.

No. 3 is from Hawleys Brothers' quarry at Huntington, Huntington county.

ANALYSES.

	No. 1.	No. 2.	No. 3.
Water expelled at 212° F	1.18	0.90	0.50
Silicic acid	1.20	0.70	0.50
Ferric oxide	1.30	2.70	8.25
Alumina	4.40	3.75	
Lime	45.45	45.08	31.92
Magnesia	4.01	4.36	9.58
Carbonic acid	40.11	40.21	49.52
Sulphuric acid	0.27	0.44	0.54
Loss and undetermined	2.08	1.86	
	100.00	100.00	100.81

After passing north of a line reaching from Huntington, on the upper Wabash river, and following a little north of this stream at Logansport, and thence through the northern part of White and the southern part of Newton counties, no beds of stone are found in the State exposed to view, but lie buried beneath the glacial drift, which varies, in this part of the State, from fifty to two hundred feet and upward in thickness.

By penetrating through this drift deposit at any point in the State north of the line designated, the Niagara rocks will be found, and as these beds of stone occupy a horizon many hundreds of feet below the coal measure rocks, it will be readily seen how futile must be the efforts of those who seek to find seams of coal in this part of the State.

Underlying the buff, magnesian limestone of the Niagara, so extensively used for making quick-lime in Wabash, Huntington and other counties bordering the upper Wabash river, there is a gray, argillaceous limestone that possesses dydraulic properties to a considerable degree. This stone has not yet been able to make its way into market against other cements which, if we should judge from their chemical constituents as usually rendered in analyses of cement stones, one would be puzzled to understand wherein lay the superiority of the latter. For the purpose of illustrating this subject I will here give the analyses of some of these rocks, together with that of well known cements from this and other States:

HYDRAULIC STONE ON THE DAVIESS FARM, NEAR SOMERSET, WABASH COUNTY.

Moisture		1.000
Silicic acid		30.600
Alumina		16.720
Carbonate of lime	(CaO., 14.336)	25.600
Carbonate of magnesia	(MgO., 6.052)	12.713
Ferric oxide		2.480
Organic matter, alkalies, undetermined and loss		10.887
Ratio: Silica 100 to 130 Base.		100.000

ANALYSIS OF THE CELEBRATED ROSENDALE CEMENT STONE, NEW YORK.*

Carbonate of lime	(CaO., 25.76)	46.00
Silica, clay and insoluble silicates		27.70
Carbonate of magnesia	(MgO., 8.46)	17.76
Alumina		2.34
Protoxide of iron		1.26
Sulphuric acid		0.26
Chlorides of potassium and sodium		4.02
Hygrometric water		0.22
Loss		0.44
Ratio: Silica, 100; Bases, 181.		100.00

CUMBERLAND CEMENT STONE, MARYLAND.

Carbonate of lime	(CaO., 23.408)	41.80
Silica, clay and insoluble silicates		24.74
Carbonate of magnesia	(MgO., 1.952)	4.10
Alumina		16.74
Peroxide of iron		6.30
Soda		4.64
Sulphuric acid		2.22
Hygrometric water		0.60
Ratio: Silica, 100; Base, 213.		101.14

* This and the three following analyses are taken from "Coignet-Breton and other artificial stone" by Gen. Q. A. Gillmore, p. 13.

BALCONY FALLS STONE, VIRGINIA.

Carbonate of lime	(CaO., 17.376)	31.03
Silica		34.22
Carbonate of magnesia	(MgO., 9.507)	19.97
Alumina		7.80
Water and loss		0.69
Free carbonic acid		6.29
		100.00

Ratio: Silica, 100; Base, 100.

VASSY CEMENT STONE, FRANCE.

Carbonate of lime	(CaO., 35.728)	63.8
Silica		14.0
Carbonate of magnesia	(MgO. 714)	1.5
Alumina		5.7
Carbonate of iron		11.6
Water and loss		3.4
		100.0

Ratio: Silica, 100; Base, 383.

The amount of alumina in the Cumberland and Balcony Falls cement stones shows that they must have contained a considerable amount of combined water, the former not less than five or six per cent., and the latter not less than three or four per cent.; therefore there is likely to be an excess of carbonates of lime and magnesia, to that extent, at least, in the reported analyses. I look for the error in these salts because it requires time and patience to thoroughly wash their bulky precipitates. There is no self-evident error in the analysis of the Vassy cement stone, the 5.7 per cent. of alumina would indicate that it carried from three to four per cent. of water. The excellence of this cement was for a time thought to be due to the large per cent. of ferric oxide which it contains. But it is well known that there are many equally good cements which have but a comparatively small amount of ferric oxide, and, indeed, M. Vicate, who devoted many years of study to the subject, and is recognized as eminent authority on cements, is of the opinion that ferric oxide exerts an injurious influence upon hydraulic mixtures. The Vassy cement stone contains a small amount of silica as compared to the bases. Assuming the silica, or, rather, silicic acid to be 100, the ratio is, silicic acid, 100; bases, 383.

The Rosendale cement, which is one of the best natural cements in America, has a ratio of silicic acid, 100; bases, 181. Cumberland cement, silicic acid, 100; bases, 213. Balcony Falls cement, Va., silicic acid, 100; bases, 100. Wabash county, Ind., cement, silicic acid, 100; bases, 130.

For hydraulic purposes the essential constituents of a cement stone are carbonate of lime and silica. By calcination the carbonate of lime converts the silica into silicic acid, which forms a gelatinous mass with acids. Carbonate of magnesia acts in a similar manner to carbonate of lime, and when the two are present in the proper proportions, hydraulic energy is uninterrupted, and a stone is formed, of great strength and durability, which consists of a double silicate of lime and magnesia. A portion of alumina is not objectionable in a cement stone in the presence of plenty of carbonate of lime and silica; it enters into combination as a hydrated silicate of lime and alumina. Sulphuric acid, or sulphate of lime, does not promote hardening or setting of the cement, and the same may be said of the oxide of iron. Large quantities of these substances are therefore objectionable, and they may be looked upon as adulterations.

Since carbonates of lime or magnesia, aided by alkalies, when present, are the active agents during the calcining of the cement stone in bringing about the decomposition of the silicates, and forming a silicate that is soluble in acids, it will be interesting to present a tabular arrangement of the ratio of silica to the carbonates of lime and magnesia in the above, and some additional analyses of cement stones that are in common use:

ANALYSIS.

	Silicates.	Carbonates.
Balcony Falls, Va	100	149
Rosendale, N. Y	100	248
Wabash county, Ind	100	124
Cumberland, Md	100	186
Beache's, Clark county, Ind	100	262
Vassy, France	100	465
English	100	341
Bologne	100	311

Between the silicates and carbonates, including the carbonates of lime, magnesia and alkalies, when present, there is a wide variation in cement stones of good repute for hydraulic energy.

It has already been stated that for hydraulic properties the essential constituents of a cement are silicic acid and caustic lime. The hardening under water is mainly due to the chemical combination of these two constituents through the agency of water, producing hydrated silicate of lime; where other bases are present, such as alumina and magnesia, double silicates are formed that become very hard and strong. In order to bring about this chemical change the silica must be brought to that condition which will enable it to form a gelatinous paste with acids. A portion of the silica may be in this condition naturally, but by far the larger portion remains unacted upon by acids until brought to a white heat in the presence of carbonate of lime.

If the bases are in excess of the silicic acid they are constantly being removed by the soluble action of water, and the strength of the cement is thereby improved. Rainwater standing for twelve months in a cement cistern made for the use of the geological laboratory was found to contain as much as eleven grains of carbonate of lime in an imperial gallon, and this solvent power of rainwater on the cement continued up to the time of our leaving the office at the old State House, a period extending over seven years.

In the following analyses of hydraulic stones collected by Prof. John Collett from the sub-carboniferous formation in Harrison and Crawford counties, Ind., and Rock Haven, Meade county, Ky., the investigation was conducted by Dr. G. M. Levette, under instructions to make the analyses in such a manner as to ascertain the effect produced upon the insoluble silicates, by calcining the stones at a full white heat. Each specimen was, therefore, analyzed three or four times. A moderate sized lump that fully represented the stone was crushed and pulverized to an impalpable powder in an agate mortar, and from this separate portions were taken.

First—A weighed portion of the powder was digested with hydrochloric acid and the filtrate treated in the usual way for the determination of the soluble salts. The insoluble silicates remaining on the filter were ignited and weighed, the result of which is given in the first column of the following table.

Second—Another weighed portion of the same powder was calcined at a white heat and then treated as the first; results shown in the second column of the table.

Third—Another weighed portion of the same was fused with four times its weight of carbonate of potash and soda, in a platinum crucible, and treated as the first; results shown in third column.

Fourth—In some instances the insoluble silicates found by the first process were fused with carbonates of potash and soda, and the composition placed in the fourth column.

Fifth—The amount of silica soluble in water, from the calcined stone, is also given as a matter of interest.

The sample first analysed is a specimen taken from the lower part of the quarry at Rock Haven, Ky. The cement made at this place, though the works have only been in operation for a few years, has already gained a high reputation for hydraulic energy, and is said by the manufacturers to be greatly preferred to the Louisville cement. However this may be, I wish it understood that I do not believe that this point is at all established beyond question. The same strata of stone are found in Indiana, and we will now direct attention to the analyses:

ROCK HAVEN CEMENT STONE, MEADE COUNTY, KY.—BOTTOM OF BED.

	No. 1. Not Calcined.	No. 2. Calcined.	No. 3. Fused in Alkalies.
Water expelled at 212° F.	0.75	0.75	0.75
Insoluble silicates	34.30	27.10	25.90
Soluble silica	0.20	1.10	1.10
Ferric oxide	} 1.90	6.75	7.45
Alumina		2.40	3.00
Lime	30.80	31.00	31.12
Magnesia	0.66	0.66	0.66
Carbonic acid	24.20	24.35	24.45
Sulphuric acid	1.80	1.80	1.80
Combined water, organic matter, traces of alkalies and loss	5.39	4.09	3.77
	100.00	100.00	100.00

Silicic acid, soluble in water, 1.2.

It is common to render the lime and magnesia as carbonates, but I have thought best to separate the carbonic acid, since in the practical preparation of cement the stone is calcined, and nearly or quite all the carbonic acid is expelled by the heat.

In order to compare these results with the analyses of cements made by other analysts, I have taken the figures given in the second column, which shows the composition of the calcined stone. I will also add for the better understanding of those who may wish to repeat or extend this analytical research, that the carbonic acid was determined by fusing the powdered stone with borax glass.

To show the relation of the silicic acid to the bases, the former is taken to be 100.

ROCK HAVEN CEMENT STONE—TOP PART OF BED.

	No. 1. Not Calcined.	No. 2. Calcined.	No. 3. Fused.	No. 4. Insoluble Matter of No. 1 fused.
Water expelled at 212° F	1.00	1.00	1.00	
Insoluble silicates	36.90	31.00	27.85	28.15
Soluble silica	0.30	0.35	0.35	
Ferric oxide	1.25	6.67	4.20	4.55
Alumina			4.40	4.45
Lime	28.42	28.60	28.83	
Magnesia	0.43	0.43	0.43	
Carbonic acid	22.33	22.47	22.65	
Sulphuric acid	1.20	1.20	1.20	
Combined water, organic matter, traces of alkalies and loss	8.17	8.23	8.09	
	100.00	100.00	100.00	

Silicic acid, 100; Soluble bases, 114.

JOHN KINTNER'S HYDRAULIC CEMENT, CEDAR GROVE, HARRISON COUNTY, INDIANA.

	No. 1. Not Calcined.	No. 2. Calcined.	No. 3. Fused.	No. 4. Insoluble matter of No. 1 fused.
Water expelled at 212° F	0.80	0.80	0.80	
Insoluble silicates	29.75	26.20	9.70	9.20
Soluble silica	0.60	1.00	0.90	
Ferric oxide	5.00	7.10	3.25	1.80
Alumina			5.45	2.50
Lime	34.84	35.14	41.61	8.26
Magnesia	....	....	1.67	
Carbonic acid	27.37	28.06	32.70	6.49
Sulphuric acid	0.80	0.80	0.80	
Combined water, organic matter, traces of alkalies and loss	0.84	.90	3.12	
	100.00	100.00	100.00	28.25

Silicic acid, 100; Soluble bases, 131.

CEDAR GROVE CEMENT ROCK, BRIGGS' FARM, HARRISON COUNTY, IND.

	No. 1. Not Calcined.	No. 2. Calcined.	No. 3. Fused.	No. 4.
Water expelled at 212° F	1.00	1.00	1.00	
Insoluble silicates	27.70	25.40	23.65	22.50
Soluble silica	0.10	0.10	0.15	
Ferric oxide	} 4.00	4.90	{ 2.50	2.50
Alumina			2.80	1.65
Lime	35.00	36.46	36.80	0.60
Magnesia	trace	trace	0.63	
Carbonic acid	27.50	28.64	29.27	0.47
Sulphuric acid	trace	trace	0.20	
Organic matter, undetermined and loss	4.70	3.50	3.00	
	100.00	100.00	100.00	27.72

Silicic acid, 100; Soluble bases, 144.

SHACKLEFORD'S CEMENT ROCK.

	Top.	Middle.	Bottom.
Moisture expelled at 212° F	0.20	0.25	0.18
Insoluble silicates	11.00	10.25	12.80
Soluble silica	1.18	1.13	1.10
Ferric oxide	2.35	1.95	3.10
Alumina	2.70	2.00	1.30
Lime	43.37	46.65	43.37
Magnesia	0.18	0.50	0.27
Carbonic acid	34.86	36.55	34.07
Sulphuric acid	0.27	0.14	0.26
Combined water, organic matter, undetermined and loss	3.89	0.58	3.55
	100.00	100.00	100.00

Silicic acid, 100; Soluble bases, 468.

One could hardly look upon this as a hydraulic lime, and the analysis would place it with the fat limes.

NATURAL CEMENT—HARRISON AND CRAWFORD COUNTIES.

	Not Calcined.	Calcined.
Water expelled at 212° F.	0.60	0.60
Insoluble silicates	29.50	27.45
Soluble silica	....	1.40
Ferric oxide, Alumina	4.10	4.75
Lime	23.52	23.50
Magnesia	2.98	2.98
Carbonic acid	21.77	21.76
Sulphuric acid	none	none
Chloride of alkalies	2.80	2.80
Combined water, organic matter and loss	14.73	14.76
	100.00	100.00

Silicic acid, 100; Soluble bases, 113.

This stone is said to make a good cement when ground without being calcined, but its analysis does not show it to be possessed of much hydraulic energy under such circumstances.

In order to make a further comparison, samples of English Portland cement and Louisville cement were obtained from the commission house of R. S. Foster; Milwaukee cement from Andrew Wallace's store, and Fayetteville, N. Y.; Buffalo-Portland, manufactured by the Union Cement Co., Buffalo, N. Y., from the office of the Indiana State House Commissioners. The latter were sent to the Commissioners as samples to compete with others in supplying the demand for building the State House. The specimens taken from the stores are of cements that are sold to meet the general wants of our market.

ANALYSIS OF ENGLISH PORTLAND CEMENT.

Water expelled at 212° F.	1.20
Insoluble silica	20.60
Soluble silica	3.80
Ferric oxide	2.00
Alumina	8.40
Lime	44.07
Magnesia	0.86
Carbonic acid	4.00
Sulphuric acid	5.58
Chloride of alkalies	2.60
Combined water	5.02
Loss and undetermined	1.87
	100.00

Four per cent. of carbonic acid represents 9.09 per cent. of carbonate of lime.

It is possible that the sulphuric acid exists in combination with lime, $CaO,SO_4 = 9.50$, and so far from this being a benefit, competent authorities consider that even 3.5 per cent. of sulphate of lime is detrimental to the strength and durability of hydraulic cement. In determining the ratio of silicic acid to bases I have, therefore, deducted from the lime 3.92 as combined with the sulphuric acid and rendered inert. We have, then, silicic acid, 23.40, and bases, 54.01.

Ratio: Silicic acid, 100; Bases, 280.

This cement effervesced, and the silica was gelatinous when treated with acid. The 4.00 per cent. of carbonic acid found will represent 9.09 per cent. of carbonate of lime. The 3.8 per cent. of silica soluble in chlorohydric acid and thrown down by evaporating the acid solution to dryness is much in excess of what was found in any other cement. The amount of silica soluble in water is 1.4 per cent. By recalcining the cement at a bright white heat the water which could not be expelled at 212° was estimated after deducting the carbonic acid from the loss.

LOUISVILLE CEMENT--MANUFACTURED IN CLARKE COUNTY, INDIANA.

Water expelled at 212° F	1.40
Gelatinous silica	15.70
Soluble silica	2.10
Ferric oxide	3.40
Alumina	20.60
Lime	38.38
Magnesia	1.30
Carbonic acid	5.90
Sulphuric acid	2.67
Chloride of alkalies	5.50
Combined water and loss	3.05
	100.00

This cement contains a large amount of alkalies, and differs mainly from the English-Portland in having less silicic acid and an excess of alumina. It contains a less quantity of sulphuric acid, 2.67 per cent., which, if combined with lime, will be equivalent to 4.54 per cent. of gypsum.

The ratio of silicic acid to bases is 100 to 411.

MILWAUKEE CEMENT.

Water expelled at 212° F	0.60
Gelatinous silica	22.60
Soluble silicic acid	1.20
Ferric oxide	2.20
Alumina	22.20
Lime	29.89
Magnesia	5.70
Carbonic acid	10.40
Sulphuric acid	1.18
Chloride of alkalies	2.10
Combined water and loss	1.93
	100.00

The 1.18 of sulphuric acid represents 2.02 per cent. of calcic sulphate
The ratio of silicic acid to bases is as 100 to 265.

This cement contains too much alumina and not enough lime. The ratio of silica to bases is very fair, but alumina is not as good a base as lime for the formation of hard and durable stone.

FAYETTEVILLE CEMEMT, ONONDAGA COUNTY, NEW YORK.

Water expelled at 212° F	0.80
Gelatinous silica	14.30
Soluble silicic acid	1.40
Ferric oxide	trace
Alumina	21.00
Lime	40.80
Magnesia	2.37
Carbonic acid	5.15
Sulphuric acid	1.84
Chloride of alkalies	5.20
Combined water and loss	7.14
	100.00

Silicic acid, soluble in water, 2.10 per cent.

Ratio of silica to bases, as 100 to 453.

The 1.84 per cent. of sulphuric acid represents 3.14 per cent. of calcic sulphate.

This cement contains too much alumina and not enough silica.

BUFFALO CEMENT COMPANY, LIMITED.

This company manufacture two brands of cement. A barrel of each was sent to the State House Commissioners as samples of what they would be able to furnish for use in constructing the state house. These barrels are marked respectively, "Buffalo-Portland Cement," which is here called No. 1, and "Buffalo Cement," No. 2, of the following analyses, made of samples taken from the barrels by boring into them with an auger:

ANALYSIS.

	No. 1.	No. 2.
Water expelled at 212° F	0.60	0.75
Silicic acid	24.80	24.30
Ferric oxide	1.65	2.61
Alumina	7.85	6.20
Lime	38.58	37.29
Magnesia	7.60	6.16
Carbonic acid	2.10	3.55
Sulphuric acid	1.00	2.16
Chloride of alkalies	4.95	5.30
Combined water and loss	10.87	11.68
	100.00	100.00

No. 1.—Ratio of silicic acid to bases as 100 to 218.

No. 2.—Ratio of silicic acid to bases as 100 to 205.

The analyses show no material difference in the chemical composition of these two cements, and, indeed, I was informed by one of the company that they are both made from the same cement stone, but they claim that there is a physical difference, and give decided preference to the Buffalo-Portland cement, which is made in this way: When the calcined stone is ground as fine as possible between the mill stones it forms the ordinary quality branded "Buffalo Cement." To the feel this cement contains some hard grains, which are still more apparent when the powder is placed under the microscope. These hard grains are the hard-burned, or vitreous part of the stone, which the manufacturers call "slag." This slag is separated by a fine bolting-cloth and re-ground, to make what they term "Buffalo-Portland Cement." A bushel of the latter cement is much heavier than the common (120 lbs. per bu.), and the manufacturers claim that it makes an infinitely harder and more durable concrete. This mode of manufacturing cement has been patented by the company. Of this I have no personal knowledge, but I may add that it had already been conjectured in my report of 1873, p. 157, that the cinder, or rejected, over-burned stone, would, if ground up with the other stone, improve the quality of the cement.

CUMBERLAND HYDRAULIC CEMENT, CUMBERLAND, MARYLAND.

Sample taken from a keg that was sent by the manufacturers to the State House Commissioners:

Water expelled at 212° F	1.00
Silicic acid	27.75
Ferric oxide	4.00
Alumina	11.00
Lime	40.75
Magnesia	0.72
Carbonic acid	6.50
Sulphuric acid	2.80
Chloride of alkalies	3.10
Combined water and loss	2.38
	100.00

Ratio of silicic acid to bases as 100 to 189.

WESTERN CEMENT ASSOCIATION, 98 MARKET STREET, CHICAGO, ILL.

Sample sent by express through the kindness of P. H. Decker, of Chicago. Manufactured at Utica, Ill. Light buff colored powder, meagre feel.

Water expelled at 212° F	1.20
Silicic acid	27.60
Ferric oxide	0.80
Alumina	10.60
Lime	33.04
Magnesia	9.26
Carbonic acid	2.70
Sulphuric acid	2.40
Chloride of alkalies	7.42
Combined water and loss	4.98
	100.00

Ratio of silicic acid to bases as 100 to 191.

This cement has a very good reputation, and differs but little in composition from the preceding. The main difference being in the large amount of alkalies which it contains. Estimating the sulphuric acid to combine with the lime to form an inert salt, or rather a combination that is an injury to the cement, and the carbonic acid combined with lime, we have 5.75 per cent. of the base that is of no value, so that the ratio of silicic acid to effective bases is 100 to 170.

Having now gone through with a large number of analyses, for convenience and comparison, the results will be presented in tabular form:

ANALYSIS OF CEMENT STONES AND CEMENTS.

NAME OF BRAND, OWNER OR QUARRY.	Silicates—Insoluble.	Soluble Silica.	Ferric Oxide.	Alumina.	Lime.	Magnesia.	Carbonic Acid.	Sulphuric Acid.	Chloride of Alkalies.	Moisture at 212° F.	Combined Water and Loss.	Ratio of Bases to 100 of Silica.
Balcony Falls, Virginia	34.22	......	....	7.80	17.37	9.51	30.41	......	......	......	0.69	100.
Buffalo Cement	24.30	......	2.61	6.20	37.29	6.16	3.55	2.16	5.30	0.75	11.68	205.
Buffalo-Portland Cement	24.80	......	1.65	7.85	38.58	7.60	2.10	1.00	4.95	0.60	10.87	218.
Briggs, Harrison county, Indiana	25.40	0.10	2.50	2.80	36.46	*	28.64	*	......	1.00	3.10	144.
Cumberland Cement Stone, Maryland	24.74	......	6.30	16.74	23.40	1.95	30.55	2.22	4.64	0.60	....	213.
Cumberland Cement, Maryland	27.75	......	4.00	11.00	40.75	0.72	6.50	2.80	3.10	1.00	2.38	189.
Fayetteville, New York	14.30	1.40	*	21.00	40.80	2.37	5.15	1.84	5.20	0.80	7.14	453.
Kintners, Harrison county, Indiana	26.20	1.00	3.25	5.45	35.14	1.67	28.06	0.80	......	0.80	....	131.
Louisville Cement, Indiana	15.70	2.10	3.40	20.60	38.38	1.30	5.90	2.67	5.50	1.40	3.05	411.
Milwaukee, Wisconsin	22.60	1.20	2.20	22.20	29.89	5.70	10.40	1.18	2.10	0.60	1.93	265.
Natural Cement	27.45	1.40	*	4.75	23.50	2.98	21.76	......	2.80	0.60	14.76	113.
Portland Cement, England	20.60	3.80	2.00	8.40	44.07	0.86	4.00	5.58	2.60	1.20	6.89	280.
Rockhaven, Kentucky, Top	31.00	0.35	4.20	4.40	28.60	0.43	22.47	1.20	......	1.00	6.30	114.
Rockhaven, Kentucky, Bottom	27.10	1.10	6.75	2.40	31.00	0.66	24.35	1.80	......	0.75	4.09	151.
Rosendale, New York	27.70	......	1.26	2.34	25.76	8.45	29.55	0.26	4.02	0.22	0.44	181.
Shacklefords, Harrison county, Indiana	10.25	1.13	1.95	2.00	46.65	0.50	36.55	0.14	......	0.25	0.58	468.
Somerset, Wabash county, Indiana	30.60	......	2.48	16.72	14.33	6.05	17.93	......	......	1.00	10.88	130.
Vassy, France	14.00	......	11.60	5.70	35.72	0.71	28.87	......	......	......	3.40	383.
Western Cement Company, Utica, Illinois	27.60	......	0.80	10.60	33.04	9.26	2.70	2.40	7.42	1.20	4.98	191.
Roman Cement Stone	16.89	......	8.67	4.71	37.52	1.16	30.35	......	......	......	....	257.

* A trace.

There is a very wide difference noticeable in the relation of the silicic acid and the earth bases with which it combines; lime, magnesia, and alumina. I mention only these earths since they alone are serviceable in connection with the silicic acid to form a good hydraulic mortar. If these substances are present in combining proportions, the ratio of silicic acid to bases may be 100 of the former to 366 of the latter. If lime and magnesia form the base, the ratio should be about 100 to 277. If lime alone constitutes the base, the silicic acid should be 100 to 200; and when of lime and alumina 100 to 398. When foreign substances are present, which we find always to be the case, then these ratios will of course have to be varied.

Take for example the cement made in Clarke county, Ind., and sold in the market as Louisville cement, calculated for 100 parts of effective substances, or silicic acid, lime and alumina, and leaving out the other constituents, will be:

Silicic acid	20.89
Alumina	32.10
Lime*	47.01
	100.00

The ratio of silicic acid to bases is 100 to 337, which falls but little short of the true combining ratio for silicate of alumina and lime, 398.

The English-Portland cement, calculated for 100 parts of active constituents, contains:

Silicic acid	31.43
Alumina	10.80
Lime and magnesia	57.77
	100.00

Ratio of silicic acid to bases, 100 to 218.

*This also includes the small quantity of magnesia which the cement contains.

The true combining ratio lies between that of the silicates of lime and alumina, as in the case of the Louisville cement. To form a silicate of lime and alumina, the proportion of each substance is:

Silicic acid	20.00
Lime	41.40
Alumina	38.60

It appears from actual tests, that while the Louisville cement makes a strong and durable concrete, comparing favorably with any other American cement, it will not make as strong and hard hydraulic stone as the English-Portland cement. To render it equal to the latter cement, to every 100 pounds of the former should be added 100 pounds of silicic acid, calcined with 100 pounds of carbonate of lime. This would add about ten per cent. to the silicic acid, ten per cent. to the lime, and reduce the alumina twenty per cent.

The large consumption of English-Portland cement in the United States renders it a matter of very great importance that we should be able to manufacture a cement that will take its place and prove its equal in every respect. For sub-aqueous masonry ordinary mortar is worthless; when placed under water it becomes gradually softened and disintegrated from the loss of lime, which is gradually dissolved away. The hydraulic cements, on the other hand, possess the valuable property of hardening under water. Cements of this kind have long been known to the world. At Puzzuoli, near Naples, a porous volcanic substance is found called Puzzuolano, which forms an excellent hydraulic cement when powdered and mixed with lime. It was employed by the Romans in many buildings, which are still in good preservation, having resisted the ravages of time more perfectly than the bricks it was used to cement. Vicat, one of the first to manufacture hydraulic cement on sound principles, used four parts of chalk (carbonate of lime) ground and levigated in water with one part of clay; when allowed to subside, is moulded into blocks, dried and calcined at a carefully regulated heat. The calcined blocks are then ground to a fine powder.

Portland (English) cement is also artificially prepared from clay, obtained from the valley of Medway, and chalk. The name is derived from the circumstance that when dry it resembles the Portland stone in color. In the preparation the clay and chalk are ground with water, the mixture is allowed to subside, then dried and burnt until slightly vitrified. The calcined material is again ground, and the resulting powder, when mixed with a proper proportion of water, forms a mortar that will harden under water into a strong and durable stone.

The rapidity with which hydraulic cement sets varies according to its composition. It is stated that if clay (clay is rather an indefinite term, since it may contain a large or small quantity of silica) does not exceed ten or twelve per cent. of the weight of the original limestone the mortar requires several weeks to harden; if the clay amounts to fifteen to twenty-five per cent. it sets in two or three days, and if twenty-five to thirty-five per cent. of clay be present it will solidify in a few hours.

Roman cement is prepared from nodules of septaria, which are found in the valley of the Thames. Cement made from these nodules will set in a few hours. The composition of these nodules, according to Meyer's analysis, is:

ROMAN CEMENT.

Soluble in acid 76.000	Carbonate of lime	66.990
	Carbonate of magnesia	1.670
	Carbonate of iron	6.950
	Alumina	0.390
Insoluble in acid 23.305	Silica	16 890
	Alumina	4.320
	Oxide of iron	1.720
	Lime	0.005
	Magnesia	0.370
		99.305

Bologne cement is made of similar material obtained in the neighborhood of Bologne, and has an almost identical composition.

I have in previous reports called attention to the occurrence of large beds of fresh-water chalk—carbonate of lime—found on the borders of many of the small lakes in Fulton, Kosciusko, Steuben and Noble counties, in the northern part of the State. This chalk exists in the form of a fine powder, which is almost a pure carbonate of lime. The composition of a sample taken from the farm of G. W. Slocum, on Sec. 30, T. 37, R. 13, in Steuben county, Ind., is:

Moisture expelled at 212°	8.00
Insoluble silicates	0.30
Alumina with trace of iron	1.50
Lime	45.36
Magnesia	3.42
Carbonic acid	41.50
Sulphuric acid	0.10
Phosphoric acid	0.38
	100.56

I am satisfied that a superior quality of hydraulic cement can be made by intimately mixing 100 parts of this chalk with 30 parts of clay that contains but little alumina, grind them together in water, form the sediment into cakes, dry and calcine as in the process of making Portland cement.

The economy of using this chalk over the common limestone, is the facility with which it my be reduced to powder and mixed with the clay before burning.

One of the largest deposits of this chalk in the State is at Rome City, in Noble county, but it may be had in any desirable quantity at many other localities in the above-named counties.

BUILDING STONE.

The preparation for building a State House has awakened a deep interest in the subject of building stone, from the fact that the structure will require nearly a million cubic feet of stone, and that no State in the Union can boast of more extended quarries of this essential mineral.

The beds of heavy, close-grained, compact, magnesian limestone, so extensively quarried on Flat Rock creek, near St. Paul, and by the Greensburg Stone Company, on Sand creek, near Greensburg, Decatur county, the blue limestone at North Vernon and Deputy, and other localities in Jennings and Jefferson counties, have long held an enviable reputation for massive masonry, such as foundations for public buildings, bridge abutments, etc., etc., where great strength and durability are essential elements. The Deputy and North Vernon building stone is blueish gray, commonly called blue, moderately close-grained, slightly conchoidal fracture, and lies in seams from one to two feet thick. The total exposure of the "North Vernon Blue Stone" is from twenty-five to thirty-three feet thick, and the bed covers an extended area in Jennings and Jefferson counties. It occupies a position almost immediately under the "Black Shale" and in the Hamilton division of the Devonian. Of the entire exposure only two or three layers are considered of first quality, and as we follow the crop to the south and southwest the character of the stone is materially changed, being charged with a large percentage of clay, which gives the stone hydraulic properties and supplies the material for the manufacture of the "Louisville Hydraulic Cement," so long and favorably known as a cement for submarine masonry, and to which allusion has already been made.

The analysis of the so-called "North Vernon Blue Stone" shows it to be almost a pure carbonate of lime. The tests for strength made by General Q. A. Gilmore, for the

State House Commissioners, indicates that it requires 15,750 pounds to the square inch to crush it. A cubic foot will weigh 165.43 pounds, and the ratio of absorption is 1 to 156; that is, a cubic foot will absorb less than a pint of water.

The specimen used in this test was furnished by F. H. Wrape & Co., of Deputy.

ANALYSIS OF WRAPE & CO.'S BUILDING STONE, DEPUTY, JEFFERSON COUNTY, INDIANA.

	Per Cent.
Water, dried at 212° F	0.85
Insoluble silicates	1.75
Ferric oxide	1.00
Alumina	2.20
Lime	50.06
Magnesia	0.85
Carbonic acid	40.27
Sulphuric acid	1.21
Chloride of alkalies	trace
Organic matter and loss	1.81
	100.00

The carbonate of lime in the above equals 89.4 per cent.

This is a homogeneous stone, and hard and difficult to work for a free stone.

The building stone sold in the market as Greensburg or Flat Rock stone belongs to a geological age known as the Niagara, which, in this State, immediately underlies the Hamilton.

At North Vernon we can see the two formations in conjunction, but at the latter locality the Niagara beds are of a deeper buff color, and too porous to be used for building material. In Dearborn county, in the vicinity of Greensburg on Sand Creek, and St. Paul on Flat Rock creek and some of its tributaries, the Niagara beds furnish a light gray, close-grained, magnesian limestone that is of very uniform structure and is strong and durable. The crop is from twenty to thirty feet thick, composed of a number of layers from four inches to two feet thick. Flagging may be obtained of this stone in flags fifty by two hundred feet, and four, six or seven inches thick, and without break or flaw, that will not vary one inch in thickness over the entire surface. Stone twenty-two inches thick may be had in like dimensions and evenly bedded, if it were possible to handle such masses.

The chemical composition of this stone is shown by the following analysis of samples taken from the Greensburg Stone Company's quarries, and from Eck & Son's quarry at St. Paul.

GREENSBURG STONE COMPANY.

According to General Gilmore, a cubic foot will weigh 169.98 pounds; crushing strength of a cubic inch, 16875 pounds; ratio of absorption, 1 to 117.

ANALYSIS.

	Per Cent.
Moisture dried at 212° F.	0.85
Insoluble silicates	5.90
Ferric oxide	2.50
Alumina	3.70
Lime*	41.55
Magnesia	4.93
Sulphuric acid	0.90
Carbonic acid	38.07
Chloride of alkalies	1.60
	100.00

W. W. LOWE'S STONE, ON FLAT ROCK CREEK, NEAR ST. PAUL, DECATUR COUNTY.

Whitish gray, close-grained.

According to General Gilmore, one cubic foot will weigh 168.09 pounds; crushing strength of a cubic inch, 16000 pounds; ratio of absorption, 1 to 336.

* Equal 74.2 per cent. carbonate of lime.

ANALYSIS.

	Per Cent.
Water, dried at 212° F	0.60
Insoluble silicates	5.10
Ferric oxide	1.00
Alumina	2.40
Lime	46.42
Magnesia	3.00
Carbonic acid	39.78
Sulphuric acid	0.80
Chloride of alkalies	0.50
Loss and undetermined	0.40
	100.00

Lime 46.42 equals carbonate of lime 82.71.

SCANLAN'S STONE, ST. PAUL, ON FLAT ROCK CREEK, DECATUR COUNTY.

Whitish gray, close-grained.

ANALYSIS.

	Per Cent.
Moisture dried at 212° F	1.20
Insoluble silicates	5.30
Ferric oxide	1.20
Alumina	1.30
Lime	46.48
Magnesia	3.00
Carbonic acid	39.82
Sulphuric acid	1.00
Chloride of alkalies	1.40
	100.00

Lime 46.48 equals carbonate of lime 83.00.

The three last stones are magnesian limestones, and, chemically tested, there is but little difference, and they represent a large class of building stones, not only in Indiana, but in the adjoining states of Ohio and Illinois, such as the Dayton stone of the former and the Joliet and Lamont of the latter. Perhaps no building stones in the west have been more thoroughly tested or are better known to the architects and builders. Being more costly to dress than the oolitic limestones, it has been chiefly used in this State for foundations and bridge abutments, for which purpose it is admirably adapted. In Chicago the Lamont stone has not only been used for basements, but in the form of facings forms one of the chief building materials. As shown by the following analysis, made from a sample which I obtained from a stone to be used in the Cook county, Ill., court house, it is less homogeneous than the Indiana magnesian stones, and contains a far greater per cent. of clay, magnesia and alkalies.

ANALYSIS OF LAMONT STONE.

	Per Cent.
Water, dried at 212° F	0.85
Silica	15.90
Ferric oxide	2.30
Alumina	7.00
Lime	25.65
Magnesia	9.94
Carbonic acid	31.08
Sulphuric acid	0.38
Chloride of alkalies	2.85
Combined water and loss	4.05
	100.00

Lime 25.65 equals carbonate of lime 45.80; magnesia 9.94 equals carbonate of magnesia 20.87.

In large cities, where bituminous coals are used, the atmosphere becomes charged with sulphurous acid gas, and this is changed to sulphuric acid, which exerts a very marked action upon magnesian stones by converting the carbonate into sulphate of magnesia (Epsom salts) which is readily soluble in water, and is washed out by the rains to stain, disfigure, and finally destroy the cohesion of the stone.

Magnesian limestones are of very variable composition as regards the clay, carbonate of lime and carbonate of magnesia, which enter into their composition.

Magnesian limestone covers an extensive area in the northeastern part of England, and was used in the construction of York Minster and the Houses of Parliament in London, which are among the finest architectural works in the country. In remote places, where the atmosphere is free from the sulphurous effusions derived from the extensive consumption of coal, the stone appears to be durable, but under the influence of the atmosphere of London its destruction was so rapid in the Houses of Parliament that it has become necessary to coat the surface, from time to time, with a coat of silicate of soda to stop the decay. According to Henry Law, "Civil Engineering, Weales' Series," the average weight of a cubic foot of the magnesian limestone employed in the construction of the Houses of Parliament is 144 pounds. Weight in pounds required to crush a cubic inch, 5,219 pounds; this multiplied by 144 will give the weight that will crush a square foot, 751,536, and this divided by eight will give the practical weight which a square foot of this stone is able to support.

In estimating the crushing weight of the stones tested for the State House Commissioners, by General Q. A. Gilmore, they will all be found greatly in excess of what is required; but in this connection it must be remembered that these results are for the ultimate crushing of the stone, while many will commence to yield to somewhat less than half the weight required for their total destruction.

We come now to consider a class of building stones that belong to the sub-carboniferous age. The quarries that have been worked for supplying the general market in this geological formation, with one exception, furnish almost a pure limestone. The most noted building stone here is supplied from strata that are supposed to be the equivalent of the rocks which crop at St. Louis, Missouri, and are called St. Louis limestone in the geological reports of Illinois. The crop of this stone may be followed from Montgomery county on the north, to Harrison county on the south. The workable beds are from ten to upwards of one hundred feet thick. The color ranges from grayish white and bluish gray to chalk white. The structure is oolitic, so named from its resemblance to the roe of a fish (egg-stone.) These segregated particles are sometimes so small that it is difficult to recognize them with the naked eye; at other times they are so large as to be quite conspicuous. It may be quarried in blocks of any thickness and size. At Matthews & Son's quarry I saw blocks cut out by the steam "channeler," six and a half by nine and a half and forty-two feet long. At the Chicago & Bedford Stone Company's quarry, at Bedford, Indiana, a block of the same width and thickness was sixty-six feet long, cut out by a channeling machine. At most of the localities where this stone is quarried, blocks of much greater length, thickness and width can be obtained if required, and Cleopatra's needle might be duplicated, should a market be opened for monoliths of that character.

A number of tests of this stone were made by General Gilmore, for the State House Commissioners, to determine its resistance to crushing, density and ratio of absorption.

A specimen of oolitic limestone from Simpson & Archer's quarry, four miles east of Spencer, on the Indianapolis & Vincennes railroad, gave the following result:

A cubic foot weighs 140.03 pounds, and it required 7,500 pounds to crush a cubic inch; ratio of absorption, 1 to 30.

ANALYSIS OF SIMPSON & ARCHER'S STONE.

	Per Cent.
Water at 212° F	0.41
Insoluble silicates	0.70
Ferric oxide and alumina	0.91
Lime	54.20
Magnesia	0.11
Carbonic acid	42.64
Sulphuric acid	0.20
Chloride of alkalies	0.32
Combined water and loss	0.51
Lime, 54.20 equals carbonate of lime 96.80.	100.00

A sample of stone from the quarry of Dunn & Company, near Bloomington, Ind., gave for crushing strength per square inch 13,750 pounds; weight of a cubic foot, 137.24 pounds; ratio of absorption, 1 to 43.

ANALYSIS OF DUNN & COMPANY'S STONE.

	Per Cent.
Water, dried at 212° F.	0.25
Insoluble silica	0.65
Ferric oxide and alumina	1.00
Lime	53.50
Magnesia	0.19
Carbonic acid	42.20
Sulphuric acid	0.40
Chloride of alkalies	0.55
Combined water and loss	1.26
	100.00

Lime 53.50 equals carbonate of lime 95.54.

Sample of stone from Chicago & Bedford Stone Company's quarry, Bedford, Indiana, gave crushing strength 11,750 pounds; weight of cubic foot, 146.56 pounds; ratio of absorption, 1 to 28.

ANALYSIS OF CHICAGO & BEDFORD STONE COMPANY'S STONE.

	Per Cent.
Water, dried at 212° F.	0.35
Insoluble silicates	0.50
Ferric oxide and alumina	0.98
Lime	54.10
Magnesia	0.13
Carbonic acid	42.62
Sulphuric acid	0.31
Chloride of alkalies	0.40
Combined water and loss	0.61
	100.00

Lime 54.10 equals carbonate of lime 96.60.

A sample of stone from S. M. Stockslager's quarry, Harrison county, Indiana, gave crushing strength, 10,250; a cubic foot weighs 149.59 pounds; ratio of absorption, 1 to 27.

ANALYSIS OF STOCKSLAGER'S STONE.

	Per Cent.
Water, dried at 212° F	0.50
Insoluble silicates	0.31
Ferric oxide	0.18
Alumina	0.14
Lime	54.93
Magnesia	none
Carbonic acid	43.17
Sulphuric acid	0.25
Chloride of alkalies	0.40
Combined water and loss	0.12
	100.00

Lime 54.93 equals carbonate of lime 98.10.

This is a chalk-white stone, soft when first taken from the quarry, but hardens with age.

Specimens from Matthews & Son's oolitic limestone, Ellettsville, Monroe county, Indiana, show a crushing strength of 13,500 pounds; a cubic foot weighs 142.23 pounds; ratio of absorption, 1 to 28.

Perry Brothers' oolitic limestone, Ellettsville; crushing strength, 12,628 pounds to the square inch; a cubic foot weighs 152.39 pounds; ratio of absorption, 1 to 41.

Dunn & Company, of Bedford, Indiana, oolitic stone; crushing strength, 6,500 pounds; weight of a cubic foot, 147.03 pounds; ratio of absorption, 1 to 24.

John Glover, Bedford, Indiana, oolitic limestone; crushing strength, 10,125 pounds; weight of a cubic foot, 152.39 pounds; ratio of absorption, 1 to 32.

Hege & Jackson, near Spencer, Indiana, oolitic limestone; crushing strength per cubic inch, 8,750 pounds; weight of one cubic foot, 145.16 pounds; ratio of absorption, 1 to 23.

E. Zink & Son, Salem, Indiana, oolitic limestone; crushing strength per square inch, 8,625 pounds; weight of one cubic foot, 144.28 pounds; ratio of absorption, 1 to 22.

Dunn & Company, Dark Hollow, Bedford, Indiana, oolitic limestone; crushing strength per square inch, 6,750 pounds; weight of one cubic foot, 140.3 pounds; ratio of absorption, 1 to 18.

The chemical composition of the Indiana oolitic limestones is remarkably uniform throughout the State; it is almost a pure carbonate of lime; its average density may be put at 150 pounds per cubic foot, and the ratio of absorption at 1 to 30.

Examined along the crop this stone shows a wonderful resistance to weathering, and presents a bold and well defined face along the valleys. As a durable building stone it has withstood the ravages of time in buildings for upwards of fifty years and still retains the hammer and chisel marks almost as sharp as when first cut. The density as shown above exceeds that of the celebrated English Portland oolite. It likewise possesses greater strength. The ratio of absorption of the English stone is 1 to 20, while the Indiana stone is 1 to 30. The reliable sustaining weight of a square foot of English Portland stone is 82,000 pounds, while that of the Indiana stone is not less than 135,000 pounds to the square foot. For the purpose of showing the weight which building material may have to support, I will state that the piers that support the dome of St. Paul, London, sustain a weight of 39,000 pounds to the square foot, and the piers at St. Peters, Rome, support a weight of 33,000 pounds to the square foot.

At Putnamville, in Putnam county, Mr. James E. Lee has a quarry of close-grained, hard, silicious limestone, which is strong and durable. The face exhibits twelve layers, ranging from five to twenty-two inches in thickness. General Gilmore found the crushing strength to be 11,750 pounds to the square inch; weight of a cubic foot 166.36 pounds, and ratio of absorption 1 to 170.

ANALYSIS OF PUTNAMVILLE STONE.

	Per cent.
Water, dried at 212° F	0.30
Insoluble silicates	27.50
Ferric oxide	2.00
Alumina	1.70
Lime	35.23
Magnesia	0.33
Carbonic acid	28.03
Sulphuric acid	2.60
Chloride of alkalies	0.75
Undetermined and loss	1.56
	100.00

The small amount of water which this stone absorbs is much in its favor. It differs from the oolitic limestone in carrying a large per cent. of silica, and in its greater density.

There are other excellent building stones in the State, of which mention is not made in this connection; some having received attention in former reports, and others are reserved for future investigation and notice.

GLACIAL DRIFT.

No phenomena encountered in the study of geological history has proven more perplexing to students than those which brought about the destruction of vast beds of rock, and left their fragmentary remains scattered over immense areas of country far from their native locality. Various theories have been, from time to time, propounded to reconcile observed facts with natural forces now in action. The most prominent of these are known as the Glacial theory, Iceberg theory, and water and atmospheric or denudation theory.

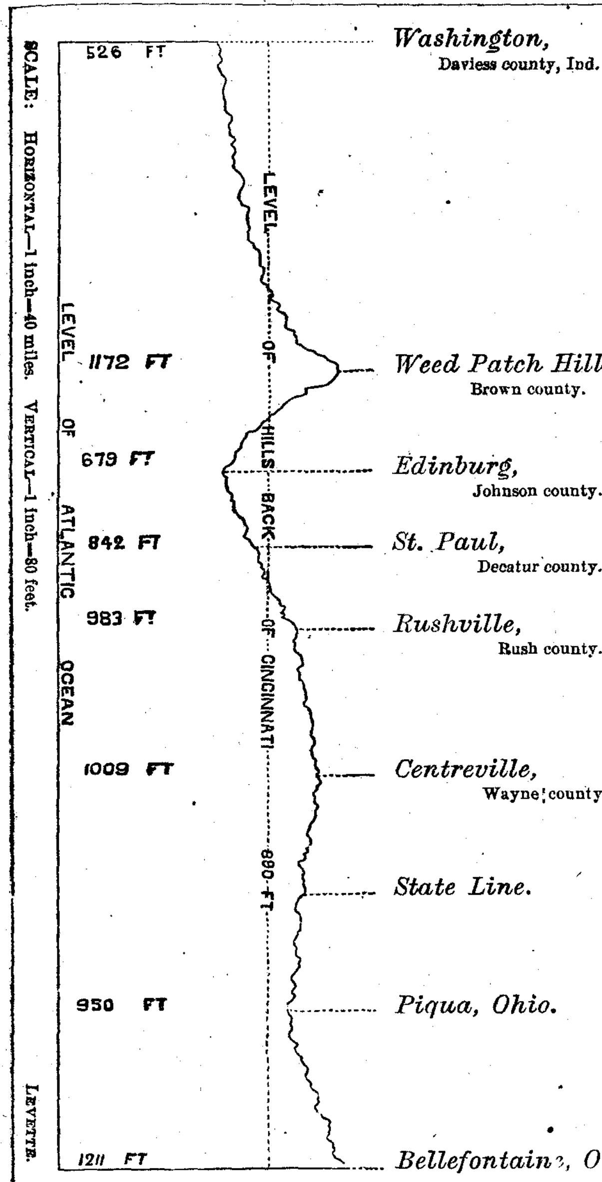


PLATE II.

Profile from Washington, Daviess county, Indiana, to Bellefontaine, Ohio.

(See Page 15 for Description.)

Every working geologist must admit the immense influence which the action of running water, aided by the corroding force of the air, has had in modifying the surface configuration of the land. Every drop of rain that falls upon elevated ground, over and above that which is absorbed by or permeates the strata, forces its way to a lower level, loaded with suspended and dissolved matter which it has removed from above to be deposited at lower levels. This force, continued over indefinite time, must of itself cut down mountain chains and leave plains in their stead, which are composed, in their upper part, of fragments of rock, gravel, clay, and sand, the debris of superior strata.

This leveling and transferring power of moving water exerts a very marked influence in modifying the configuration of continents and the ocean's bed. The sediment carried down by large rivers, like the Mississippi, and poured into the Gulf of Mexico, has pushed the shore lines many miles beyond its ancient boundary. The dashing of the waves of the ocean on other parts of the continent are wearing and forcing the shore line farther back, so that the contour of a continent is in this way perceptibly changed in a remarkable short time, when compared with most geological phenomena. As the relative proportion of land and water must ever remain the same, the mechanical action of water would alone, if uninterrupted by other forces of nature, depress continents and islands, and extend their surface area.

A proper regard must also be had for the active part which icebergs play in the transportation of rocks and sediment; but no matter with what ingenuity the advocates of these theories construct their arguments, they totally fail to satisfy the most casual observer of their adequacy to accomplish the work of building up the Drift deposit of Indiana, Illinois and Ohio.

The most visionary admirer of the force which running water exerts in moving forward, especially if the track be inclined, as a mountain valley, great masses of rock, and, by abrasion, round them into boulders, can not go so far as to believe that the crystalline and metamorphic boulders found over all parts of Indiana, from the northern to the southern limits, and in some places still further south, could have reached their present places of rest, hundreds of miles from their northern home, through the force exerted by currents of water, however great the flood. Nor can they be so unreasonable as to suppose for a moment that the fragments of crystalline and metamorphic rocks comprising the drift could have been derived from the cutting down of mountains that reared their granite crests far above the present plains. The geologist can here find no fractures or dykes through which eruptive rocks could be forced to overtop the palæozoic beds.

Again, to admit that these erratic masses were distributed by icebergs is to suppose that the drift was formed under the waters of the ocean, in which event we should be able to find in some parts of the formation the remains of marine organisms. No such discovery has yet been made, and there is but little to encourage the search. The remains so far discovered in the drift are trunks and limbs of trees and the bones of animals that lived upon the land.

Turning now to glaciation, we find it all-sufficient to account for the moving of rocks, as well as finer debris, from one region of country to another, and scatter them over lands far distant from their parent beds, and this without calling to our aid any causes not seen in action on existing glaciers. It is not necessary to bring to our assistance as a means to account for the frigidity of the glacial epoch the unnatural problem of a change in the polar axis of the earth. Rather let us conclude that it was due to the then relative position of land and water, and a change in the deflection of the warm currents of water that flow from the equatorial region to the northward. A change in the course of the Gulf Stream would materially alter the meteorological conditions of Great Britain, and the present mild climate of California and Oregon is greatly due to warm currents that flow north along the eastern shores of Asia being deflected in their direction. A change, then, in the direction of these currents of warm water, and the elevation of the mountain chains of Laurentian and Huronian rocks in British America until their crests were clothed in perpetual snow and ice, would be all that is needed to usher in the glacial period. An upward movement of the northern part of the American continent had, in my opinion, been in progress, with possibly some intermission, since the close of the coal epoch. Up to glacial times the great lakes were a part of the ocean, but, cut off by the rise of the land, and having an outlet but no influx from the ocean, the immense drainage of fresh water and small amount of evaporation in time deprived them of salinity. All marine life that could not adapt itself to this change sought the way out or perished. The late Dr. William Stimpson found a species of marine crustacea, *Mysis*, in deep dredgings in Lake Michigan, and similar discoveries of marine forms of life have been found in fresh water lakes in Europe, which point to their ocean parentage.

Then, again, I do not believe that it is possible for glaciers to make erosions to so great a depth as the beds of some of these lakes, and to the extent required by their area, nor is such a history demanded for a solution of the problem of their existence.

I can see no evidence of a subsidence of the land to terminate the glacial period, nor can we find in Ohio, Indiana or Illinois anything to militate against the commencement of the glacial period dating back to tertiary times, and continued until brought to a close by its own erosive force, aided by atmospheric and meteorological influences. By these combined agencies, acting through time, the mountain home of the glacier was cut down, and a general leveling of the land took place all along its course.

The glacial period was the result of high elevations in the northern regions, and its force was expended in eroding and cutting down, and in removing mineral matter from a higher to a lower level. This grinding and equalizing work of the glaciers was bound in time to effect a material change in the topography and in the meteorological condition of the continent; not only were elevated mountain peaks worn down and the general leveling of the land brought about, but vast quantities of mud and sand were carried forward by the streams of water which flowed beneath the glaciers, and these streams, swelled during the summer time to floods by the melting of the ice, would carry the sediment forward until deposited in the ocean. In this way the shores of the continent were pushed from year to year, and from century to century, and the superficial area of the land would in this way be materially augmented.

The changes to be wrought in the physiognomy of a continent by the combined glacier, atmospheric decomposition, and running water, are marvelous; but so slow do they appear to act, when measured by man's brief opportunity to observe, that we are prone to under-estimate their value, and seek for some grand power to lift up or dash down the earth's crust at all times, and in just such manner as may be satisfactory to the mind of the cataclysmic philosopher.

The configuration of the earth's surface in North America, as well as its climatic laws, gave direction to the glaciers and caused them to move from the north in a southerly course. There are some exceptions to this general bearing of the ice-flow, but they do not militate against the above generalization and may be referred to local causes, such as influence the course of the tributaries that flow into the valley of the Mississippi River. Though they move in various directions, all bend to the southward and are but feeders to the great river which flows from north to south, and forms the principal outlet for the drainage of a vast portion of the continent. Again, it is evident to me that the main channels of drainage were formed by glaciation; but, in many respects, they have been subsequently modified by atmospheric erosion and the abrading force of running water.

The valley of the Ohio River was the southern terminus of the glacier, and its channel was formed by the melting of the ice, and the flow of water which always underlies the ice-bed. As the glacier became less and less powerful, by the dying out of the cause which created and sustained it, the terminal margin withdrew to the north; and wherever there remained undestroyed rock barriers or dams, they gave direction to the waters of the terminal moraines. The course of the Wabash river and its principal tributaries, East and West Forks of White river, as well as the Ohio, owe their main direction to this cause. The undestroyed rock barriers which crop in Adams, Wells, Huntington, Union, and Cass counties, in the northern part of Indiana, turned the waters from the glacial moraine in a course a little south of west nearly across the State. The barrier being more completely removed in Tippecanoe county, the direction trends more to the south until, in Fountain and Warren counties, a more formidable barrier of massive, pebbly sandstone, belonging to the Millstone Grit epoch, which has a north and south trend, turned the river channel from thence to its confluence with the Ohio almost directly south.

It is not my purpose to go into great detail in tracing out the effects of glaciation in modifying the topography of

Indiana and determining its system of drainage, but to throw out these general views on phenomena which elicit so much general interest among the uninformed as well as those who are skilled in geological lore.

While in operation, the glacier was capable of cutingt down mountains and strewing their fragments over its track. It tore up ledges of gold and copper bearing rocks from the Archæan and the Laurentian and Huronian beds, ground them into dust, that was carried forward to the moraines where the glacier terminated. In like manner it transported fragments of palæolozic rocks and fossils, coal from the carboniferous beds of Michigan, trunks and limbs of trees that grew along its shores, and left them in strange places and in inharmonious order in so far as relates to the sequence of the respective objects in geological time.

The large boulders found in all parts of Indiana are mostly granitoid rocks belonging to beds that are nowhere represented in the State, and must have come from beyond her borders.

The greatest deposits of these erratic rocks are to be found in the northern part of the State, but they are not uncommon in all the counties bordering on the Ohio river. In Dearborn and Ohio counties in the southeastern corner, and Gibson county in the southwestern part of the State, there are a great many notable granite boulders. In the latter county the drift material has a variable depth of ten to twenty-five feet or more, mostly sand, clay and small pebbles; but near the line of Posey county, and in what is called the Barrens, there are a number of very large granite boulders, which attracted the attention of William Maclure, one of the very earliest geological explorers in this country, us well as that of his associates and co-laborers in science, Thomas Say and C. A. LeSueur. These able observers made a trip from their home in New Harmony to this locality as early as 1828, in order to study the character of the phenomena. They lie on a level, sandy plain, and there is no crop of any kind of rock for miles around. About fifty miles almost due west of this locality, in Illinois, I found a number of granitic boulders, one of which I estimated to weigh ten to fifteen tons. I also saw a few boulders in Gallatin county, in the same State, by the roadside, going from Shawneetown to Equality. There is a single granite boulder that will weigh several hundred weight lying on the hillside just above the town of Carrsville, in Livingston county, Kentucky, about latitude 37.2. This is the most southerly point I have been able to find granite boulders above reach of river currents.

The most remarkable prolongation of glacial drift southward is seen in Dearborn and Ohio counties, Indiana, and Boone county, Kentucky. In the two first named counties the drift is found in greatest force along the hillsides bordering Laughery creek, resting upon the bluish clay shale beds of the Hudson River group, and one hundred and fifty feet above the bed of the stream. The entire drift deposit is fully fifty feet thick, and is made up of the usual material, stratified clays, sand and gravel, above which there are numbers of massive granitoid boulders. One of these boulders I estimated to contain over one hundred cubic feet.

The lower bed of sand and gravel which rests upon the silurian bluish clay shale contains a portion of gold dust, and gold washing has been carried on here in a small way for some years. When I visited this locality—which is on land once owned by William Gerard, Sr., but now owned by W. H. and J. B. Miller, and situated about one mile a little north of west from Hartford—there was to be seen the ruins of what had been extensive preparations for washing this gold sand in sluice-boxes, but the scheme had fallen through for want of funds and the confidence of those who had at best lent it but a feeble financial support.

Dr. George Sutton, who accompanied me from Aurora, and to whom I am indebted for very many favors, the Hon. Freeman, Dr. J. B. Gerard and several other gentlemen of Hartford, were with me at the time of this examination. While I felt confident that the locality had furnished some gold as represented by the statement of the workmen who were engaged in prospecting, to set all doubts aside, we went to Mr. Miller's house, close by, and had him bring his spade and a tin pan, and try to wash out some gold in our presence. After scraping off a small portion of the surface, a spade full of gravel and sand was thrown into an old pan with coarse holes in the bottom, and the fine material that would pass through the holes was sifted out into the washing-pan. In a few moments Mr. Miller succeeded in separating some particles of gold mixed with a quantity of black, magnetic sand. There is no means of getting water to this place in sufficient quantity and at reasonable cost, but if hydraulic washing could be resorted to it is possible that considerable gold might be washed out. It is not my object, however, in saying this much of the drift gold in the vicinity of Hartford, to excite capitalists to take hold of the property with a view of profitable mining, but to call attention to the fact that gold is found there, and as one of the evidences that the whole deposit has been brought from ancient rock-beds that are not found in places south of the great lakes, and that it is veritable glacial drift. This is not the only spot where gold has been found on this creek. I am told that it has been washed out of the sands on the opposite side of Laughery creek, in Dearborn county, on the farm of Preston Conway. These are important facts, and serve to prepare the minds of those geologists who doubt the extension of glacial drift south of the Ohio river, for the account of its discovery by George Sutton, M. D., in great force in Boone county, Kentucky.

At the Buffalo meeting of the American Association for the Advancement of Science, 1876, Dr. George Sutton, of Aurora, Indiana, read a paper on "Glacial or Ice Deposits in Boone county, Kentucky, of two distinct and widely distant periods."

Dr. Sutton called the attention of the late Dr. John Locke to this drift, and he published an account of it in the *Cincinnati Gazette* in the year 1845. The drift in question is found at two localities and at two elevations—one about seven miles, and nearly east of Hartford, the other from ten to twelve miles and a little south of east. Dr. Sutton is an intelligent observer, whose views are worthy of careful consideration, and I have therefore taken the liberty to reprint this very able paper.

GLACIAL OR ICE DEPOSITS IN BOONE COUNTY, KENTUCKY, OF TWO DISTINCT AND WIDELY DISTANT PERIODS.

[By George Sutton, M. D., of Indiana.]

Upon the most elevated portion of the table-land in Boone county, Kentucky, at an elevation of between 450 and 500 feet above high-water mark of the Ohio river, or about 1,000 feet above the ocean, may be seen extensive accumulations of drift. This drift, in some places, is cemented into firm conglomerate, and caps the highest hills on the north side of Middle creek, and also on each side of Rattling run—a small stream entering Middle creek—presenting perpendicular cliffs, varying from thirty to forty feet in height, making a marked contrast to the general appearance of this section of country, and affording a fine subject for investigation and speculation to the geologist.

Near the mouth of Wolper creek, between five and six miles northwest of this formation, may be seen another deposit of drift, also cemented into conglomerate, which overhangs the creek with perpendicular bluffs. This formation is more than 100 feet in thickness above high-water mark, but between 300 and 400 feet below the deposit of conglomerate on the highlands above Middle creek. The two deposits have received but little attention from geologists. No mention is made of them in the geological reports of Kentucky, and the only notice that I have seen published of the deposits on the highlands above Middle creek, is a brief description by Prof. John Locke in the *Cincinnati Gazette*, in the year 1845. Mr. Robert B. Warder, in the Geological Report of Indiana for 1872, merely directs attention to Split-Rock, opposite the mouth of Laughery creek, as possibly being the terminal moraine of an ancient glacier. Prof. Locke regarded this conglomerate as the evidence of the destruction of a great arch of rocks which united the coal-fields of Ohio with those of Indiana and Kentucky. He says: "The question arises, did this mountain arch ever exist in fact at the place of our city, or, in other words, were the bent layers which are cut off both to the east and to the west, ever complete and continuous? I am of opinion that these layers were continuous, and that causes difficult to be ascertained have swept the upraised layers away, leaving a level country, the surface of which cuts the layers of rocks obliquely and in reverse order both east and west of us." * * * * "What has become of the ruins of these removed layers? I am decidedly of opinion that the conglomerate of Split-Rock exhibits a portion of them, for there we have the layers of blue limestone with its millions of characteristic fossils, forced up, piled chaotically together, and re-cemented in the fantastic heaps in which it was piled by the whirlpools."

We direct attention to these two drift formations, presenting evidence not of the destruction of a great arch of rocks which possibly at one time united the coal-fields of Ohio with those of Indiana, but of the transporting power of ice either by glacial or river action at what appears to me to be two distinct and widely distant periods; both, however, since the formation of the great drainage lines across the continent. The deposits of the one period must have been made prior to the formation of the present Ohio Valley; the other after the river had cut down its channel to nearly its present depth.

It is well known that the surface of the country over all this portion of the *Lower Silurian* formation, was once nearly level, or only slightly undulating, and that the Ohio river and small streams have cut their channels through this table-land to the depth of from 400 to 500 feet.

The altitude above the ocean at the Ohio and Mississippi railroad depot at Aurora is 492 feet. The depot is about ten feet above the high-water mark of the Ohio river, and a few miles to the north of the conglomerate in Kentucky.

The table-land at Milan, about ten miles to the west of Aurora, is 506 feet 10 inches higher, making the highest portion of the country about 1,000 feet above the ocean, and showing the depth of the valleys to be between 400 and 500 feet. The table-land in Kentucky, above Middle creek, is probably the most elevated of any throughout this section of country.

The conglomerate upon the most elevated portion of the table-land may be seen in a retired part of the country about two miles and a half from the mouth of Wolper creek; from this point it may be traced across the country in a southeasterly direction, following the trend of the river hills to Middle creek, where it attains its greatest thickness, varying from 30 to near 100 feet, and at an elevation of about 500 feet above high-water mark in the Ohio river.

On the south side of Middle creek we again find this formation upon the highest portions of the country. It may be traced capping the hills in a southeasterly direction, giving a reddish appearance to the soil, but presenting here more the appearance of uncemented drift, than on the north side of Middle creek. It caps the hills, apparently, along the line of ancient drainage, evidently having been deposited before the river and small streams had worn out their present valleys. But little of this drift is found in the valley of Middle creek; occasionally, on the hill-sides, a piece of conglomerate may be seen that has rolled down from its more elevated position.

The composition of this conglomerate and drift presents a great variety of formations, the silurian, however, predominating. The angles of the fragments are rounded, and every fragment bears the most conclusive evidence of being water-worn. No evidence of stratification can be seen in the perpendicular cliffs; small pebbles and large angular boulders may be seen mingled in confusion and so firmly cemented together that it is difficult, in some places, to break fragments from the main mass.

The conglomerate at the mouth of Wolper creek is about five miles northwest of that seen on the highlands above Middle creek; it presents perpendicular cliffs, and is more than 100 feet in thickness. The perpendicular height in one place that I measured was 73 feet. Above this cliff there was a rise of 20 feet to the highest point, and it probably extended many feet below the soil and rubbish at the bottom, making the deposit at this place at least 100 feet in thickness. Above the mouth of Wolper creek a large mass of this conglomerate has been undermined by the river, and slid off from the main body, making a narrow chasm of several hundred feet in length, and from five to six feet in breadth; this point is known as *Split-Rock*. On one side of this chasm we measured a perpendicular height of 72 feet, and above this conglomerate there is at least 20 feet more of drift and soil. How much below the rubbish at the bottom of this chasm the conglomerate extends, we do not know, but it is below high-water mark.

The conglomerate, like that on the highlands, is composed of a great variety of formations; fragments varying from the finest sand, to several hundred pounds in weight, intermingled in every state of confusion.

Large boulders of granite may be seen imbedded and cemented along the perpendicular wall 60 feet above high-water mark—showing that there must have been a transporting power much greater than water alone to have piled up these masses of stone to such an elevation. They show, also, that when this conglomerate was deposited, the Ohio river must have had a much greater volume of water than it has been known to have during our highest freshets within the last 80 years, or since the country has been settled.

This accumulation of conglomerate is between one and two miles in length, and in some places nearly a mile in breadth. It blends with a stratified and also an undulating terrace formation, which is six or seven miles in length along the river and in some places more than a mile in breadth.

When we stand upon the most elevated portion of the cliff overhanging the mouth of Wolper creek, and look over the undulating cultivated fields back to the river-hills which rise 300 feet above the terrace formation, and bear in mind that on the top of these hills is the conglomerate to which we first directed your attention, the conclusion seems to me to be irresistible that these two deposits of conglomerate were made at widely distant periods. The one dating back to a period *prior* to the formation of our valleys, the *other after* the river had cut down its channel 450 feet below this table-land. The antiquity of the one is seen most clearly where it caps the hills on each side of Middle creek, and, also, on each side of Rattling run, showing that the deposit of the one *must* have preceded that of the other by the length of time which it took to form the Ohio valley and the valleys of its tributaries.

Such, briefly, are some of the facts which may be seen by a visit to this section of country.

The question arises, how came this accumulation of drift at these points? When we look at the map of this part of the country, we see that the Great Miami, and the White Water rivers running from the north, empty into the Ohio valley near this point.

Here, also, we find that the river makes a sudden bend to the southeast, forming the western angle of the great *North Bend* in the Ohio river. A line drawn from the White Water and Miami valleys across this acute angle, intersects the conglomerate at Wolper creek. Along this line behind the hills to the east of Petersburgh, Kentucky, may be seen *an ancient valley* which the Ohio river has long since abandoned. This valley is between three and four miles in length, and from one-fourth to one-half a mile in breadth. It was evidently cut down through the strata of rocks, and shows that at one time here was an extensive island, not formed by the accumulation of drift or sediment, as most of the islands in the Ohio river now are, but an island made by the river eroding out two channels through the strata of the silurian formation. It is now above the highest floods of the Ohio river, is extremely fertile, and is cultivated throughout the whole length. Wells sunk in it pass through loam, sand and gravel similar to what we find in our low bottom-lands.

Along the White Water and Miami valleys we see accumulations of drift. We are told in the Geological Reports of Ohio, that the drift formation is traced across the State of Ohio from Ashtabula to Dayton. It is seen in large quantities near the mouth of White Water, and its outlet to the south and southwest was the mouth of the Miami valley. Now, if we imagine a time when there was a vast accumulation of ice at the junction of these streams—this ice principally brought down from the north through the Miami and White Water valleys—the ancient drainage lines probably valley glaciers—this ice meeting the ice in the Ohio, and forming an enormous ice gorge at this point, grinding along the eastern bank of the Ohio river, and piling up in confusion sand, gravel, and boulders—it seems to me we have an explanation for the accumulation of the drift found near the mouth of Wolper creek.

The sudden bend in the Ohio river and the narrow valley just below the bend probably produced ice obstructions in an ancient day just as we see ice obstructions produced at this portion of the river at the present time. It is also probable that at some remote period the ice obstructions turned a part of the volume of water across this acute angle in the river and formed the cut-off or ancient valley seen beyond the hills east of Petersburgh.

On the Indiana side of the river, we again find the drift near the river hills between two and three miles above Rising Sun, or nearly opposite Laughery Island, and at about the same height as the river terrace formation in Kentucky.

We also find near the mouth of Hogan creek, and extending back from the river along the valley of this creek to the town of Cochran, another terrace formation which is nearly of the same height as the terrace on the opposite side of the river in Kentucky. From an excavation made for a turnpike, and also in excavations made for the O. & M. R. R., we see that this terrace, unlike the terrace in Kentucky, is almost entirely composed of laminated clay and loam; scarcely any gravel can be seen. It is away from the current of the Ohio river and was evidently formed by the deposits of sediment in the back water during ancient floods or freshets of the Ohio river, just as deposits are left after the freshets at the present time on the lowlands back from the river. But it is difficult to account for the thickness of this terrace, rising as it does from a level of the bed of the river to nearly fifty feet above high water mark, unless we adopt the theory that there were at one time floods in the Ohio river far greater than any known since the country has been settled, a view which would be in accordance with the theory of the melting of a great continental glacier.

The accumulation of drift on the highlands above Middle creek were probably produced by causes similar to those that made the deposits in the valley, but at a far more ancient period. We can imagine how ice borne down from the north along the ancient drainage lines of the White Water and Miami rivers, and meeting the ice in the Ohio at this bend, would crowd it on to the south side of the then shallow valley, and leave deposits; the same which we now see, and which have so effectually resisted the decomposing effects of time.

In attempting to account for the formation of these deposits it is not necessary to allude to the changes that may possibly have taken place at different periods in the elevation or depression of portions of the continent. The same great drainage lines now seen in this part of our country must have continued from the time the river first began to erode out its present valley, and in this long series of years changes of climate have taken place, and the conglomerate to which we now direct your attention is evidence, we believe, to sustain the theory that ice has brought down from the north boulders and drift at two distinct and widely distant periods.

Dr. Sutton was kind enough to take me in his carriage to see the drift deposits mentioned in this paper, and after an examination of the locality, I am inclined to agree with him in most of his views regarding their origin. The drift breccia is composed for the most part of large, more or less, rounded boulders of Hudson River rocks, readily recognized by their fossils, and a smaller portion of metamorphic and crystalline rocks. They are cemented together and form a coarse, conglomerate or brecciated mass, one hundred feet or more in thickness. The difference in the elevation of the drift at the mouth of Wolper creek, and that on Rattling run and Middle creek, may be accounted for in this way:

When the glacier pushed its way from the frigid regions at the north to the southward, it moved over the surface of the land, impelled by gravity, and was only stopped by reaching a climate where the ice was melted, and at that point the debris would be dropped, as the sediment of the Mississippi is deposited in the Gulf of Mexico. The direction of the glacier, as indicated by the topography of the country, was from north to south, or nearly so, and the surface over which it moved in Ohio and Indiana was then as high, if not higher, than the point where it terminated.

The drift, then, on Rattling run and Middle creek, in Boone county, Kentucky, represents the terminal moraine of the earliest life of the prolonged glacier. As it cut down its bed and diminished in force—which it may have done rapidly in the soft, shaly beds of silurian rocks over which the main gorge of ice, that formed these beds, was passing in Ohio and Indiana—another moraine, on a lower level, was formed at the mouth of Wolper creek. The glacier, then, which formed these drift beds, when it tore away the silurian rocks, left two long and narrow valleys in Ohio and Indiana, separated from one another by an elevated ridge. This ridge was capped with Niagara limestone, and lay along the boundary line of the two States. The two glacial currents came together at the mouth of the Big Miami river, and the valleys which they eroded are those through which the Big Miami and White Water rivers flow.

These two rivers now unite their waters just before they debouch into the Ohio. Near the present mouth of the Big Miami there is abundant evidence that the Ohio river at one time had its channel to the east of its present bed, and almost in a straight line south to the mouth of Wolper creek. This channel was probably due to the abrading force of the combined waters of Big Miami and White

Water rivers, at a time when their currents were powerful enough to turn the Ohio almost at right angles to its present course; or at a still earlier period, when the glaciers were in action. A deposit of drift near the head of the old river-bed, and the large deposit near its mouth, at Wolper creek, would leave us to refer it to glaciation.

It is not possible to measure, by years, the time that glaciers remained in action over the States south of and bordering on the lakes, but it must have been a period of very great duration. The area, however, which it covered was slowly diminished, as the temperature of the continent became less frigid, and the southern margin was finally withdrawn to the Arctic regions. Strictly speaking then, it would not be amiss to say that the drift on Rattling run was formed before that at Wolper creek; but, in my opinion they can not be referred to distinct glacial epochs any more than the drift in Marion county can be referred to a different epoch from the drift in Laporte county, in the north part of the State.

During this remarkable ice period, though the entire State of Indiana for the greater part of the season was covered by a vast sheet of ice, this ice field was not of uniform depth and force, since the physical features of the State must have been much more strongly marked than at the present time. The prevalent mountain chains would direct it into river-like channels, and it is along the shores of these ancient rivers of ice that we find lines of stranded boulders, like drift wood left by freshets on the banks of streams, and at a greater elevation than the finer sedimentary matter. The boulders and gold bearing drift on Laughery creek, near Hartford, lies about two hundred feet above the drift on Wolper creek, and is about two hundred feet lower than the deposits on Rattling run. There are a number of localities in Indiana, besides these mentioned, where gold is found in glacial drift, but the most noted and best known are in Morgan and Brown counties. In the latter county gold was washed from the drift sands in the valleys of most of the streams flowing into Bean Blossom creek at a very early day, and the county has been the scene of numerous mining excitements within the last forty years. Its geological position was well studied by the first State Geologist, the late Dr. David Dale Owen, and as early as 1837 he cautioned the public against expending large sums of money in mining adventures, since the gold had been brought from the metalliferous veins which have their existence north of the lakes.

The gold bearing quartz torn from these northern lodes by the ice was reduced to fine dust by the grinding motions of the glacier, and in this condition, along with some larger fragments of erratic rocks, it was borne along until finally deposited by the melting of the ice in lower latitudes. In this way also the fine particles of gold were set free from the rock matrix. Under such circumstances the gold must be widely scattered and require a large expenditure of time and money to collect it. According to Prof. Collett (6th Rep. 1874, p. 108,) there had been taken altogether from the drift of Brown county not to exceed ten thousand dollars worth of gold dust.

There has also been found in the drift of Brown county several diamonds, one of which weighed four carats. On Little Indian creek, in Morgan county, Mr. J. J. Maxwell found, some ten years ago, a diamond which weighed three carats. These are interesting facts, and point to the existence of a true diamond field somewhere in the beds of crystalline rocks to the north. I have had no opportunity to examine the diamonds that have been taken from the drift, but learn that they were pronounced upon by competent critics and dealers. Some of the corundum gems approach the diamond so closely in hardness and physical features, when not in perfect crystals, and being usually found in the beds of streams among the debris of crystalline rocks, might, without a direct test, be readily mistaken for diamonds.

From the very nature of things, as already set forth, it will be found an unprofitable business to search for diamonds within the bounds of this State.

Some large pieces and many particles of native copper have been found in the drift, both in the northern and southern part of the State; also fragments of galena, sulphuret of lead. In the northern counties it is not uncommon to find pieces of bituminous coal, and it has been the means of leading many parties to believe that beds of coal could be found in the vicinity of the streams where the samples were picked up.

In Daviess county the drift rests immediately on the carboniferous beds, and contains, locally, fragments of Hudson river limestone and well-preserved fossil shells of the same age. The most abundant fossils are: *Orthis occidentalis; O. lynx; Rhynchonella capax,* and *Strophomena alternata.* There is a bed of block coal not more than ten feet below the drift in which we find these disintegrated and worn fragments of strata that in geological order belong more than two thousand feet below the coal beds. We must expect, then, to encounter in the drift resting upon the rocks of Indiana, no matter what their age, portions of all the formations that lie to the northward of the locality, with their mineral and organic components. So far as we have any knowledge, the drift has furnished in Indiana no rocks or strata newer than the coal. The limbs and trunks of trees that are found imbedded in the blue clay at the base of the drift are of Alpine species, pines and cedars. They were torn from their mountain home by the ice, and drifted with the mud beyond the moraines until quietly deposited in some protected basin. Indeed, the general character of the drift differs but little in its lithological features, or in the order in which the clay, sand and gravel and coarse particles are arranged in alternating beds, either in Indiana, Ohio or Illinois, a feature that is due to a common cause and common origin.

While the drift is not likely to furnish any amount of precious metals it has been invaluable in furnishing gravel for road-making, clay for potteries and brick-makers, and is the source of the principal supply of potable water. At Indianapolis the drift varies from seventy to ninety feet in depth, and is built up of alternate beds of sand, gravel and compact clay, in the following order:

Surface, clay and gravel.
Sand, with water, 1st seam.
Blue compact clay.
Gravel and sand, with water, 2d seam.
Blue compact clay.
Gravel and sand, with water, 3d seam.
Devonian limestone.

The first seam of water is usually found at a depth of 18 to 22 feet; the second seam at 30 to 40 feet; and the third seam at 70 to 90 feet.

These various strata of water have the same fountain source, since they rise to about the same level when tubed.

They are all what is called "hard water." The first seam, reached at 18 to 22 feet below the surface of the city, contains the largest amount of mineral water—principally calcium carbonate, magnesium carbonate, chlorides, and ferrous sulphate. The amount of chlorine is so large that its presence is, in a great measure, due to sewage contaminations. The second seam of water contains but little chlorides, but has about the same amount of calcic and magnesic carbonates as the first. It is a good potable water, when properly protected from contaminations from the upper seam, but is too hard for domestic and steam purposes. The third seam of water is also a hard water—that is, its salts will decompose a portion of soap and form a curd; but it contains less carbonates and more sulphates of the alkaline earths, lime and magnesia. This renders it decidedly preferable for steam-boilers, since the magnesium sulphate is remarkably soluble in water, and the calcium sulphate, in connection with the former, seems to prevent the formation of scales in the boiler. In other words, the scales in boilers is formed by the deposit of calcium and magnesium carbonates, that were previously held in solution by an excess of carbonic acid; the latter is driven off by heat.

CHAMPLAIN PERIOD.

Following the drift there is, in Indiana, a local deposit of lacustril sediment, called Loess. It is a fine-grained, friable, yellowish, buff-colored material, containing a considerable amount of carbonate of lime. In places where it abounds it has also received the name of marl. The Loess is only found along the lower portion of the Wabash, East fork and West fork of White river, and in the counties bordering the Ohio river, and capping the bluffs of that stream, from Crawford county to the mouth of the Wabash river. I have not observed the Loess along the Wabash river farther north than Parke and Vermillion counties—that is, any deposit assuming the physical features of this material, as above described. Usually, it contains a large number of shells, of land and pond mollusca. The land shells are such as live on the borders of ponds and in quite moist places, such as the following named genera and species, found mostly in the Loess along the Wabash river, at New Harmony, in Posey county:

Macrocyclas concava, Say; *Zonites arboreus*, Say; *Hyalina indentata*, Say; *Patula perspectiva*, Say; *Helicodiscus lineatus*, Say; *Pupa armifera*, Say; *P. fallax*, Say; *Strobila labrynthica*, Say; *Stenotrema hirsuta*, Say; *S. monodon*, Rack.; *S. monodon var. fraterna*, Say; *Vallonia pulchella*, Muell.; *Succinea avara*, Say; *Valvata tricarinata*, Say; *Pomatiopsis lapidaria*, Say; *Helicina occulta*, Say.

The last named is extinct in Indiana, and almost so in the United States, being found in limited numbers in a few localities only. All the others are still found living in the State.

The elevation of the Loess in Parke county is about seven hundred feet above the ocean, and in Crawford and Perry counties, on the Ohio, it is about the same, or five hundred feet below the highest table-land in the State, near the head waters of the Wabash river and its main tributaries. From this elevation there is a gradual fall to the mouth of the Wabash, where the deposit is not more than four hundred feet above ocean level. The Loess or "Bluff" formation, as defined above, is not found at any considerable distance inland from the immediate high bluffs bordering the above streams. This fact leads to the conclusion that it is the sedimentary deposit of shallow lakes or ponds that were left along the lateral borders of the glacier after it had cut the deeper channel forming the present beds of the streams. On sandy soils the Loess marl is used advantageously as a fertilizer; it is especially good for wheat and corn.

ANTIQUITIES.

The high bluffs and second bottoms along the Ohio river, and those of its principal tributaries in the southern part of the State, were famous places of resort for the ancient race of people known as Mound-builders.

The following map and diagrams are reduced copies of a most elegantly executed map of Lawrenceburg and its surroundings, made and presented to the Indiana Archæological Society by Mr. Samuel Morrison, C. E., of Indianapolis. Mr. Morrison is one of the oldest and best informed civil engineers in the west, and has stored up a vast amount of useful material in regard to the true boundary lines of streams and the location of errors incidental to the running of the township and section lines.

Plate G* shows the location of two remarkable earthwork enclosures, named on the map, pre-historic forts. One of these works is shown, enlarged, on Plate H.† This fort is situated in Hamilton county, Ohio, a short distance from the Indiana boundary line. It is on the last hill between the Ohio and Great Miami rivers, and on land belonging to the heirs of the late President, General William Henry Harrison. The hill is 200 feet high. The area enclosed contains about twelve acres. It has an open space called a gateway, and two projecting narrow arms called bastions by Mr. Morrison. The table-land within the enclosure is about ten to twenty feet higher than the walls, which appear to be of material scooped from the brow of the hill. The situation of this work is admirably chosen to command a view of the extensive level bottom lands which surround it and render the inmates secure against sudden surprise. The wall is followed by a ditch on the inside.

*See page 123. †See page 125.

Plate I* gives an enlarged plan of the ancient fort on the hill north of Hardensburg, in Dearborn county, Indiana. The wall is four feet high in places, and is partly constructed of loose stones and partly of earth. There are two gateways on the north end, formed by an earthwork that is nearly circular. The hill is nearly 200 feet high, and as at the former fort, commands an extensive view over the country around. On the ridge leading to the northeast and northwest there are eight mounds. There is also a mound on the hill to the south, and two close to the road leading from Lawrenceburg to Hardensburg. There is also a mound northeast of Lawrenceburg, near the track of the Ohio and Mississippi railroad. All these mounds are shown on Plate G, page 123.

There are a number of mounds in the vicinity of Aurora, and quite a large mound was within the city limits, but has been almost entirely removed by cutting a street-way through it. Dr. George Sutton, of Aurora, has a large and interesting collection of ancient stone implements, which he collected from this county and from Kentucky. Dr. Sutton has visited many times the ancient forts mentioned above, and was kind enough to point out their locations to me, as well as that of the mound in the city of Aurora.

J. B. Gerard, M. D., in connection with others, opened a mound near the mouth of Laughery creek, in Ohio county, which was about 100 feet in diameter and 15 feet high; excavations were made at several places, and they found human bones, one whole earthen pot, and a great many fragments of pottery. Mr. Stratton also found a whole pot in this mound, and still another was found by H. C. Miller. Dr. Gerard has noticed from twenty to thirty mounds along the bluffs of Laughery creek, and has opened a number of others, but found nothing of note except ashes, which lay at the base of them all. At Hartford I had the pleasure of

* See page 125.

For description of plate, see page 121.

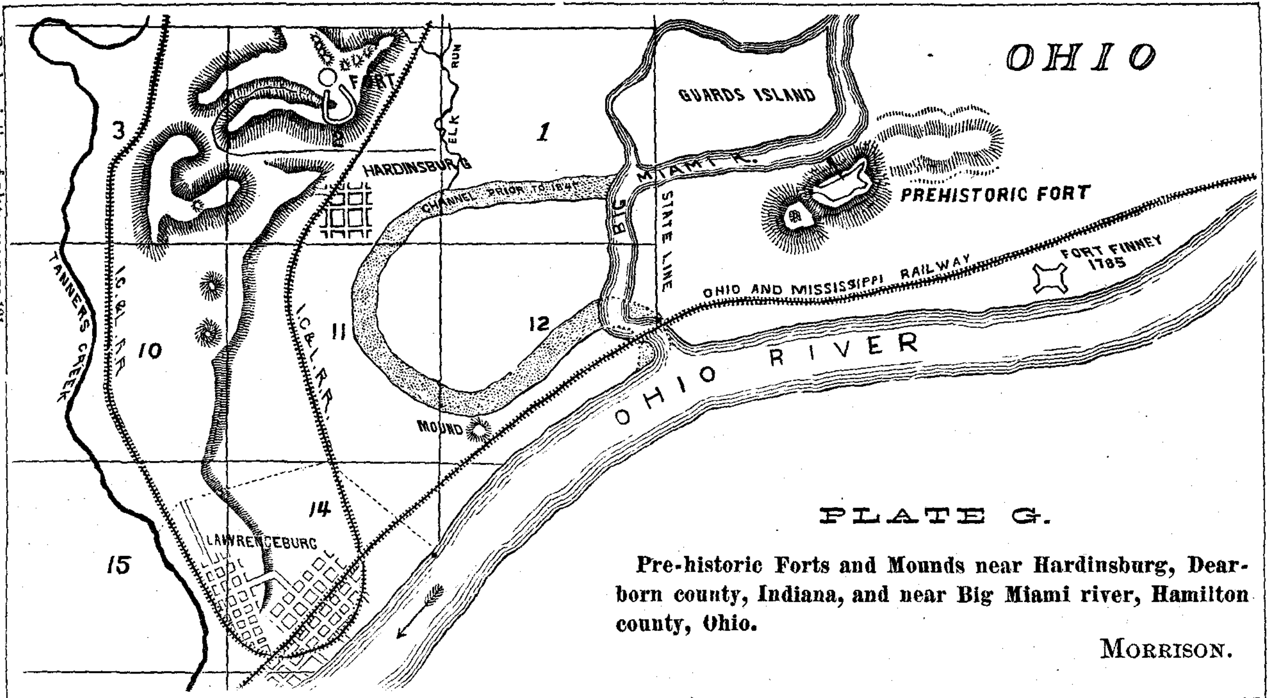


PLATE G.

Pre-historic Forts and Mounds near Hardinsburg, Dearborn county, Indiana, and near Big Miami river, Hamilton county, Ohio.

MORRISON.

seeing the admirable collection of archæological objects, collected principally from this locality by Rev. C. W. Lee. They are well arranged in a case, and among them are several rare and interesting specimens. Mr. Lee is an enthusiastic collector, and, I understand, has added many things to his cabinet since I saw it.

Going down the Ohio river to the mouth of the Wabash river there are a great many mounds and earthworks of small magnitude. One of the most remarkable works south of those mentioned above is called the "Stone Fort;" it is on a hill at the mouth of Fourteen-mile creek, in Clark county, and is figured and described in the Geological Rep. Ind., 1873.

Dr. Blunt, of Mt. Vernon, Ind., has made a very large collection of ancient relics from the mounds of Posey county. He has also a very large collection of pottery from the "Bone Bank," on the east bank of the Wabash river. This famous locality was first mentioned by Arthur Henrie, who surveyed and subdivided into sections that part of Indiana called the "Pocket," which lies between the Ohio and Wabash rivers. In his journal of this survey it is noted that in meandering the Wabash river he discovered in one place, on the left bank of the stream, numerous human bones, indicating the place of a very ancient cemetery*

The "Bone Bank" is figured in the Indiana Geological Report of 1873 from a sketch made by Dr. G. M. Levette. The bluff forming this bank is only a few feet above high water mark, and is the only spot for many miles around that is not submerged in time of very high freshets. Hundreds of earthenware pots, made from a mixture of pulverized mussel shells and common clay, such as may be seen in the river bank, have been found at this locality, washed out

*This information was obtained from Samuel Morrison's historical sketch of Posey county.

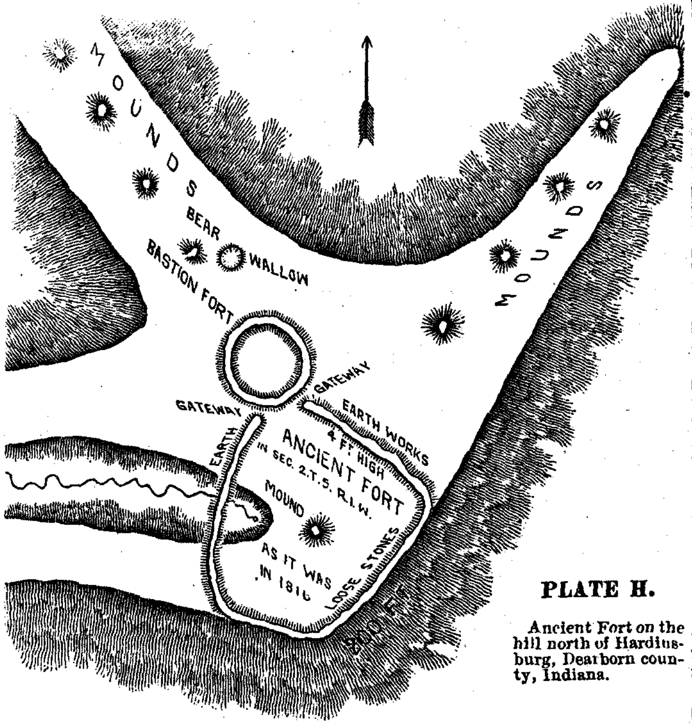


PLATE H.

Ancient Fort on the hill north of Hardinsburg, Dearborn county, Indiana.

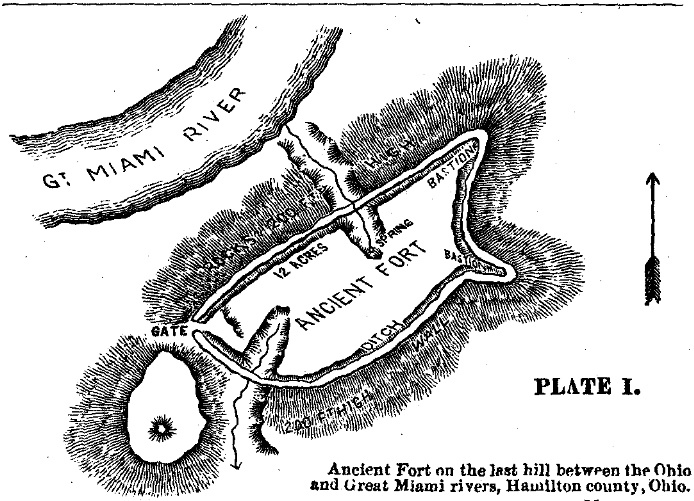


PLATE I.

Ancient Fort on the last hill between the Ohio and Great Miami rivers, Hamilton county, Ohio.

MORRISON.

For description of plates, see pages 121 and 122.

by the river, which has been cutting away the river bank ever since the occupancy of the country by the whites. Many of the pots from this locality are of unique forms and ornamented with the heads of animals, birds and human beings. I have a jug found at the "Bone Bank" which has a neck supporting an admirably formed human head, and the ears are pierced with holes, indicative of the custom of wearing pendant ornaments of some kind.

Mr. Joseph Reeves, a farmer, whose residence is on the southern and higher end of the "Bone Bank," states that he rarely digs a post hole or makes any other excavation of equal depth without exposing human bones or pottery. Mr. Reeves' kitchen garden is on this bank, and, according to his statement, every spade full of earth turned up in preparing and working it shows fragments of ancient pottery. It is to be regretted that the river floods are cutting this historic spot away so rapidly that the last fragment of pottery may disappear in less than a half century.

Bordering the Wabash river on both sides, from its mouth to Fountain county, mounds are found on all the second bottoms and on all the prominent ridges facing the stream; they are particularly numerous in the vicinity of New Harmony, sixty miles above the mouth of the Wabash. The town, which is situated on the sandy and gravelly, second bottom of the river, occupies the site of an immense group of mounds. A number of small ones are still to be seen in the German burying ground, and a large one still remains in the yard at the residence of the late R. H. Fauntleroy. The eminent naturalist, C. A. LeSueur, of New Harmony, was the first to make mention of mounds in this State. In connection with Thomas Say he opened some mounds on the top of a hill facing the Cut-off, near the town, and described the cists and articles found and the position of the human skeletons which they contained. He also published an account of the large shell heap which is seen on the top of a short ridge near the above mounds. This shell heap ("kitchen midden") is about three hundred yards from the Cut-off, an arm of the Wabash at New Harmony, and covers to the depth of thirty feet, about one-half an acre of the top of one of the highest hills in the county—one hundred and seventy-five feet above the stream. It is composed of the shells of a great many species of mollusca, such as are now living in the river; only a few bones of animals, all belonging to indigenous species, are found, and, judging from the size of the bed, mollusca must have formed an important, if not predominant, part of their food. These mounds and shell heap are mentioned by Prince Maximillian in his travels in North America. Prince Maximillian visited New Harmony in 1835 and 1836, and spent some months there in making collections of birds and mammals. Sir Charles Lyell also visited this locality on his second journey to the United States, and makes mention of it in his "Second Visit to America." Mr. James Sampson, of New Harmony, has a very large collection of antiquities, collected from the mounds in his neighborhood. Mr. Lycurgus Chaffen, of the above place, has also collected a great many interesting relics; among them is a very peculiar shaped plummet, made of native copper, that he presented to the State collection. The next most important locality for mounds along the Wabash, in this State, is in Knox county. In the vicinity of Vincennes there are several of unusual size, being the largest yet found in the State. These mounds were carefully studied and described by Prof. Collett in the Indiana Geological Report of 1873. At Merom, in Sullivan county, there is a broad area of high table-land bordering the Wabash, which appears to have afforded the Mound-builders an admirable site for the display of their peculiar genius in laying out walled enclosures. The works here were all described under the name of Fort Azatlan by Prof. Collett in his report on Sullivan county, Geological Report of Indiana, 1870. Dr. B. F. Harper, of Merom, opened several mounds at "Azatlan." In one he found a number of human skulls, which have been loaned to the State museum. I visited this locality in company with Professors F. W. Putnam, Caleb Cooke and James Emerton, of Salem, Massachusetts, Prof. John Collett and a number of the citizens of Merom, for the purpose of making a careful exploration of the mounds. Though a number were opened here and in the neighborhood, nothing of note was found except one skull, which Prof. Putnam thought to be typical of the mound-building race.

There are a number of mounds in Vigo and Vermillion counties, but no antiquties of any note have been discovered within the State farther up the Wabash.

The second bottoms and bluffs along White river and its East fork are well studded with mounds. When grading for the Indianapolis & Vincennes railroad, at Edwardsport, a large shell heap (kitchen refuse pile) was cut through, but so far it has afforded no relics of interest.

Mounds are abundant in Greene, Owen, and Morgan counties. In the latter county they have furnished a great many interesting relics. A number of mounds at one time existed within the city limits of Indianapolis, but they have given way to the changes required by the growth and development of the city. Mr. Daniel Hough, formerly of Indianapolis, now of Ann Arbor, Mich., has one of the largest archæological collections in the Western States. It comprises implements and relics from all parts of the Union.

Besides mounds, there are a number of circular earthwork enclosures in Hamilton and Tipton counties. The principal works in Tipton county are close to Strawtown, and in a cultivated field. The largest is a circle, with an open gateway on one side. It has been so badly obliterated by the plow that I was unable to make a complete survey of it, especially as the field was covered with a heavy crop of corn at the time of my visit. Enough was left to show that it was several hundred feet in diameter, and had a ditch or fosse on the outside—being singular in this respect, as all other works in the State of which I have any knowledge have the ditch on the inside of the wall. Judge Overman, of Tipton, has made a large collection of Mound-builders' relics, principally from his own and the surrounding counties.

By far the most unique and well preserved earthworks in this State are on the banks of White river, in Madison county, about three miles from Anderson, the county seat. See plates E and F. The principal work in a group of eight, shown on plate E,* is a circular embankment with a deep ditch on the inside. The central area is one hundred and thirty-eight feet in diameter, and contains a mound in the center four feet high and thirty feet in diameter. There is a slight depression between the mound and the ditch. The gateway is thirty feet wide. Carriages may enter at the gateway and drive around the mound, as the ditch terminates on each side of the gateway. The ditch is sixty feet wide and ten and a half feet deep; the embankment is sixty-three feet wide at the base and nine feet high, and the entire diameter of the circle is three hundred and eighty-four feet.

When I first visited these works, which go by the name of the "Mounds," there was growing upon the embankment a great many large forest trees, from one foot to four feet in diameter. Several large walnut trees have since been cut off; with that exception the work still remains covered with a growth in no respect differing from the adjoining forest,

*See page 131.

and the embankment and ditch are in as good a state of preservation as when abandoned by the builders.

Fig. B is 238 feet S. 30° E. of the center of A, is 33 feet across and has two gateways; the bank is two and a half feet high and has no ditch.

Fig. C is 710 feet S. 20° W. from the center of A, is 100 feet in diameter, has a bank which shows in the woods two feet high, and a gate ten feet wide. The public road runs through this circle, and has obliterated the greater part.

Fig. D is 475 feet S. 39° W. from center of A, is 126 feet in diameter, has a bank two and a half feet high, with a slight ditch on the inside; the central area is fifty feet in diameter, and the entrance-way fifteen feet across.

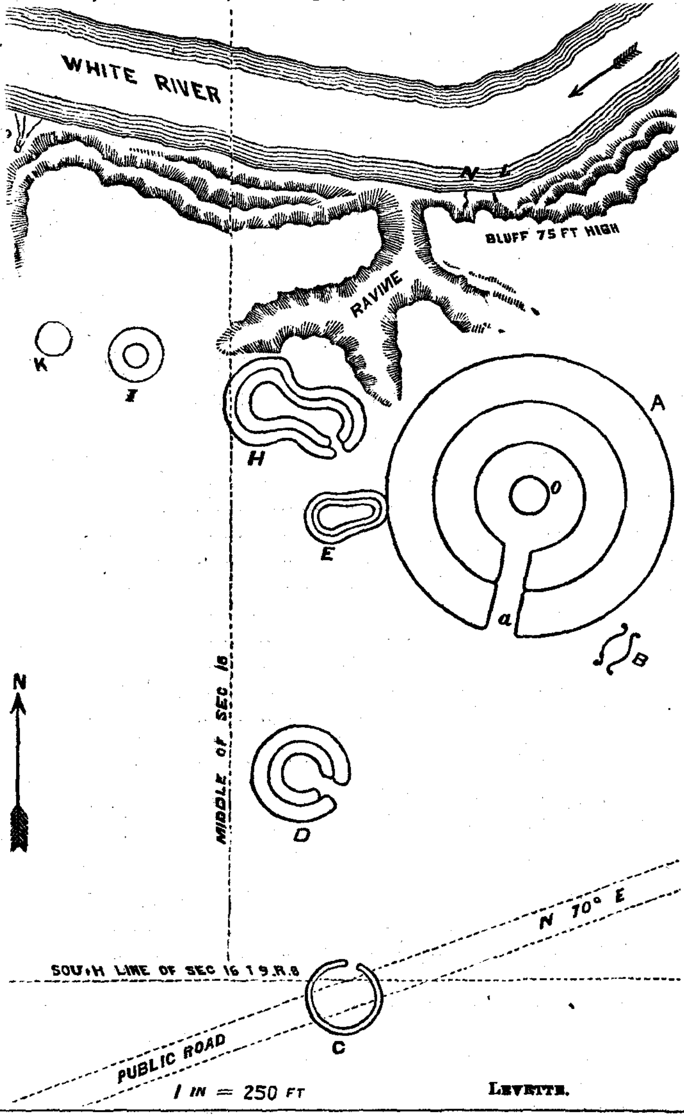
Fig. E is 245 feet S. 84° W. from center of A; extreme length 106 feet; thirty-six feet across the widest part, thirty-three feet across the narrow end, and twenty-seven feet across the constricted part of the figure; has a slight ditch on the inside of the embankment, which is from 0 to 2 feet high; no visible gateway or entrance.

Fig. H is 325 feet N. 70° W. of center of A; has an extreme length of 181 feet; is 122 feet across the wider end, 115 feet across the narrow end, and fifty-seven feet across the constricted part; the central area is ninety-five feet long, and has a varying width of from ten to thirty feet; the wall is from one to six feet high, with a ditch on the inside—now partly filled but still plainly visible; evidences of a small mound on the western end of the central area are still traceable.

Fig. I is 552 feet N. 70° W. from the center of the large circle A; it is a plain circular embankment thirty-six feet in diameter, with a wall two and a half feet high; with no visible ditch or entrance-gate; near the center is a slight mound, thirteen feet in diameter.

PLATE E.

Groupe of ancient earthworks near Anderson, Madison county, Indiana, on section 16, township 9, range 8. 1 inch=250 feet.



For description of plate see page 129.

Fig. K is 662 feet N. 71° W. of the center of A; it is a plain circle, with wall two feet high; no ditch or central mound.

These interesting works are located on the south side of White river, on a bluff seventy-five feet above the water. At the base of this bluff—which is composed of gravel, sand, and clay—there are several bold, running springs of chalybeate water. As this water possesses valuable hygienic properties, the analysis is here given:

ANALYSIS OF WATER FROM SPRING AT THE "MOUNDS," NEAR ANDERSON, INDIANA.

Bold, running spring; cold and clear; strong inky taste; bubbles up through sand; no appearance of escaping gases; decidedly alkaline reaction.

	Grains in an Imperial Galon.
Insoluble silicates	1.6580
Oxide of iron	.7287
Lime	8.1610
Alumina	trace
Magnesia	trace
Sulphuric acid	2.7500
Carbonic acid, combined	7.1070
Iodine	trace
Alkalies	trace
Loss and undetermined	3.5953
Total in one gallon	24.0000

	Per Cent.
Total gas in an imperial gallon	13.580
Free carbonic acid	6.473

The above constitutents are probably combined as follows:

Bicarbonate of lime	10.898
Carbonate of protoxide of iron	1.177
Sulphate of lime	6.672
Insoluble silicates	1.658
Magnesia	trace
Alumina	trace
Alkalies	trace
Iodine	trace
Loss and undetermined	3.595
Total	24.000

This is a very pure calcic chalybeate water, a fine tonic and alterative, and is admirable for persons laboring under general debility and dyspepsia.

The location is all that could be desired for a watering-place and resort for health. The antiquities will furnish a never-ending interest to those who like to study the works of past generations of men.

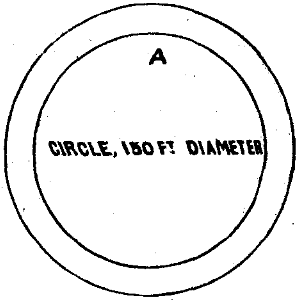
On the same section of land, but half a mile farther up the river, and on the same side of the stream, there is another cluster of earthworks that are of nearly equal interest; in fact, the principal work A, on plate K*, is, in some respects, more remarkable than the large circle on plate E. The outline is of irregular shape—constricted on one end and at the sides; at the other end there is a gateway (D) nine feet wide, protected by two small mounds (B and C), now about four feet high. The wall is thirty to thirty-five feet wide at the base, and about four feet high; ditch eight feet wide. A central line through the longer way is N. 67° E. and 296 feet long; it is 160 feet across at the widest and 150 feet across at the narrowest part—near the middle. With the exception of the two mounds at the gateway, which lie on the cultivated side of a section fence, and have been cut down by the plow, the remainder of this antiquity is in as good state of preservation as when deserted by its original occupants. Large trees are growing over it, and the underbush is so thick that it was difficult to obtain accurate measurements; in fact, there is hardly a stick of timber amiss over the ruins.

The works represented on plate F† are near that last described. A is a plain circle, 150 feet in diameter; it lies in a cultivated field, and is being fast obliterated. B, on the same plate, is in a tolerable state of preservation; its longer diameter is 106 feet, and forty-eight feet across either end and is slightly constricted at the middle; wall about two

*See page 135. †See page 135.

feet high; ditch on the inside fifteen feet wide; gateway (c) is fifteen wide. The part on the east side of the section line lies in a woods, and is very well preserved. On the west side of the fence the land is cultivated, and the embankment is fast being destroyed. These works, with that on plate K, are close to the bluff of the river, which is here also composed of glacial drift, and is seventy-five feet above the water.

The largest walled enclosure in the State is situated near the town of Winchester, in Randolph county. It is figured in Squier and Davis' Antiquities of the Mississippi Valley, but as that plat was inaccurately made it is reproduced here, page 137, from actual measurements made by Dr. G. M. Levette. It contains thirty-one acres, and a good portion of it lies within the boundary of the Randolph county fair ground, the remaining portion, with the exception of the public roadway on the west end, lies in cultivated fields, so that the whole work is in a fair way to be obliterated. There are two gateways, one on the eastern end, twelve feet wide, and has no defenses, Sugar creek and the intervening bluff probably being deemed sufficient, but at the west end there is an embankment in the shape of a half circle which overlaps the gate and complicates the passage-way. The enclosure is in the shape of a parallelogram with curved angles; the sides are 1,320 feet long, and the ends 1,080 feet. There is a mound in the centre 100 feet in diameter and nine feet high. When the horses are trotting, at fair times, this mound is covered with spectators, as it commands a view of the entire track. I once had the pleasure of witnessing a spirited trot from the top of this mound. The walls of the enclosure are from eight to nine feet high where they have not been disturbed by the plow. A cross-section of the half-circle at the west gate is shown on the plate; it has a slight ditch on the inside, also a cross-section of the main



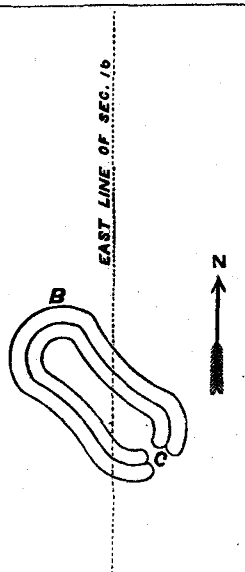


PLATE F.

Ancient earthworks on northeast corner section 16, township 9, range 8, near Anderson, Madison county, Ind.

1 inch=150 feet.

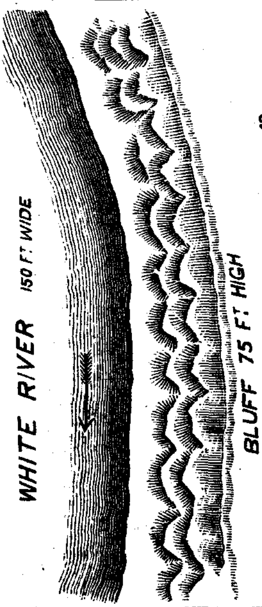
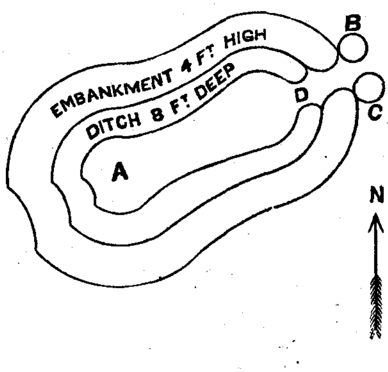


PLATE K.

Ancient earthwork on section 16, township 9, north range 8, near Anderson, Ind.

1 inch=150 feet.



wall which has no fosse. You will perceive that the location for this large and remarkable work was selected with due regard to protection against the sudden attack of an enemy. It is at the junction of Sugar creek and White river, which affords protection on two sides, and the mound in the centre served as a look-out station.

Mounds are found in all the northern counties, along the streams and on the borders of small lakes, and Lake Michigan.

Dr. T. S. Arthur, of Portland, Jay county, has been actively engaged for some years in collecting archæological relics, and his collection is now very large, and comprises many objects of special interest. Colonel R. S. Robertson, of Fort Wayne, is an active member of the State Archæological Society; he has a choice collection of relics and a valuable library of works on pre-historic races. J. Wes. McBride, of Waterloo, and G. C. Glatte, of Kendallville, are also enthusiastic collectors of relics, and each has his well-filled cabinet. Mr. Cheshire, of Lake county, has made a collection of mound relics of his district, and possesses some rare things. The High School at Laporte has also a large collection of objects, mostly taken from mounds in the county.

My reports have always contained some account of the archæology of the State, which, together with the establishment of a State Archæological Society, has given an impetus to this branch of study, so that collectors have sprung up in nearly every county, and they are materially aiding in making known all that remains of its archæology.

The address which I delivered before the State Archæological Society in 1877 has not been published, and I have thought that it would not be out of place to give it to the public in this report.

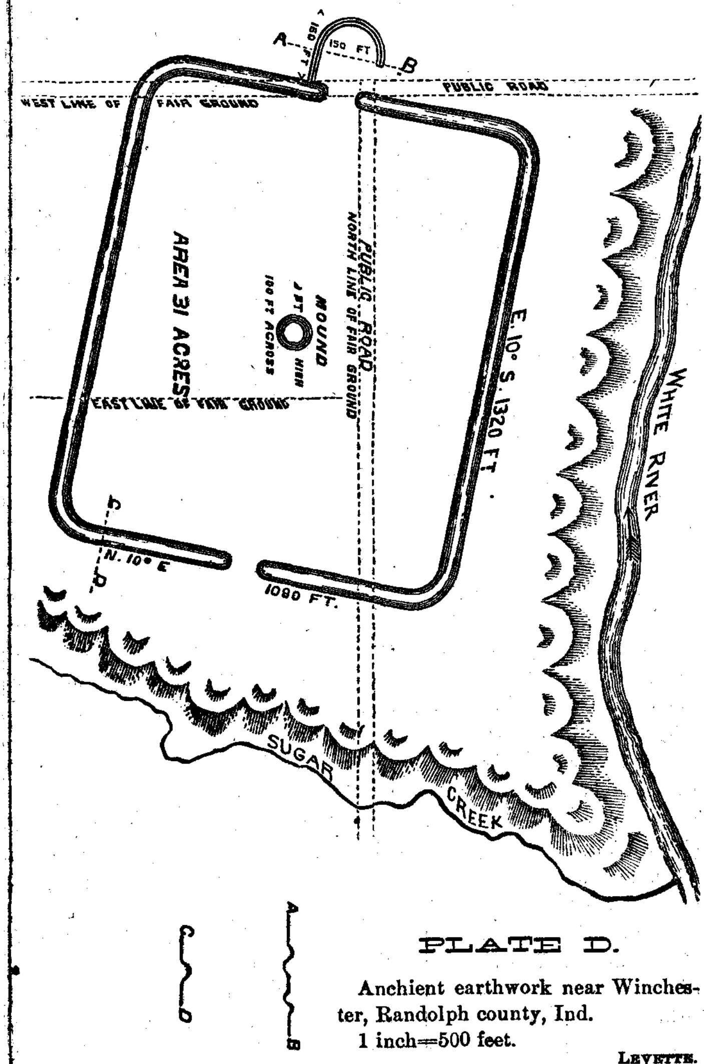


PLATE D.

Anchient earthwork near Winchester, Randolph county, Ind.
1 inch=500 feet.

LEVETTE.

ARCHÆOLOGY.

[Address delivered before the State Archæological Society, at Indianapolis, October 18, 1877, by E. T. Cox.]

Gentlemen of the State Archæological Association of Indiana:

It is the duty of the president of this association to deliver an address at the annual meeting of its members upon such subjects as are prescribed by its organic laws for special study.

I regret exceedingly that my duties have been of such a character that, until within the last three or four days, no time could be spared for the preparation of this address, and I fear that what I have to say will fall far short of your expectations.

No department of natural history is, at this time, receiving more attention from the votaries of science and thoughtful readers than that which pertains to man and his antiquities. Indeed, so familiar are its students with the present status of anthropology that it will be difficult for me to present novel facts in research or new channels of thought worthy of the attention of a body of such able co-laborers. I crave your indulgence, therefore, if some parts of my address should prove to be devoid of special interest.

Matter and life are universal. The solar system, as well as all other heavenly bodies, is the result of simple substances aggregated into compound substances. These complex bodies forming the universe are produced by the affinity or affection which certain elementary and compound substances have for each other, and the process of evolution in the mineral kingdom, as well as in the organic world, is in constant operation.

Organized matter, or life, results from the combination of the fewest number of simple substances, namely: carbon, hydrogen, oxygen and nitrogen. These four elements constitute the chief part of all organized tissues. Woody fibre, sugar, starch, gum, fat, oils and many organic acids contain only three: carbon, hydrogen and oxygen, yet I must not omit to mention that in organized matter a small per cent. of other elements is found; such as phosphorus, sulphur, calcium, potassium, sodium, magnesium, silicon, and some others, but the chief mass of plants and animals are formed of the four elements first mentioned. The fourteen or fifteen elements which constitute the principle mass of the mineral world are almost the same which occur in organized matter, the difference being chiefly this: that in inorganic nature the predominant elements, nearly in the order of their abundance, are oxygen, hydrogen, nitrogen, silicon, chlorine, sodium, aluminum, carbon and iron, after which follow potassium, calcium, magnesium, sulphur, phosphorus, iodine and fluorine;

while in the organic departments the order is nearly as follows: carbon, hydrogen, nitrogen, potassium, calcium, phosphorus, silicon, sulphur, sodium, magnesium, chlorine, iron, iodine and fluorine.

From this it will be apparent that no essential distinction can be made between inorganic and organic bodies founded on the nature of the elements concerned in their production.

Since spectrum analysis has revealed the presence of these elementary substances, common to organized bodies, in the stars, sun and all of its dependent planets, how can we doubt the existence of life in some form throughout the universe. The heavenly bodies which come to us in the shape of meteorites are in many instances found to contain graphite, a form of carbon most likely due to the destruction of organized matter in some form or other.

The law of change pervades all nature, and there appears to be no such thing as stability. The solid crust of our globe and the life evolved upon it when passed in review before the eye of the earnest student of nature presents an ever-changing panorama from old to new forms of life, and though we are not able to assign specific dates in the history of progress from the lowest forms to the earliest traces of man, geology has pointed out the way by which relative records may be established.

If we dig down into the earth beneath our feet, we find that it is composed of layers of many kinds of stone, resting upon unstratified, crystalline rocks—the so-called archean rocks, which form, as it were, the backbone of the earth. The superstructure of stratified rocks were formed by the destruction of older rocks, and once lay at the bottom of the ocean in the condition of mud or ooze. The sedimentary rocks, so formed, are of very great thickness, since we are able to deduce not less than ten miles by measuring from the top of mountain peaks to the bottom of deep sea soundings, while the aggregate thickness of the earth's crust within the reach of the geologist may be set down as twice this amount.

A close study of this crust, composed of stratum upon stratum that enfold the earth like so many successive rings of growth, reveals a most wonderful history, for they are largely made up of the petrified skeletons of the denizens of an ancient ocean. The bottom layers were necessarily formed first, and are therefore the oldest in time; they likewise contain old forms of life, most of which have long since been lost to the world—so that, step by step, as we ascend in the series, new types of life are met with, and by successive epochs we finally pass through eozoic or dawn of life, palæozoic or ancient life, mesozoic or middle life, to cenozoic or recent life. These are simply great divisions of the earth's stony crust, like dividing a column into lower, middle, and upper parts, and will serve our present purposes of pointing out the vast time required for the accumulation of such a mass of sedimentary matter, and the long endurance of life, in one form or another, on the globe.

Lyell, in his Principles of Geology, has undertaken to furnish datum for ascertaining, approximately, the length of time required to form a given amount of strata, by measuring the quantity of sediment annually brought down by the Mississippi river and deposited in the area of 12,300 square miles comprising the delta. "Borings near New Orleans have gone to the depth of 600 feet in these fluviatile deposits, and the average depth was assumed to be 528 feet, or the tenth of a mile. The quantity of solid matter brought down annually by the river is given at 3,702,-758,400 cubic feet, and the accumulations of the whole deposit must have taken 67,000 years." Yet, this deposit made by the Mississippi river represents but a mere fraction of geological history, and belongs to the Quaternary or modern epoch. It will serve, however, to prepare your minds for the reception of a chronology which, though we can not fix the exact date of the beginning, is absolutely demanded at the very threshhold of the earth's history.

In tracing the history of mankind, back or down the stream of time, various systems of classification have been proposed, having for their object the division of the subject into distinct periods.

Sir John Lubbock recommends a division of pre-historic archæology into four great epochs:

1. Palæolithic (ancient stone period), that of the Drift, when man shared the possession of Europe with the cave bear, the woolly haired rhinoceros and other extinct animals.

2. Neolithic (polished stone age), a period characterized by beautiful weapons and instruments made of flint and other kinds of stone, but without a trace of any knowledge of metals except gold, which appears to have been used sometimes for ornaments.

3. Bronze Age, in which bronze was made for arms and cutting instruments of all kinds.

4. Iron Age, in which that metal had superseded bronze for arms, axes, knives, etc., bronze, however, still being in common use for ornaments and frequently for the handles of swords and other arms, though never for blades.*

These divisions are more strictly applicable to European Archæology than to that of America, for during pre-columbian times man on this continent had not advanced beyond the second or neolithic age.

* "Pre-historic Times." Sir John Lubbock.

There can be no doubt that primitive man was a cannibal, scarcely more elevated, in a moral sense, than the beasts which surrounded him, and he was long devoid of a knowledge of all but the simplest forms of art, and was taught by necessity to clutch a stick or unwrought stone as implements of defense or offense, or with which to crush roots or crack nuts for food.

Indeed, this was the condition of the inhabitants of Australia when that continent was first discovered by Europeans. While, therefore, we may justly regard these four ages as natural steps through and by which mankind have progressed from the simplest to the present grand achievements of art, yet the fact can not be overlooked that this progress was not uniform over the entire globe, and that from the present civilization of Europe and the United States we may point to vast regions of country peopled by native races in the lowest stage of savagery, "people who have not conceived the art of fashioning a stone or shaping a bow."

In digging up the bottoms of many of the caves which abound in France, Belgium and Spain, the remains of man, associated with the bones of extinct animals, flint flakes, arrow points and stone knives, have from time to time been found. In some instances these remains were found buried beneath a solid floor of stalagmite of very great thickness, and covered up by many feet of cave-earth (red-ferruginous clay), which is again overlaid by another stalagmitic floor and cave-earth.

Dr. Charles C. Abbott, of Trenton, New Jersey, has for some years past been finding large numbers of palæolithic implements in the glacial drift which forms the lower terrace of the valley on the north side of the Delaware river. The deposit is twenty to thirty feet above the freshets of the river, and extends beneath the bed of the stream. It is composed of large boulders, pebbles and sand, many of which are from archean beds which lie beyond the borders of the State. Though unable to find here any traces of glacial striation on the boulders or pebbles, Dr. Abbott considers the deposit similar to the drift seen in other parts of the State, where striation and grooves are prevalent, and clearly point to glacial origin. The implements are, from their form, called "turtle-back" celts.

Prof. F. W. Putnam also visited the locality where these implements are found, and informed me that he saw numbers of the "turtle-back" celts sticking out of the drift, where they are exposed by cutting away several feet from the face of the cliff, going to prove that they were not brought from near the surface by the sliding of the bank.

Prof. N. S. Shaler, State Geologist of Kentucky, subsequently visited the locality, and while corroborating the testimony of Dr. Abbott and Prof. Putnam that the implements were in place, could not satisfy his mind that the rounded pebbles and boulders belonged to the glacial epoch. This very important discovery of human implements in the drift deposits of New Jersey, by Dr. Abbott, tends to strengthen the evidence in regard to finding a human skull in the glacial deposits of California.

Though there are highly probable accounts of finding the remains of man in the Pliocene deposits of America and Europe, the evidence is not clearly such as will satisfy the strictest demands of science. We may, therefore, look upon the cave-dwellers, who were cotemporaries of the extinct elephant, woolly-haired rhinoceros, hippopotamus, cave-bear, etc., as the most ancient man, and they ante-date the dog and other domestic animals.

The cave-dwellers were probably followed by the mound-builders and the constructors of earth and stone circles; and if, at any period, universal man exhibited but one status, it might justly be claimed for the mound-builders' age—tumuli, or mounds, being found in Egypt, Turkey, Arabia, India, China, Germany, England; indeed, in all countries of Europe, North and South America. Stone circles are reported even in Australia, where the lowest type of man is found, and they are also seen in Japan.

Mr. Shuze Isawa, a native of Japan, who read a paper on the origin of the Japanese people at the Nashville meeting of the A. A. A. S., informed me that the Japanese always built a mound when an Emperor died. Mr. Isawa stated, in his paper, that the Japanese people came from India, and found the island inhabited by a race of savages. These savages were driven to the north part of the island, where a remnant of the race are still to be found.

Notwithstanding this universality of tumuli and stone and earth circles, I think we may justly claim North America as pre-eminently the home of the mound-builder. Here his works are seen in greatest numbers, and culminated in the (so to speak) perfection of his humble but laborious style of architecture, when we consider the simple tools with which the work was accomplished. The step of progress in art, from the cave men to the mound-builders, prevailed only with a branch or offshoot from the primitive stock of men. So it is with regard to all other races who show a decided progress in civilization and arts up to the present time. They are the results of so many developed branches, while the primitive races are still in the lower stages of savagery and barbarism with brains as incapable of ratiocination as their congeners of remote ages. In this stage they will continue until exterminated by the spread of civilization, with which they are unable to cope. In the white race we find the perfection of anatomical and physiological development, and a brain that exceeds that of all other races of men in its size and weight, and immeasurably superior to them in its refined powers of thought. By whatever means we may strive to elevate the Turanian races, and however apt they may be in accumulating ideas and expressing thought, a limit is soon reached, and no amount of training will suffice to surmount the barriers to progress interposed by physiological inabilities. Each race in its respective sphere may continue to achieve triumphs in progressive arts, and grow more and more perfect in knowledge, yet each has its limit, and that limit is determined by organization.

In the prosecution of our investigations of the antiquities of pre-historic man, it is not inappropriate to take a look at the condition and differences which are apparent in his living representatives of to-day.

Ethnologists and naturalists divide mankind into a number of distinct races. Cuvier makes but three, Pritchard seven, Agassiz eight, Pickering has as many as eleven, but the most commonly received classification is that of Blumenbach, who makes five. First is the Caucassian, or white race, including the greater part of the European nations and western Asia; Mongolian, or yellow race, occupying Tartary, China, Japan and India; Ethiopian, or negro race, occupying all Africa south of the Sahara; American, or red race, embracing the Indians of North and South America; Malayan, or brown race, inhabiting the islands of the Indian archipelago and Australia.

There is such a blending of characteristics in some of the lower races that it is by no means easy to establish a boundary line between them, and hence the diversity of opinion in the classification.

Prof. Huxley, with that clearness of thought and profound research that characterizes all his labors, in a paper read before the International Congress of Pre-historic Archæology, which assembled in England in 1868, divides the human family into four races, and I take the liberty of reproducing entire what refers to this point. He says: "By races I mean simply the great distinguishable groups of mankind—such groups as a naturalist would form if all mankind were put before him to be sorted according to their physical likenesses and unlikenesses. And by distinct races I mean those which do not grade into one another, except under such circumstances as make it certain, or at any rate highly probable, that inter-breeding has taken place.

"The number of races in this sense appears to me to be small; indeed, I do not see my way to the recognition of more than four, which I shall call Australioid, Negroid, Mongoloid, and Xanthochroic races.

"The characteristics of the Australioid are: A dark complexion, ranging through various shades of light and dark chocolate color; dark or black eyes; the hair of the scalp black, neither coarse and lank, nor crisp and woolly, but soft, silky and wavy; the skull always belonging to the dolichocephalic group, or having a cephalic index of less than 0.8.

"Under the head of Negroid race are included those people who have dark skins ranging from yellowish brown to what is usually called black; dark or black eyes; dark or black hair, which is crisp, or what is usually called woolly in texture; with very rare exceptions these people are dolichocephalic.

"In the Mongolian race the complexion ranges from brownish yellow to olive; the eyes are dark, usually black; the hair of the scalp black, long, coarse and straight; that of the body remarkably scanty; the proportions of the skull, so constant in the two preceding races, vary in this from extreme dolichocephalic to extreme brachycephalic.

"Finally, in the Xanthochroic race the complexion is very fair; the eyes are blue or gray; the hair yellow or yellowish-brown. In this race again the skull ranges through the whole scale of its varieties of proportion from extreme breadth to extreme length."

All other forms of mankind he considers lie between some two of these primary stocks.

"The Australioids include only the inhabitants of Australia, and are not found in any of the neighboring islands. But, in the Dekkan, which is bounded on the north by the valley of the Ganges, Indus, and Himmalaya mountains, and on the east and west by the sea, there is a people—the Coolies of East India, which, though they have undergone considerable change by intermixture with an invading arianised population, are, he thinks, clearly referable to the Australioids. While the inhabitants of Malacca and the Andaman islands are not considered sufficiently distinct to form a separate race from the true negro who inhabits Africa south of the Sahara, he has applied to them the name of Negritos.

"The Mongolians have their most prominent home in Central Asia, and extend from thence to Lapland, and the Arctic Circle on the north-west and north; to North Hindostan on the south to the Malay archipelago on the east; on the east to China, and thence over the whole of the Pacific islands (except those occupied by Negritos), in the extreme northeast to America, and then through its whole length and breadth.

"The Xanthochroi inhabit a much smaller area of the earth's surface than the Mongoloids. Their center being in Central Europe, whence they extend into Scandanavia and the British islands on the northwest. They extended their wanderings over the great plains of Northern Asia to the frontier of China, and are traceable southward into Syria, and in a fragmentary fashion through Northern Africa to the islands of the western coast, while eastward they occur as far as Northern Hindostan."*

*Report International Congress Pre-historic Archæology, 1868.

The manner in which these races dispersed themselves from specific centres to their present habitats, is a matter of very great interest. It is generally believed that the Mongoloid, or Indians of America, came from Asia by way of the Aleutian islands, but it is far more difficult to understand how the Australioid people found their way to the Dekkan, and the Negros to the islands of Polynesia, that are separated by "broad and stormy seas, when their only known means of navigation was a rude raft."

Mr. A. R. Wallace, President of the biological section of the British Association, in his address at the Glasgow meeting, in September, 1877, among other points of interest bearing on the subject before us, says that "while all modern writers admit the great antiquity of man, most of them maintain the very recent development of his intellect, and will hardly contemplate the possibility of men equal in mental capacity to ourselves having existed in pre-historic times." The weakness of this argument, he says, has been shown by Mr. Albert Mott, in his "very original but little known presidential address to the Literary and Philosophical Society of Liverpool, in 1873," in which he maintains that "our most distant glimpses of the past are still of a world peopled as now with men both civilized and savage," and "that we have often entirely missed the past by supposing that the outward signs of civilization must always be the same, and must be such as are found among ourselves." In support of these views Mr. Mott, as quoted by Mr. Wallace, calls attention to the existence of gigantic stone images, now mostly in ruins, often thirty or forty feet high, and formed of stone, some of which must weigh over one hundred tons. The Easter Islands, he says, on which these images are seen, are more than two thousand miles from South America and two thousand miles from Marquesas and more than one thousand from the Gambier Islands. It has only an area of thirty square miles. The existence of such works, Mr. Mott says, "implies a large population, abundance of food and an established government," and to maintain all of which, he thinks, "necessarily implies the power of regular communication with larger islands or continents, the arts of navigation, and a civilization much higher than now exists in any part of the Pacific." Very similar remains in other islands scattered widely over the Pacific, Wallace says, adds weight to this argument.

While there is little room to doubt, as I have already stated, the existence of various stages of civilization in pre-historic times, yet we must admit that if the Pacific Islanders ever possessed the art of navigating broad seas and carrying on commerce from island to island, or with the continents, they must have lost it before losing the art of fashioning the soft coral rock into images, since Capt. Cook mentions that on some of the islands these images were being constructed at the time of his visit, and the canoe constituted their only means of ocean trade. But it may be well to state here, that it is very singular, in his special mention of Mr. Mott's lecture, Mr. Wallace overlooked the fact that Mr. J. H. Lampry read a paper, in 1868, before the British meeting of the Pre-historic Congress of Archæology, in which he calls attention to the antiquities in the Easter and other South Sea islands as a proof that "in ancient times these seas may have been traversed in all directions by a race of men of high intelligence, great physical endurance, capable of patient toil in the accomplishment of great works, whose scant remains, simple as they are in form, are not destitute of that mystic rythm in arrangement which at once entitles them to a place in the records of pre-historic times."

In answer to Mr. Wallace, I desire simply to call your attention to the fact that ethnological authorities seem now disposed to agree that the aborigines of America belong to the Mongoloid race without admixture of other races. Admitting, then, that the latter conclusion is perfectly tenable, how does it happen that the builders of stone images, upon stone terraces, in the Polynesian Islands, by a people who are of the Negrito type, if possessed of a superior knowledge of arts and skill in navigation, failed to leave the impress of their race upon the American continent? It is a little singular, also, that while Terra del Fuego and Patagonia are inhabited by man, the large islands of the Falkland group, off their coast, were uninhabited; so with the Galapagos, under the equator, while numbers of inhabited islands in the Pacific are less favorable for man's support. I do not believe that man has been degraded from a higher knowledge of art to a lower, nor do I believe that his dispersion over the Pacific islands and the American continent can be explained by a passage from Asia to America by the aid of the Aleutian chain of islands alone, but by a much broader and more extended area of land which in pre-historic times connected the two continents. For the existence of such a connection we need not, from a geological point of view, go farther back than the glacial epoch, when, in order to spread over North America a glacial sheet of ice reaching as far south as 37° of latitude required an elevation of the region to the north that would lay bare vast areas of land now covered by the waters of the Pacific ocean. And it is to geological changes in the physical geography of the earth that we must mainly look, as a cause, for the distribution of pre-historic men. The time required to swell the population of America from a few pairs of voluntary or involuntary voyagers to its aboriginal magnitude could scarcely be less than that required by the intervention of geograpical changes.

In evidence of the slow rate of increase among savage tribes I may cite the accounts furnished by the Jesuit Fathers who settled among the Indians of the Pacific coast soon after its discovery by the whites, for the purpose of converting them to Christianity and instructing them in agriculture and other industrial pursuits. They state that debauchery, tribal wars and exposure of infants, through neglect of the mothers, are fast decimating the race.*

In regard to the character of the works left by pre-historic man, whether in Europe or America, after a careful study of what has been written on the subject, and making due allowance for the inaccuracies of detail woven into many of the accounts from hearsay traditions of the savages, I have failed to see in the antiquities any evidence of a higher order of intellect or mechanical skill than is to be found in the tribes now living. The massive structures, of which the ruins are now only to be seen in New Mexico, Arizona, and other portions of the Rocky Mountain region, Mexico, Central America and Peru, while impressive in size and remarkable for the amount of labor required for their completion, do not surpass or equal for comfort and the moral development of the people, the present adobe houses to be found in some of the existing Pueblo tribes of North America.

In studying the ancient Pueblos, we must discard as totally worthless the grossly false and mythical histories published of the conquest of Mexico by Cortez, Bernal Diaz, the anonymous conqueror, and other Spanish writers. They were subject to revision by the seven ecclesiastical censors of Spain, and made to glorify the church and to magnify the importance of the empire, vanquished by the basest treachery and cold-blooded massacres; yet these so-called histories have been copied and quoted from by subsequent historians, eminent as scholars, without questioning their inaccuracies.

We are indebted to Robert Anderson Wilson, author of the "Conquest of Mexico," for a complete refutation of these authors, based upon a careful study of the subject and a survey of the field of Cortez's exploits. Instead, therefore, of seeing in the Aztecs a people highly advanced in the art of government and surrounded with luxuries, indicative of refinement, we must look upon them as they really were, naked savages, and in no way differing from the Pueblo, or town Indians, of the present day.

In this State the antiquities we have to deal with are, so far as at present known, earth mounds, stone mounds, earth wall enclosures and stone wall enclosures. These remarkable monuments of an extinct people may be traced from Texas to Florida, scattered along the shores of the

*Smithsonian Contributions to Knowledge.

Gulf of Mexico, and extending along the Atlantic coast as far north as South Carolina, and from the mouth of the Mississippi river almost to its head-waters, and following up all its tributaries, and their innumerable branches, to the southern shores of the great lakes. Indeed, so abundant are these antiquities that many have been led to believe that the people who constructed them were at one time the most numerous of all the inhabitants of America. Neither history nor trustworthy tradition can furnish any account of these antiquities, and all efforts, therefore, to define the uses to which they were put, beyond the fact substantiated by exploration, that some of the mounds were used as sepulchers for the dead, is, in my opinion, sheer guesswork. From the fact that these antiquities are never found except along the sea shore, water courses, or by the side of lakes or living springs of water that are not far from a stream, and that the sites which were selected for them have, in many cases, proved the most eligible locations for modern towns and cities, we may reasonably infer that the builders cultivated the alluvial river bottoms and depended mainly on vegetables, fish and mollusks, for their food. The mounds vary in hight from three feet and less, to sixty feet and more, and from a few feet in diameter to several hundred feet.

In shape they are circular, oval and square; some are conical, others truncated, and a few are reported to have winding stairways leading to their summits. The great mound at Grave creek, West Virginia, is said to be seventy feet high, and one thousand feet in circumference at the base. At Miamiburg, Ohio, there is a mound, reported by Squier and Davis, to be sixty-eight feet high and eight hundred and fifty-two feet in circumference at the base. The Cahokia truncated mound in Illinois, is, by the same authority, 700 feet long, 500 feet wide and 90 feet high.

The highest mounds yet found in Indiana are in Knox county. Prof. Collett, in his report on this county, says the "Pyramid mound, one mile south of Vincennes, is 47 feet high, greatest diameter 300 feet, lesser diameter 150 feet; the level area on the top is 15 by 50 feet, and is crowded with intrusive burials of a later race." Sugar Loaf mound, just east of the city limits, was opened up by a shaft which, he thinks, reached the bottom at forty-two feet after passing through:

	Ft.	In.
Loess sand	10	00
Ashes, charcoal and bones		10
Loess sand	17	00
Ashes, charcoal and bones		10
Loess sand	9	00
Ashes, charcoal and bones	2	00
Red altar-clays, burned	3	00
Total	42	8

The mound E. N. E. of Vincennes Court House, is built on a spur of the hills, and the top is sixty-seven feet above the plain. Mr. Collett calls it a "terraced mound," which has a winding roadway to the top. Archæologists have, as I think, without due consideration, classified the mounds into altar and sacrificial mounds, sepulcral or burial mounds, lookout mounds and mounds of habitation.

When we dig into a mound and find that it contains human bones, it may then with propriety be called a sepulchral or a burial mound. But to speak of others as altar mounds or mounds of worship, mounds of habitation or lookout mounds, is assigning to them a purpose which can not be sustained unless fortified by some better proof than the mythical writings of Spanish historians.

It is a common occurrence to find in mounds some ashes and charcoal mixed with human bones, and for this reason the builders have been accused of cremating their dead. So far I have not been able to find any charred human bones, though charred wood and charcoal are of common occurrence. A few fragments of charred bones are reported by Squier and Davis in their so-called sacrifical mounds at Mound City, Ohio. My own opinion is that mounds were simply erected as burial places for the bones of dead chiefs or other persons high in authority. The bones were sprinkled over with ashes and, finally, with earth. Where ashes and charcoal are found in mounds, but no bones, it is possible that the latter disappeared from decay. Charcoal, as is well known, is the most durable of all known substances. Associated with human bones are sometimes seen flint flakes, arrow and spear points, stone axes, knives, pipes, pottery, etc. The practice of burying with the dead, flints, gravel and ashes, prevailed in Europe to a comparatively modern time. It is an old usage, hence "ashes to ashes, dust to dust."

Shakspeare alludes to this custom in the play of Hamlet, in the scene where the priest who had charge of the burial of Ophelia, is made to say, in reply to Laertes:

> "Her obsequies have been so far enlarged
> As we have warranty: Her death was doubtful;
> And but that great command o'ersways the order,
> She should in ground unsanctified have lodged
> Till the last trumpet; for charitable prayers,
> Shards, flints and pebbles should be thrown on her,
> Yet here she is allowed her virgin crants,
> Her maiden strewments, and the bringing home
> Of bell and burial."

In Wisconsin there are a large number of mounds built to imitate the shape of various kinds of animals, not omitting man. These mounds contain ashes and the remains of human skeletons, with copper and carved stone trinkets, pottery, etc. In the latter respect they do not differ from the conical, square and truncated mounds of other localities.

The romance which has been thrown around the so-called *Teocalli*, or temple-mounds of Mexico, by the Spanish historians of the conquest, and so inconsiderately adopted by American archæologists, vanishes when put to the crucial test by accurate observations.

Torquamana, who examined the celebrated Mexican temple-mound of Cholula, says: "It still remains without any steps by which to ascend, or any facing of stone. It appears now like a mound covered with grass and shrubs, and possibly it was never anything more."

Mr. Robert A. Wilson also visited this mound before writing his history of the "Conquest of Mexico," and corroborates the statement of Torquamana, and he is further satisfied, from the general appearance, that it is of common origin with similar mounds scattered through the country.

Associated with the mounds we have earth wall and stone wall enclosures—some are perfect circles, some square, some ovoid, and still a larger number that are anomalous in design. The hight of the walls vary from a foot or two to ten feet or more. Most generally they are accompanied by a fosse, or ditch, which is placed on the inside, rarely on the outside of the wall. In area these works include from a few square feet to upwards of one hundred acres. Like the mounds, they are built on river terraces or high table-lands, bordering streams.

The uses for which they were designed by the builders are, in most cases, to say the least, beyond the discernment of careful students of antiquities; and opinions on the subject are almost as numerous as the observers themselves. Where the walls are built around the brow of a high point of land with a level area on top, and is not commanded by the surrounding high-lands, as the "stone fort" at the mouth of Fourteen-mile creek, in Clark county, figured and described in the Indiana Geological Report, 1873, we may reasonably infer that the wall was built as a means of security against intruders upon their privacy or as a defence against warlike foes. The small circular enclosures are generally looked upon as being subservient to some religious ceremonies, I should rather say, superstitious weight, in commemoration of human prowess.

One of the most eminent of American archæologists—Dr. Lewis C. Morgan, of Rochester, N. Y.—in the July number of the *North American Review*, 1876, entertains the opinion, in an ably written article, that the earth walls served as the foundation upon which to construct dwellings. The article is accompanied by figures to show the manner of house that might be adapted to the walls, and the facility with which it could be built by inclining poles of wood against the sides and securing them at the top.

The house is divided into a number of rooms to suit their communal customs. These rooms are occupied by separate families. A place for the fire is arranged at intervals in a hall which runs the entire length, so as to accommodate the necessities of four compartments. In answer to this very plausible theory of my learned friend—Dr. Morgan—I wish to say that if his views are correct we should be able to find at intervals on the embankments, ashes and charcoal and other refuse kitchen matter, but, so far as I know, this has never been done.*

What is now demanded of the archæologist is a more careful study of these mounds and enclosures; maps should be made of the grounds, and sections given which accurately delineate the order of arrangement of the internal structure of the works, and a careful record given of the position occupied by the relics which they may contain. We should by all means discourage, and turn a deaf ear to the relation of ingeneous traditions gleaned from unworthy sources, or wormed from the aborigines by leading questions, and concluded in too many cases by affixing imaginary answers. I repeat that the problem of the condition of pre-historic man can alone be satisfactorily solved by a study of his remains and the works he has left behind him.

With regard to the cranial differences in the races of men, I wish to call your attention to a paper read by Dr. T. O. Summers, Jr., at the late meeting of the A. A. A. of Sci., in Nashville, wherein he pointed out that there is a constant relation existing between the length of the spheno-parietal suture and the capacity of the brain case, determining the brachycephalic or the dolichocephalic character of the skull. Dr. Summers has had the rare opportunity of examining the large collections of skulls in the various cities of Europe, and has also a large collection of his own, and by the aid of this important discovery unhesitatingly declares that he could at once separate from one another the skulls of white men negroes and mulattoes.

The ethnologist has long felt the want of more certain rules for the classification of crania than that afforded by a mere measurement of capacity, dolichocephalic and brachycephalic, and I believe that this discovery of Dr. Summers will, if not infallible, prove to be at least of very great assistance in accomplishing so desirable an object, since it is by a

*Since writing the above I have had an opportunity to visit a Pima Indian village in Arizona. The houses are usually made of bows stuck into the earth and the tops are bent over and tied, giving the dwelling the shape of a bird cage. A wall of earth, one to two feet high, is thrown up around the base on the outside. I saw many of these earth rings where the brush had been taken away, and they have exactly the appearance of the small circular enclosures seen in this and adjoining States, but there was no ditch on the inside. They were simply thrown up to keep out the wind and water.

study of the osteology of man that we must look for a true classification and a solution of his capabilities.

Archæologists are now fully aware that the neolitic implements and pottery of the mounds are in no way distinguishable from those made by the aborigines from pre-columbian to the present time, and as a means of classification they must totally fail. My distinguished friend, Dr. Lewis H. Morgan, in his recent and very able work called "Ancient America," has given a division and classification of ethnical periods that indicates a thorough acquaintance with the subject, and his book should be in the hands of every student of ethnology. No man in America has done more than Dr. Morgan to systematize and make known the true status of the aborigines, and I take pleasure in thus publicly acknowledging my obligations to him for so valuable a contribution to our knowledge.

In conclusion, I desire to call your attention to the care which must be exercised in reaching conclusions on the examination of objects which come under the notice of collectors.

George Rapp, who was at the head of a community of Germans known as "Harmonists," that came to this State in 1815, and settled on the Wabash river, in Posey county, where they built the town of New Harmony, found at St. Louis a large stone slab, eight feet long, five feet wide and eight inches thick, upon which is seen the images of two human feet; in front of these images is an irregularly rounded mark; the feet have the appearance of being the impress made on mud, and the scroll as having been made with a stick in the hands of the owner, and the mud so impressed subsequently hardened into stone.

This foot-print slab was held in high esteem by Rapp, and he played upon the superstitions of his followers by stating that they were left by the angel Gabriel, who alighted on the earth to warn the people of the near destruction of the world. It must be remembered that the Rappites or Harmonists were Second Adventists.

Schoolcraft, in his journey down the Wabash, in 1821, stopped at New Harmony, and gives an account of this foot-print slab, accompanied with accurate drawings. In this account he expresses the opinion that the impressions were those made by an Indian who stepped out of his canoe on a mud beach and made the mark in front of the tracks with a stick and then stepped back into his canoe; subsequently the mud hardened into stone, which preserved the fossil imprints.

Mantell, one of the ablest and most fascinating writers on geology, saw this account of the foot-print slab, and transferred it to his "Wonders of Geology," Vol. 1, p. 75, American edition from third London edition, in the following language:

"*Impressions of Human Feet in Sandstone.*—In connection with the occurrence of human bones in limestone, I will here notice a discovery of the highest interest, but which has not as yet excited among scientific observers the attention which its importance demands. I allude to the fact announced in the American Journal of Science, Vol. V., 1822, of impressions of human feet in sandstone, discovered many years ago in a quarry at St. Louis, on the western bank of the Mississippi river. The above figure is an exact copy of the original drawing, and exhibits the impressions of the soles of two corresponding human feet placed at a short distance from each other, as of an individual standing upright in an easy position. The prints are described as presenting a perfect impress of the feet and toes, exhibiting the form of the muscles and the flexures of the skin, as if an accurate cast had been taken in a soft substance. They were at first supposed to have been cut in the stone by the native Indians, but a little reflection sufficed to show that they were beyond the efforts of these rude children of nature; since they evinced a skill which even my distinguished friend, Sir Francis Chantry, could not have surpassed. No doubt exists in my mind that they are the actual prints of human feet in soft sand, which was quickly converted into solid rock by the infiltration of calcareous matter in the manner already described. The length of each foot is 10½ inches, the spread of the toes 4 inches, indicating the usual stature; and the nature of the impression shows that the feet were unconfined by shoes or sandals. This phenomenon, unique of its kind, is fraught with so much importance that I have requested Prof. Silliman to ascertain the nature of the sandstone and the period of its formation."

My honored preceptor, the late David Dale Owen, soon exposed the fallacy of the hasty conclusions reached by Schoolcraft, and pointed to the fact that the slab was a limestone belonging to the palæozoic age, and was studded with brachiopod shells, characteristic of the sub-carboniferous period, and the tracks, however perfect in form, were carved into the solid rock by human hands. The most zealous advocate of man's antiquity would hardly dream of tracing him back to palæozoic times. Subsequently Dr. Owen collected a large number of stones containing carved human feet, and from a careful study of the subject came to the conclusion that in most cases they were carved in stone, so situated, as to commemorate the highest water-mark of the streams, or to note some other memorable event.

I mention these facts to show how easy it is for one to be led astray, when every possible phase of the subject is not carefully studied. Let us, therefore, attend strictly to detailing facts of observation, and they are sure to lead to a correct solution of all problems within the compass of the human mind.

PORCELAIN, TILE AND POTTERS' CLAYS.

With a view to promote the pottery industry, and point to the value of the clays in Indiana for manufacturing porcelain, iron-stone china and encaustic tile, I have had analyses made of a large number of clays found in different parts of the State, as well as of some of the most noted clays of other States, for comparison. The large deposit of white porcelain clay found in Lawrence county has already been alluded to in my previous reports, but from its vast importance it will not be inappropriate to make further mention of it here. This large bed of white clay, to which I have given the name of *Indianaite* (Indiana stone), has been sold to the Pennsylvania Salt Company of Philadelphia, and is being extensively used by them for the manufacture of sulphate of alumina. It is readily soluble in dilute sulphuric acid, and the absence of iron and other foreign substances renders it of the greatest value for this branch of manufacture, and alum made from it has no equal in the market. It is called Indianaite because it differs from kaolin in the manner of its origin and in the amount of water which it contains. In the latter respect it is closely allied to halloysite, but differs from that in its physical characteristics. Associated with Indianaite (not Indianite, since that name is derived from Indian, not Indiana, and is pre-occupied,) we have typical specimens of halloysite and allophane.

The bed is four to ten feet thick and, where mined, has been pretty well proved to cover forty-two acres of ground. For the manufacture of fine grades of porcelain and granite ware it surpasses all other clays for purity of color and homogeneous texture. It is principally sold to the potters of Cincinnati, Tempest, Brockman & Co., being the largest customers, and the excellent quality of ware which they turn out is largely due to the use of Indianaite. East Liverpool, Ohio, potters also use a considerable quantity of this clay, and some goes to the potters of Trenton, New Jersey.

I have received and answered letters from a great many persons who make inquiries about the clay with a view to starting potteries in this State. They all admit the advantage of a closer proximity to the clay and coal, but the general depression in all kinds of business, and a want of sufficient capital, has prevented the consummation of these enterprises. Not so, however, with the manufacture of encaustic tile. After proving the existence of a great many beds of excellent clay suitable for the business, Mr. Hall succeeded in inducing Messrs. Douglass, Lyon and Harrison to join him in putting up a factory in the latter part of 1877. The manufacture proved to be a splendid success. Clays giving a variety of natural colors were obtained at a very low price, and just suited to the purpose. They are now turning out floor and mural tile that are in every respect equal to the best foreign tile. They have already had to increase the capacity of their factory to meet the growing demand for encaustic tile floors.

The following analyses indicate the composition of the porcelain, encaustic tile, and common potters' clays:

Indianaite, white porcelain clay, Lawrence county, section 21, township 3, range 2, amorphous, cuts smooth without grit, greenish white color, fades on long exposure to the light, powder white, unctious feel.

Specific gravity, 2.31; hardness, 2 to 2.5.*

	Per Cent.
Water, dried in hot air oven for six hours, at 212° F.	9.50
Water, combined	14.00
Silicic acid	39.00
Alumina	36.00
Lime and magnesia	0.63
Alkalies	0.54
	99.67

*For further information on this mineral see Indiana Geological Reports, 1874 and 1875.

Henry Pemberton, of Philadelphia, found a trace of cobalt in a sample of Indianaite.

Alophane, from same locality, emerald color, amorphous, crumbles to powder after being exposed to the atmosphere of a dry room, powder white:

	Per Cent.
Hygroscopic water	26.50
Combined water	14.50
Silicic acid	15.71
Alumina	42.74
Carbonate of magnesia	0.59
	99.54

Kaolin, Woodbridge, New Jersey, analysis by Henry Pemberton, Jr.:

	No. 1.	No. 2.
Loss by ignition	14.90	14.80
Silica	44.10	44.70
Alumina	39.36	38.77
Ferric oxide	1.04	1.08
Nickel and cobalt	trace.	trace.
	99.40	99.35

Magnesia and alkalies undetermined.

South Carolina Kaolin, by same analyst:

	No. 1.	No. 2.
Loss by ignition	14.65	14.22
Silica	44.10	44.60
Alumina	40.00	41.00
Ferric oxide	0.64	0.00
Titanic acid	0.08	0.13
	99.47	99.95

Mr. Pemberton made analyses of two samples of Indianaite. No. 1, soft white variety; No. 2, hard white variety:

	No. 1.	No. 2.
Loss by ignition	22.90	23.60
Silica	39.35	38.90
Alumina	36.35	37.40
Lime	0.40	undt.
	99.00	99.90

Dr. Robert Peter, of Lexington, Ky., Chemist of the Geological Survey of that State, found, in a sample of Indianaite:

	Per Cent.
Potash	0.190
Soda	0.204

Dr. Peter also found in the celebrated glass-pot clay of Gobel & Co., from Germany:*

	Per Cent.
Potash	0.578
Soda	0.112

Kaolin, from Wilmington, Delaware, from samples at the Centennial Exhibition:

	Per Cent.
Moisture at 212° F.	0.50
Loss by ignition	12.40
Insoluble silicates	72.40
Alumina	14.80
Ferric oxide	trace
Lime	0.35
Alkalies	0.85
	101.10

Kaolin, from National Clay Company's exhibit at Philadelphia:

	Per Cent.
Moisture at 212° F.	0.30
Loss by ignition	11.17
Silica	68.50
Alumina	17.20
Ferric oxide	1.30
Lime	0.25
Alkalies	0.79
	99.51

*Letter from Dr. Peter to the State Geologist.

Kaolin, Chester county, Pennsylvania, from Centennial Exhibition:

	Per Cent.
Water at 212° F.	0.80
Loss at red heat	10.70
Silica	70.80
Alumina	17.00
Ferric oxide	0.40
Alkalies	0.66
	100.36

Kaolin, J. Leslie Skelton, Irwinton Depot, Nelson county, Virginia, Philadelphia Exhibition:

	Per Cent.
Water at 212° F.	1.00
Loss at red heat	11.12
Silica	69.50
Alumina	19.10
Ferric oxide	none
Alkalies	1.00
	101.72

Clays used for fire brick, coarse pottery and encaustic tile manufacture. Under clay to coal seams, soft, plastic, unctious feel, and more or less gritty when tested by the teeth. Specimens sent from Parke county, by Professor Barnabas Hobbs, marked "fire clay," light gray color:

	Per Cent.
Loss by ignition	4.10
Silica	66.18
Alumina	21.15
Ferric oxide	5.30
Lime	0.70
Magnesia	0.14
Sulphuric anhydride	0.67
Soda	0.33
	98.57

Specimen from the same county, marked "slip clay," also sent by Professor Hobbs:

	Per Cent.
Loss by ignition	8.60
Silica	55.20
Alumina	14.40
Ferric oxide	9.40
Manganic oxide	1.80
Lime	6.12
Magnesia	0.90
Sulphuric anhydride	0.34
Soda	0.52
	97.28

This is a very remarkable clay, melts at a moderately low temperature, and is highly useful as a glaze for common stone pots. Potters from all parts of Illinois and Indiana use it, and so far they have not been able to find any clay in the West that can be substituted in its place.

Potters' clay from Barnett's land, near Reelsville, Putnam county; color, grayish white; unctious to the feel and remarkably plastic; it lies under a seam of coal and is four feet thick. The following section shows the order of associated beds at the crop:

Black bituminous shale	1 ft. 6 in.
Cannel coal, good	0 ft. 5 in. to 7 in.
Caking coal, good	0 ft. 9 in.
Rotten coal	0 ft. 4 in. to 6 in.
Good coal	0 ft. 9 in.
Potters' clay	4 ft. 0 in.

A sample washed lost 12 per cent. of gray sand.

Washed clay, after being air-dried in the room of the laboratory, was analyzed, and also unwashed specimens:

	Washed.	Unwashed.
Loss by ignition	6.30	6.30
Silica	60.56	61.20
Alumina	27.00	25.45
Ferric oxide	3.48	0.39
Sulphuric anhydride	0.27	0.30
Calcium carbonate	0.25	0.39
Potash	2.48	undt
Soda	0.32	undt
Magnesia	undt	0.85
	100.66	94.88

The silica contained 0.25 per cent. of baryta. This clay burns to a high cream color.

Potters' clay from Martz, Clay county, under clay to coal seam, very light ash color, unctious to the touch, contains a very small quantity of grit, is very plastic, and burns of a light cream color:

	Per Cent.
Loss by ignition	8.10
Silica	65.66
Alumina	17.20
Ferric oxide	4.05
Manganic oxide	0.80
Calcium carbonate	0.73
Sulphuric anhyd-ide	0.74
Alkalies and loss	2.72
	100.00

Ganister Rock, hard, compact, silicious clay, immediately over block coal at Watson's mine, Knightsville, Clay county.

It is used for fire-brick and for lining Bessemer converters, being very refractory:

	Per Cent.
Loss by ignition	6.80
Silica	67.87
Ferric oxide	7.24
Manganic oxide	1.95
Alumina	12.70
Calcium carbonate	1.45
Magnesia	0.85
Potash	0.17
Soda	0.08
Sulphuric anhydride	0.29
Baryta	trace
	99.40

Analysis of decomposed silica from Alex. McPike's mine, near St. Genevieve, Mo.; it is a fine powder and as white as flour, used in glazing porcelain:

	Per Cent.
Moisture	0.80
Silica	97.95
Alumina	1.00
Lime	trace
	99.75

This is a very pure silica, and requires very little preparation for the potter's use. The usual form of flint has to be calcined and ground at considerable expense to the manufacturer.

No locality in our own State has yet been discovered where flint, suitable for potter's use, can be had at a reasonable cost. Tempest, Brockman & Co., the large potters of Cincinnati, have used the St. Genevieve flint powder, and pronounce it good.

Feldspar is another mineral used along with flint in making the glaze for porcelain. The most available localities for this mineral are in Alabama and New Hampshire.

Attention is called to these minerals that potters may know where to get the materials best suited for the manufacture of porcelain, terra cotta and encaustic tile.

WYANDOTTE CAVE.

When on a visit to Wyandotte Cave, in Crawford county, I collected a number of samples of earths, some of the water from the sulphur spring,* and bat guano.

Analysis of red plastic clay, unctious to the touch, and without grit, cuts very smooth:

	Per Cent.
Loss at red heat	11.70
Silicic acid	48.50
Ferric oxide	12.30
Manganic oxide	1.05
Alumina	19.50
Lime	1.79
Magnesia	0.52
Carbonic anhydride	1.97
Sulphuric anhydride	1.11
Phosphoric acid	0.44
Chloride of alkalies and loss	1.12
	100.00

Magnesian earth, so-called, is more properly a combination of gypsum and ferruginous clay. Analysis:

	Per Cent.
Loss at red heat	24.10
Silica	31.60
Ferric oxide	10.70
Manganic oxide	trace)
Alumina	3.90
Lime	8.28
Magnesia	1.54
Carbonic anhydride	8.22
Sulphuric anhydride	11.00
Phosphoric acid	0.41
Chloride of alkalies and loss	0.25
	100.00

* For the location of this spring see Map of Wyandotte Cave, accompanying Prof. Collett's report of Crawford county, in this volume.

Nitre earth. This is a red clay similar to that used for the manufacture of saltpetre during the war of 1812. A large amount of this earth was lixiviated during that period, and owing to the high price of nitre the manufacture was conducted with profit. It contains in 100 parts:

	Per Cent.
Loss at red heat	16.50
Silica	20.60
Ferric oxide	6.03
Manganic oxide	0.75
Alumina	20.40
Lime	8.06
Magnesia	4.58
Carbonic acid	10.38
Sulphuric acid	6.55
Phosphoric acid	2.43
Nitric acid	3.50
Chloride of alkalies and loss	0.32
	100.00

The 3.5 per cent. of nitric acid would unite with 3.05 per cent. of potash to form 6.55 per cent. of nitre, or 100 pounds of the earth would yield 6.55 pounds of nitre. The large amount of phosphoric acid present is probably due to the clay containing some decomposed animal bones.

Bat guano. In portions of both the old and new caves there are large deposits of bat guano, but it is possible that the expense of bringing it out through some very narrow and rugged passages will be too great to render it available for fertilizing purposes. Composition:

	Per Cent.
Loss at red heat	44.10
Organic matter	4.90
Ammonia	4.25
Silica	6.13
Alumina	14.30
Ferric oxide	1.20
Lime	7.95
Magnesia	1.11
Sulphuric acid	5.21
Carbonic acid	3.77
Phosphoric acid	1.21
Chloride of alkalies and loss	5.87
	100.00

It will prove an admirable fertilizer, though not nearly so good as Peruvian guano.

Analysis of water from the so-called sulphur spring in Wyandotte Cave. An imperial gallon contains 55.3 grains of solid matter, composed of:

	Per Cent.
Insoluble silicates	0.200
Ferrous oxide	0.144
Calcium oxide	4.170
Magnesium oxide	9.830
Sulphuric anhydride	25.180
Carbonic anhydride	8.160
Sodium oxide	1.127
Potassium oxide	0.560
Chlorine	0.350
Loss and undetermined	5.579
Total solid matter	55.300

This is a sulphate of magnesia water, and might be more properly called an epsom spring.

The above substances are probably combined to form the following salts:

	Per Cent.
Carbon dioxide, free	5.6946
Silicic acid	0.2000
Ferrous carbonate	0.2319
Calcium carbonate	3.8899
Calcium sulphate	6.4537
Magnesium sulphate (epsom salts)	29.4929
Potassium sulphate	1.0366
Sodium sulphate (glauber salts)	2.2088
Sodium chloride (common salt)	0.5767
Loss and undetermined	5.5149
Total solid matter	55.3000

Medical properties, diuretic and tonic.

THE COST OF MAKING BESSEMER IRON IN INDIANA.

While there is much ore in Indiana that will answer for making iron, it is either lean or containing so much sulphur and phosphorus that it is useless for good grades of metal and Bessemer steel, or it is so situated with reference to fuel that the cost of transporting one or the other will place its value beyond what the present price of iron will justify. It is useless, in my opinion, to base any calculation upon an advance in the metal. If anything, iron will be lower rather than higher within any reasonable space of time.

In looking, then, for a location where iron smelting can be made profitable under the existing conditions of the market, and to meet the highest wants of the trade, the very first thing to be taken into consideration is where to find a suitable fuel and existing railroad communication with the surrounding world.

There can be no question as to what kind of fuel is required. It must be mineral coal. The days of charcoal furnaces are numbered, and they will soon be of the things that are read of in history. The fossil fuel, according to quality, must be in its natural condition, as anthracite, dry-burning bituminous, or block coal, or coke made by charring bituminous coals. The coal must contain the smallest possible quantity of sulphur, phosphorus and ash, since these impurities will be imparted to the iron, and thereby reduce its market value. If bituminous coal is used raw, or without being coked, then its physical properties must be such as will cause it to coke and burn in the furnace without melting and forming a cake, since the latter coals obstruct the draft of the furnace and interfere with ready combustion. The proper fuel having been found, the next point to be settled is the location of an abundance of iron ore that is rich in metal and poor in sulphur and phosphorus. In the west there is at present but two districts known where such ores can be found that answer these requirements in the fullest possible manner: the Lake Superior iron region and the Iron Mountain, Missouri. At neither of these celebrated districts can coal be had, and charcoal furnaces can no longer be made to pay. The question of freight now settles the point with regard to the fact that the ore must be transported to the fuel, since it will require twice as much coal, by weight, as ore to produce a ton of metal.

There are, in my opinion, only three districts where coal can be found that will enter into competition for the smelting of these ores: Youngstown and Pittsburg, Pennsylvania, and their vicinities and Clay county, Indiana. The two former localities and their capabilities are well known, so that it will not be necessary for me, at this time, to make further mention of them, but will confine myself to bringing more prominently before the public the facilities afforded by Indiana for the production of Bessemer pig iron profitably at the present low rates of iron and steel.

There are three seams of block coal in Clay county, and they are designated by the miners as upper, middle and lower block coal seams. It is rarely that the three seams can all be worked on the same property in this county. The glacial drift covers the land to a depth varying from twenty to sixty feet, and the lower seam of coal seldom lies more than eighty feet below the surface, so that the upper coal is often absent, and when present is seldom found with any roof more than gravel and sand of the drift, which makes it costly and difficult to mine. The middle and lower seams are often present and worked on the same property from a single shaft. The three seams are respectively twenty and forty feet apart, and each average from three feet to four feet six inches in thickness. The lower seam is considered the best blast furnace coal, and even this is, at some localities, unfit for such use on account of the sulphur which it contains; while at others it is as free from sulphur as wood charcoal. It contains from fifty-six to sixty per cent. of fixed carbon, and only from one to two and a half per cent. of white ashes. This coal burns freely without caking, and in grates or furnaces never leaves any cinders. Charred in ovens it makes a steel-grained, hard coke, resembling in shape the raw block coal from which it was made.

I desire to say here that many writers who have compared the block coal of Indiana with the coal of other districts, have either selected specimens from the grate and steam coal, or have extracted from my reports the analyses of coals that are not used or fitted for smelting iron. Indeed, in some instances men, eminent as geologists and chemists, have selected from my tables of analyses as a typical specimen with which to compare coals they are writing up—coals that are not block coals at all, and it is so stated in the body of my report. I do not pretend to deny that we have in Clay county caking coals and block coals that are totally unsuited for smelting iron, and I want it particularly understood that I am now writing of none but the best, and of these we can find plenty in the State and district of which I am writing.

Since the blast furnaces were built in Clay county there has been something learned in regard to the best form of furnace to run with raw coal, and especially with regard to the necessary amount of blast and the best mode of heating it, so that it will be safe to say that a furnace may now be built that will materially lessen the consumption of fuel and increase its monthly product.

We propose now to build a modern blast furnace in Clay county, Indiana, which shall be moderate in dimensions and supplied with Whitwell's hot-air ovens, and give from this the cost of making the very best grade of pig iron, such as will be suited for Bessemer steel. Before commencing its construction we will have to consider the place it is possible to have—

1. Suitable coal close at hand.
2. Abundant supply of water.
3. Railroad facilities to reach the ores and iron markets.

We will now suppose the furnace to be built sixty feet high, eighteen feet wide at the boshes, and supplied with three benches of Whitwell's hot-air ovens. The cost will be about $60,000. With regard to the cost of the property upon which to place the furnace. I will take a coal lease which I have in my mind, that comprises about 240 acres of good block coal, and pay a royalty of ten cents per long ton of 2,240 pounds of screened coal. The nut coal does not have to be paid for, and is a clear gain. The mine is opened by shaft, seventy feet deep, and is supplied by every convenience for hoisting and preparing the coal for market. This property will cost as it stands, with lease to run ninety-nine years, $6,000.

Cost of furnace	$60,000
Cost of coal property	6,000
Cost of coking ovens	2,000
	$68,000

In order to convey a better idea of the cost of running the furnace it will be necessary to quote from the accounts of the Brazil furnace, which went out of blast in the spring of 1877. In this furnace it required to make a ton of bessemer pig:

One and a half tons of Lake Superior Iron ore, which costs at Escanaba	$7 50
Freight to Michigan City, by lake	75
Freight from Michigan City to Brazil	1 30
4,250 pounds of raw coal	3 18
650 pounds of coke	1 33
1,200 pounds of limestone	62
Labor	2 50
	$17 18

At the new furnace, built on the coal seam, we will get the coal at a cost not to exceed ninety cents per ton, including royalty, delivered at the furnace. The account at this furnace will then stand thus:

One and a half tons best Lake Superior ore	$7 50
Freight from mine to furnace	2 05
4,250 pounds of raw coal	1 91
650 pounds of coke	1 33
1,200 pounds of limestone	45
Labor (about)	1 25
Repairs and incidentals	25
Cost of one ton of Bessemer pig	$14 74

The run will be about 1,600 tons per month, and the pig will be worth $19 per ton, at the furnace, for consumption in bessemer plants. In this calculation the consumption of fuel is based upon the amount required in the Brazil furnace, but with the Whitwell hot-air stoves it is reasonable to suppose that the consumption of fuel will be reduced, as well as the cost of labor, which is just as much every day or month, whether the furnace makes twenty-five or fifty tons of pigs per diem, and it must be admitted, at the present low price of labor, that in our new furnace the cost, per ton of iron, should not exceed $1.25 per ton of make.

With the advantages which Clay county unquestionably possesses for the manufacture of Bessemer pig, the iron-master can not doubt for a moment that the Bessemer plant should be placed here and by the side of the blast furnace, and the melted iron run direct from the furnace into the converters. This will secure an immense saving on the cost of making steel rails.

There are already furnaces enough in the United States, if all were in blast, and a material rise in iron would soon put them in, to supply not only this country, but leave a large surplus for exportation. Europe is also overstocked with idle furnaces, ready to rush into blast with the first symptom of an improved market for iron. Such a blowing in, it is easy to foresee, would soon cause the market to tumble. Consequently the day is close at hand when blast furnaces and Bessemer plants must be brought together and located on the coal.

Coal can be mined as cheaply in Indiana as in any other coal field. The shafts are shallow and inexpensive; the roof is good, and cheaply secured against danger of falling, and the mines are free from noxious gases. The coal itself is as free as possible from deleterious impurities, rich in carbon, and from physical structure and the peculiar arrangement of its proximate constituents, is peculiarly adapted for fuel and metallurgical purposes. The field is accessible from all points by railroads, and lies in the very center of western commercial prosperity and progress. With such advantages can any one doubt for a moment that Bessemer pig and Bessemer steel can not be made here at a less cost than in plants, located where neither the coal nor ore are to be had, without being brought from a distance. In the struggle for existence now going on, those alone can live that have the most favorable locations with regard to the cost of fuel and ore. It is the question of the survival of the fittest, and those who look for any material advance in the price of iron will look in vain.

Far better will it be to seek for furnace locations, where a ton of steel can be produced with profit under the most depressed condition that may arrive in the market. After a study of the western coal field, extending over a period of more than thirty years, I can point with confidence to the block coal field of Indiana as the locality in which to solve the problem of the lowest cost of production. Cheaper iron may be made elsewhere, but it is of *Bessemer pig* and *Bessemer steel* I speak, and for which I commend this field to the attention of ironmasters.

WAYNE COUNTY.

Wayne county was organized in 1810, and was named in honor of General Anthony Wayne. Previous to this time there were only three counties in the then Territory of Indiana, viz: Knox, Clark and Dearborn. Wayne county was formed from a portion of the latter county. The first county seat was called Salisbury; but this town was doomed soon to be deprived of its honors as a law center, and so rapid was its decay that not a vestige now remains to mark its location.

The county seat was moved from Salisbury to Centreville, so named from its geographical position in the county. It remained there until moved to Richmond, in 1875, which is the present seat of county business.

The early settlers of this county were mostly from North Carolina and Virginia, and belonged to the society of Quakers. They were mostly intelligent, sober and industrious people. They took an active interest at an early day in the internal improvement system organized by the General Assembly for the cheap transit of western produce to the chief markets of the country. The Cumberland or National road, designed by the General Government to connect Baltimore with St. Louis, passes very nearly through the center of the county from east to west. Though never completed beyond the western border of Indiana, this road was of incalculable value to the farming and manufacturing industries, and important towns grew up at short intervals along its entire course. The largest of these are the city of Richmond (which contains a population of 12,600), Centreville, Germantown, Cambridge City and Dublin. The National road was followed by the White Water Valley canal. This great improvement extended from Hagerstown, on the west branch of White Water river, down the valley of that stream to Cincinnati, on the Ohio river, passing through Cambridge City and Milton. The canal soon made Cambridge City a large shipping point for produce, and it became the center of a vast trade with the surrounding country. Another canal was located from Richmond to Brookville, in Franklin county. This work was partly completed, but never finished. The White Water canal is no longer in use for the transportation of produce, having been completely superceded by the White Water Valley railroad, which runs along its banks. Locally the Canal furnishes an admirable water power, and is still an important adjunct to the manufacturing interests of this and the adjoining county of Fayette. In the latter county, at Connersville, it furnishes the power for the large works of Messrs. Roots, in which is manufactured the world-renowned Roots' blower. At Cambridge City and at Milton the Canal is also utilized as a water-power for manufactures.

This county is now well supplied with railroads. The Pan-Handle road, from Indianapolis to Pittsburg, follows the course of the old National road, and passes through Dublin, Cambridge City, Germantown, Centreville and Richmond; the Fort Wayne & Richmond railroad, running through Fountain City, in Garden township; the Chicago division of the Pittsburg, Cincinnati & St. Louis railroad passes from Richmond through Washington and Hagerstown; Dayton & Richmond railroad; Richmond division of the Cincinnati, Hamilton & Dayton railroad; Cambridge City & Columbus railroad; Fort Wayne, Muncie & Cincinnati railroad runs through Cambridge City; White Water Valley railroad runs from Cambridge City to Cincinnati, Ohio, following the line of the old Canal; there is also a short line of road running from Hagerstown to Cambridge City. In addition to this very extensive system of railroads there are innumerable gravel roads leading in and out of all the principal towns and villages in the county, and, indeed, through almost every neighborhood, so that in respect to internal improvements, that furnish egress and ingress for travelers and commerce, no county in the State, except Marion, can boast of greater facilities.

TOPOGRAPHY AND HYDROGRAPHY.

The characteristic topographical feature of the county is that of an elevated campaign, or table-land, which gradually slopes from the northern boundary of the county to the southwest. The general elevation of the north part may be stated at 1,200 feet above mean ocean tide in New York harbor, and that of the southern part of the county at 900 feet.

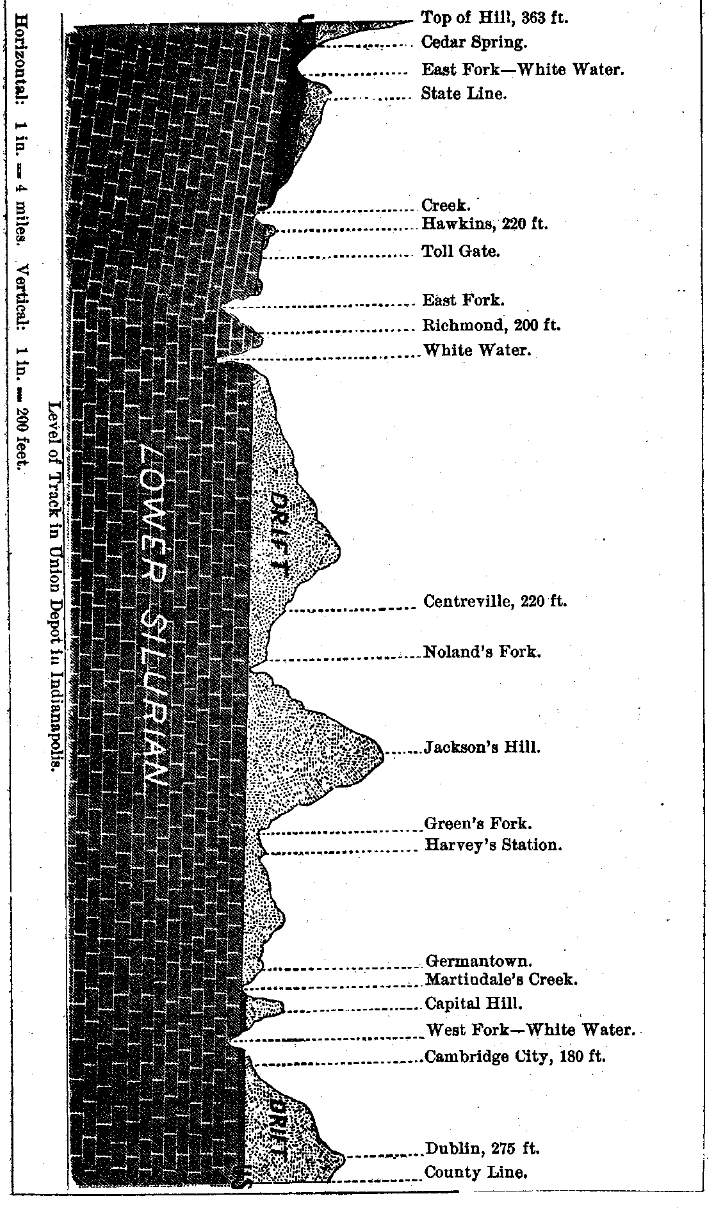
This plateau is cut through by innumerable rivulets and larger streams that have their sources in the north part of the county, and flow to the southwest, and finally fall into the White Water river. The eroding effects of these streams are not so marked in the north, where they carry but a small volume of water, as we find in the south; there they run through broad shallow valleys that are not cut below the tough boulder clays of the drift, but in the south part of the county the erosion has, in some places, been carried far down into the beds of the Hudson River group of rocks. At the city of Richmond this phenomena is so marked that we may, with propriety, speak of the eroded bed of White Water river as a veritable canon. The banks here are composed of 100 to 110 feet of Hudson River rocks, that in places form almost vertical mural shores to the stream. The Pan-Handle railroad bridge spans this stream across a narrow part of its canon. Along the principal water-courses there, this plateau is interrupted by deep erosions, which terminate very rapidly as you recede from the streams, and the country opens into beautiful level tracts. A glance at the map will show that this county is well supplied with streams of living water. The west branch of White Water river, with its principal tributaries, Nettle fork, Martindale's fork, Green's fork and Noland's fork, spread out over at least two-thirds of the county, and the balance is watered by White Water river and its tributaries, Elkhorn creek, Short creek, East fork, Middle fork, West fork, Lick creek, and numerous smaller branches that have only local names. The large area of level lands, covered with a grand forest which includes every variety of timber that grows in this latitude, and the numerous streams of clear running water, must have proved an attractive sight to the early emigrants, and the rapid growth of the county in population and wealth, has given proof that no part of the country afforded a truer prospect for happy homes.

GEOLOGY.

The oldest stratified rocks in this county belong to the Hudson River group of Prof. James Hall. The name was first applied to the rocks of the Lower Silurian age that crop on the Hudson river at New York. The name was subsequently changed by Meek and Worthen to that of Cincinnati group. I have already, on page 4, given my reasons for retaining Hall's name. This group of rocks has also been called the Nashville group by Prof. Safford in his report on the geology of Tennessee. At Cincinnati and at Nashville there are extensive crops of these rocks, and hence the desire to apply to them local names. Now, if the relative strata were found no where else we might tolerate these new names, but it so happens that they exist in various parts of the United States and cover large areas of its surface, and to multiply names is simply adding confusion to the nomenclature. The Hudson River beds are seen in the southern part of the county, where they have been exposed by the removal of the Niagara beds and the surface drift. The geological structure of the county will be better under-

PLATE 3.

Profile and Section across Wayne County, along the Pan-Handle Railway from Dublin to Richmond, from thence east along the Turnpike.



stood by the following section, which shows the order of the strata from the eastern boundary of the State to Dublin, on the western boundary of the county. It is taken for convenience along the line of the Pan-Handle railroad, from Dublin to Richmond, and from the latter place to the State line along the turnpike road from Richmond to New Paris. See Plate No. 3.

From the State line to Richmond the direction is a little south of east, and from Richmond to Dublin the course is nearly east and west. The levels are given above the city of Indianapolis, which has been taken as a base line. The Union Depot track at the latter city is, by the best authorities, computed to be 721 feet above mean ocean tide in New York harbor. The horizontal scale of the section is four miles to the inch, and the vertical scale 200 feet to the inch. The highest point reached lies to the south of New Paris, in the State of Ohio, and near the celebrated Cedar Springs. The top of the hill is here, by barometer, 365 feet above the level of Indianapolis, or 1,086 feet above the ocean. The top is covered with a deposit of drift composed of large and small boulders of crystalline and metamorphic rocks, pebbles, sand and clay, in all thirty feet thick or more. Under the drift is twenty feet or more of Niagara limestone, which is best seen at the quarries between Cedar Springs and New Paris. The Niagara beds are here worked extensively for flagging and for foundations to houses, bridge piers, etc. It is a light-buff magnesian limestone in the upper part and bluish colored in the bottom. The section seen at Leander Marshall's quarry showed the following order:

	Ft.
Soil	1
Buff magnesian limestone, flagging	7
Clay	2
Magnesian limestone, 8-inch layers	2
Blue magnesian limestone of coarse crystalline structure	2
	14

The lower bed contains one layer about one foot thick. The Niagara rocks are seen in the bank of the west fork of White Water river at several places contiguous to the State line, and are marked by characteristic fossils: *Orthoceras angulatum, O. columnare, O. crebescens, Hemipronites radiata, Pentamerus oblongus, Calymene blumenbachi, Favosites niagarensis, Lichenalia concentrica, Orthis elegantula, Platyostoma niagarensis and Dalmania verrucosus.*

Going west, the Niagara beds are mostly covered with drift, but there is a very good exposure in a ravine where it has been cut through by a small creek. The beds here are more shaly than at New Paris, and are of but little use for building purposes. The blue argillaceous soft shales of the Hudson river beds are exposed in the bed of the creek, and the Niagara above is about twenty feet thick. It contains a few fossils: *Meristina nitida, Rhynchonella tennesseensis, Orthoceras simulator, Platyostoma niagarensis, Pentamerus oblongus, Favosites niagarensis, Streptelasma minima* and reticulated Bryoza.

As we approach Richmond the Niagara is absent, and was probably removed by erosion, which must have taken place on a large scale at this part of White Water valley. There are then no other exposures of this formation along the line of the section until we reach the valley of Martindale's creek at Germantown, and the valley of west branch of White Water river at Cambridge City. The difference in elevation of the Niagara at the State line and where it is seen at Cambridge City is about sixty feet, and the distance is about twenty miles. If the section, then, was in the line of greatest dip, it would only be at the rate of three feet to the mile. Indeed, I do not feel able to say in what direction will be found the greatest dip of the strata, for locally the pitch is very slight, and you may find at any large exposure of the rocks in this county that the dip is sometimes in one direction and sometimes in another, as though the strata had been laid down on an uneven sea bottom. Jackson's hill, on the divide between Noland's fork and Green's fork, is 330 feet above the Union depot tracks at Indianapolis, or 1,051 feet above the ocean; and the hill at Cedar Springs, at the eastern end of the section, is 1,086 feet. These numbers agree so closely that I am led to conclude that at one period of the Glacial epoch the country between these two points was almost a level plain, and the intervening gaps have been eroded by the vast volume of water which flowed from the glaciers' southern border as it gradually retreated to the north. There are great numbers of large erratic boulders on the top of Cedar Spring hill, and on the dividing ridge of which Jackson's hill is a part.

At the falls of Elkhorn creek, four miles nearly south of Richmond and southwest of the Niagara crops, on the east fork of White Water, there is a crop of buff-colored magnesian limestone overlying the Hudson River rocks, and form the falls of that stream. It is from twenty to twenty-five feet thick, and has been variously referred to the Clinton and the Niagara. The upper part of this bed is unquestionably Niagara, and, for my part, I have no hesitation in referring the whole to that age, and it is also my opinion that no distinction can be drawn, either from lithological or palæontological evidence that will justify the placing of the Upper Silurian rocks of this State in any other than the Niagara epoch.

A vertical section of the rocks at this locality shows the following order:

	Ft.	In.
Drift, composed of large boulders, gravel, sand and clay...	80	
Niagara, buff magnesian limestone..................................	25	
Blue argillaceous shale..	3	

Blue limestone, Hudson River rocks, in seven layers:

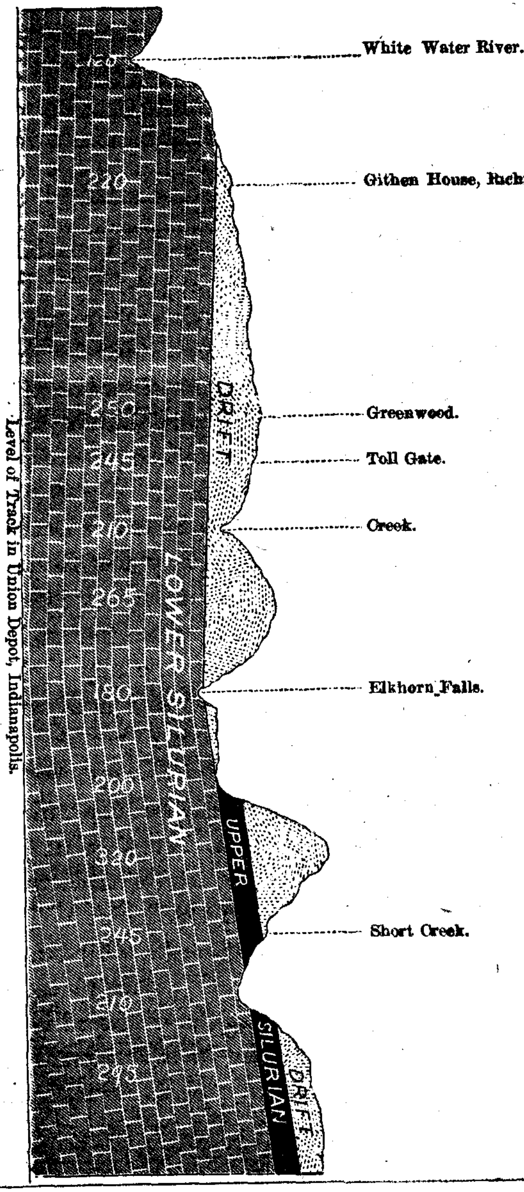
	Ft.	In.
First layer	0	7
Second layer	0	8
Third layer	0	6
Fourth layer	1	0
Fifth layer	0	6
Sixth layer	0	8
Seventh layer	0	4
Bed of Elkhorn creek.		
	112	3

The upper part of the Niagara is grayish-colored magnesian limestone, very coarse-grained, and contains a few fossils of which I recognized: *Halysites catenulata, Favosites niagarensis, Chonophyllum niagarensis, Meristina nitida*, reticulated Bryozoans, fragments of *Calymena blumenbachii*, and numerous fragments of stems of Crinoids.

The lower part of this formation is a buff-colored, coarse-grained magnesian rock, that contains very few fossils of any kind. In the upper part I found a badly-weathered specimen of *Halysites catenulata.* These magnesian beds are hard weathering, and rest upon soft, shaly beds of Lower Silurian, which are more easily eroded and carried away. At the Elkhorn mills they form a vertical wall across the creek, over which the water falls some twenty to twenty-five feet, and has cut away a portion of the underlying Hudson River shales. These falls have in time been cut back a half a mile or more, or from a point down the stream where the Niagara first makes an appearance. Where this magnesian rock terminates lower down the stream it maintains its full thickness, and there is reason to believe that the absence beyond that point to the westward is due to glacial abraision. Plate No. 4 shows a horizontal section from the falls on Elkhorn creek to Richmond, Ind., a distance of four miles. The Upper Silurian beds are here 245 feet above Indianapolis, or 966 feet above the ocean.

PLATE 4.

Section from Richmond to Elkhorn Falls, Wayne County, Ind. Distance 4 miles.



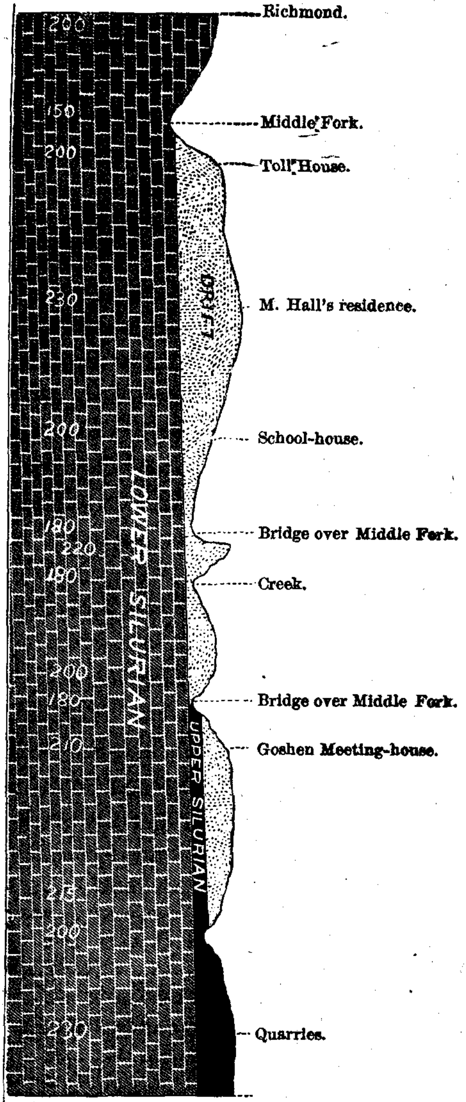
Horizontal: 1 in. = 1 mile. Vertical: 1 in. = 200 feet.

If we compare this elevation of the Niagara here with the elevation of the same beds on the East fork of White Water, and near the State line, and about six miles to the northeast, it will be found that they agree so closely that it affords no evidence of a dip in that direction. The elevation of the latter above the ocean is 961 feet—a difference of only five feet. Then, again, it will be seen by the section extending from Richmond to Middleboro, a distance of ten miles, taken along the Middle fork of White Water and following the turnpike road (Plate No. 5), that the elevation of the Niagara beds are 230 feet above Indianapolis, or 951 feet above the ocean. By this section the Niagara is thirty-six feet lower at Middleboro than at the falls of Elkhorn, and thirty-one feet lower than the crop at East fork, which lies about three miles to the south. From these sections it would appear that there was a slight dip of the strata to the northward. At Middleboro the Niagara has been extensively quarried for burning into lime and for building purposes. By the Hillsboro pike it is called seven miles from Richmond to the quarries. Boyd & Cook's quarry lies in the valley of Muddy fork, and about one hundred yards from the bank of the stream. The rock has been worked down about four feet below the bed of the river, and at the time of my visit the large basin which had been excavated by removing the stone was filled with water from an overflow of the stream, so that I did not get to see the lower beds in place. The section obtained shows:

	Ft.	In.
Buff decomposing rock, not used	1	6
Gray friable beds, lower part filled with Pentamerus oblongus	2	6
Gray and mottled schistose, thin bedded	4	0
Lower layers, under water, containing chert, and called flint stone	4	0

PLATE 5.

Section from Richmond to Middleboro, along the Middle Fork of White Water. Distance 5½ miles.



Horizontal: 1 inch = 1 mile. Vertical: 1 in. = 200 feet.

Level of Track in Union Depot, Indianapolis.

The analysis of this stone shows it to contain:

	Per Cent.
Water, expelled at 212° F.	1.00
Silicic acid	1.38
Oxide of iron	1.40
Alumina	4.30
Lime	45.10
Magnesia	4.36
Carbonic acid	40.15
Sulphuric acid	0.35
Loss and undetermined	1.96
	100.00

The gray-colored magnesian limestone is not very dissimilar in its composition from the Niagara beds of Huntington county, which are celebrated for the admirable quality of caustic lime which they yield.

Messrs. Boyd & Cook have erected by the side of their quarry two perpetual lime kilns, and burn from 25,000 to 36,000 bushels of lime per annum. The color is white, and it has a good reputation in the market. It is a slow-setting lime, and masons may spread from six to nine brick at a time before leaving.

Their lime is also used in the gas-works at Richmond as a purifier to remove the carbonic acid and sulphuretted hydrogen gas from the illuminating gas.

Boyd & Cook pay $3.00 per cord for wood, and two cords of wood are sufficient, in Page's patent kiln, to burn one hundred bushels of lime, while in Schroder's patent kiln, according to their experience, two and a half cords are required.

The most abundant fossils in the Niagara at this locality is a Brachiopod mollusc—*Pentamerus oblongus*. These fossils are so abundant that in some of the layers they lie packed upon top of one another, and constitute almost the entire substance of the stone, and have the same chemical composition. This quarry has furnished a large number of magnificent slabs, filled with these fossils, to decorate and add to the scientific value of all the cabinets in the country.

If we take a close view of the exposures made by the quarrying of the stone over a large area of its surface, it will be seen that by the road it dips 3° or 4° to the west, and on the east side the dip is at one place to the south and at another to the north, but at most only three or four degrees. In fact, the quarrymen say there is no regular dip—the slight pitch is sometimes in one direction and sometimes in another. It will be observed on the section that there is a crop of the Niagara at two places on the Middle fork, between Middleboro and Richmond, at about the same level as the quarries; at these localities there is a paucity of fossils. We have here the following succession:

	Feet.
Drift, composed of large boulders of metamorphic and crystalline rocks, lying upon the surface gravel and clay......	20
Niagara beds:	
Buff colored, rough weathering magnesian limestone, containing *Halysites catenulata*, and *Favosites niagarensis*.............	10
Hudson river:	
Blue schistose limestone, with intercalated argillaceous shale, containing *Zygospira modesta*, *Rhynchonella capax*, *Orthis occidentalis* and *O. biforata*................................	8
Bed of Middle fork.	

A little to the southeast of the above crop of the Niagara we have at nearly the same elevation another crop of these beds that give rise to the falls of the West fork of White Water river. It is here, also, a buff magnesian limestone, about ten feet thick, and forms a complete mural cliff across the stream, over which the water falls a distance of ten feet or more. The surface above the falls is scratched and grooved by glaciation. Some of these grooves are deep and long. Their direction, as nearly as I could determine, is south 40° west. The following section shows the order of strata at this locality, extending up to the mound in Mr. Ratliff's field:

	Feet.
Surface soil and clay	10
Drift, large boulders, gravel, sand and clay	40
Niagara limestone	10
Argillaceous shale and bluish thin-bedded schistose limestone, belonging to the Hudson River series, in the bed of stream.	?

The rock forming the falls is a buff-colored magnesian limestone, that contains in the upper part a number of fossils; the most abundant are Rhynchonella.

There can be no doubt of this rock being the equivalent of the strata that form the falls of Elkhorn creek, about eight miles to the south, with which it agrees also in its color and general lithological features. Though in the latter respect it differs from the beds at Middleboro and on the the East fork. The equivalency is clearly proved by tracing the intervening crops.

To the south of Cambridge City about two miles, and on Simon's creek, the Niagara appears only a few inches thick, and rests immediately upon thin layers of Hudson River limestone. The position is shown on Plate No. 5. Along the bottom of Simon's creek, and on Mr. M. K. Meyer's land, section 33, township 14, range 12, the above rocks are seen at the water's edge, and have been quarried on a small scale for lime and for walling cellars, underpinning barns and dwelling houses.

The quarrying is carried on in the bottoms along the creek, by throwing off the superincumbent alluvial deposit, some three or four feet thick, and then prying up the stone, which is in quite thick layers, and has a rough, uneven surface. The first freshet of the creek fills up these pits with sediment and water, so that it becomes easier to make a new opening than to clean out the old, when the work of quarrying is renewed, and a great many abandoned pits are scattered over the locality. As no quarrying has been done here for some time, the only opportunity afforded for the examination of the stone was a small lot of partly refuse stone, which still remained by the side of one of these pits. In times past this locality furnished caustic lime for the surrounding country, but the quality is not good, and with the improved facilities for transportation, it has been entirely replaced by a better article from a distance, and the manufacture abandoned. The Niagara layers are buff-colored, coarse-grained, and contain a number of crinoid stems. The Hudson River layers contain *Orthis lynx, O. occidentalis* and *Strophomena alternata.*

On Mr. A. Baldwin's farm, not far from this place, there is a so-called "Shaky Hill." The citizens of Cambridge City were from time to time astounded by reports, which found their way into the newspapers, of the wonderful shakes that were convulsing this hill, and my friend Dr. E. S. Hoshour, of that city, sent for me to come down, and accompanied me to the spot to take a look at it. Mr. Baldwin says that "Shaky Hill" was first settled by Willis Ragan, over fifty-five years ago, and that he was repeatedly alarmed, while living there, by the violent shaking of his house, when all other portions of the country were undisturbed. Other families, who subsequently lived in the house, testified also, that the hill was known to shake, and at one time so violently as to throw the dishes from the table, and that the shaking was accompanied by a rumbling noise. The spot is not, strictly speaking, a hill, but is a portion of the tableland that terminates abruptly on the bottom of Simon's creek, and is bordered on the sides by shallow washes that give rise to ravines. The elevation above the bottom is about sixty feet, and the whole mass is made up of glacial drift—gravel, clay, sand and small boulders. The drift is underlaid by Niagara limestone, which is seen in the bed of Simon's creek, and just covered at low water.

Everything was quiet at the time of my visit, and I could see no trace of any kind of disturbance in the heterogeneous drift which everywhere forms the high land in this part of the county, and is from sixty to 120 feet thick. The underlying stone is not seen immediately at the so-called hill, consequently we have to judge its character by what is known at the quarries already alluded to above; this indicates that it is a schistose and thin bedded rock near the surface, and here, as elsewhere in the county, underlaid by thin-bedded limestone, alternating with beds of argillaceous, shaly rocks, a character of strata that are yielding and too much broken by vertical joints or fissures to lead us to attribute to them the cause of any local disturbance that would give rise to the phenomenon claimed to have been witnessed at "Shaky Hill."

Though I can see nothing here that would enable me to refer such a phenomenon to geological or any other cause than of unconscious personal deception, it will not do to lose sight of the fact that in certain localities disturbances of the surface strata have been known to take place from the cracking and bursting of the rocks. This may be due to various causes, some of which may not be fully understood. Colonel Totten, of the United States department of engineers, made a series of experiments to determine the rate of expansion of various kinds of rock for an increase of one degree of temperature. From the data he furnished, Sir Charles Lyell has calculated that a mass of sandstone a mile thick, raised in a temperature 200° F. would have its upper surface elevated ten feet.*

*Principles of Geology, Vol. 11, p. 237.

Elevations or depressions of the surface of rock beds due to climatic changes would naturally be brought about very slowly, but where the beds are of an unyielding character, or in very thick and persistent layers, the strain may become sufficient to finally crack and break the mass, accompanied by a report and more or less shock.

Mr. W. H. Niles, of Cambridge, Mass., gave a very interesting account of the uneasy condition of rocks in a quarry at Munson, Mass., in a paper read before the American Association for the Advancement of Science, and published in their proceedings of the Portland meeting, 1873, p. 156, from which the following extract is taken:

> The quarry embraces an area of five or six acres, upon the gentle slope of a moderate-sized hill. The rock is gneiss, without any apparent planes of stratification, but of schistose structure. Divisional planes cut across the stratification and divide the rock into beds, which vary in thickness from one inch and a half to five feet or more. These beds are extensive, and are not broken by any other divisional planes. They conform to the surface of the hill, being in some places horizontal, at others dip about 10°. When a strata of any considerable length is quarried, it is found to expand in the direction of the strike, northerly and southerly. The expansion was found to be one and a half inches in 354 feet long.

Another result of this rock expansion, he says, is the formation of numerous cracks and fissures, attended sometimes by violent explosions. Mr. A. T. Wing informed him that in the latter part of June, 1872, there was a natural breakage which extended about two hundred and seventy-five feet, and was about seventy-five feet back of the working face. One end of the loosened mass remained solidly attached to the underlying rock, and by its expansion about 10,000 tons of rock were moved.

These cracks or rents are more commonly formed slowly, but sometimes suddenly, attended not only by the breaking, shattering, and even crushing of the solid rock, but by a loud report and sometimes by the throwing of stones of considerable size for a short distance. On the morning of the 18th of June, 1873, at about six o'clock, the engineer was startled by an explosion, and looking toward the quarry saw stones and other debris in the air, being thrown to a considerable distance. Mr. Niles visited the spot on the 20th, and found it looking much as though a small but powerful earthquake had taken place. A bed five feet four inches thick had been ruptured in two nearly parallel fissures, each of which measured sixty-eight feet in length. Besides these the rock was otherwise much broken, and in places shattered and crumbled, and some of the liberated stones were thrown southward, but none in any other direction. These fractures were from eighteen to twenty feet from the working face.

I mention these phenomena for the purpose of showing that we have well authenticated cases of uneasy beds of rock, which may under certain conditions give rise to a local shaking up of the surface.

There is another tradition connected with that relating to "Shaky Hill," and that is, on a spot near by, and also on Mr. Baldwin's land, the surveyor's compass will not point to the magnetic pole. This being a question susceptible of direct proof, I was enabled to show that my own compass was in no wise disturbed at any place tested, but would point out with unerring accuracy that the fence on a section line was in a north and south course.

I will state in this connection that it is not an uncommon thing for me to receive notice that in certain localities, on land in different parts of the State, the surveyor's compass will not work properly. When such localities have been examined it invariably proved that the compass will work as readily there as anywhere else. But it is not to be denied that there are places on the earth's surface where the magnetic needle is disturbed and drawn from the magnetic pole, such as in the presence of large bodies of magnetic iron ore. But there is no possibility of finding this mineral in places within the borders of Indiana. Small pieces have been picked up now and then from the glacial drift, but at no time has it been found in sufficient quantity to effect the needle of a compass unless they are purposely brought very close together.

The needle of a surveyor's compass may be disturbed by the possible electrical state of the glass which covers it, and this might lead to the belief that the cause was to be looked for in the earth.

There is a general tendency in the minds of people, who have not been schooled to observe, to deceive themselves and indulge in mysteries where none exist; such illusions are readily dispelled when put to a crucial test.

By looking at the plates giving sections of the rocks in different directions from Richmond, north, south, east and west, it will be seen that there is but little difference in the elevation of the Niagara beds at any of the crops, and if left to study the dip from them alone, we should be unable to decide on its general direction; but carrying the investigation beyond the boundary of the county it is proved to be in a west or southwesterly direction. At Terre Haute the Niagara was probably reached at the depth of 1,700 feet in the artesian well bored for petroleum. The elevation of the Niagara on Elkhorn creek is 965 feet above tide-water in New York harbor. In the artesian well at Terre Haute it is 1,196 feet below tide-water, and 216 feet below the crop on Elkhorn creek. The lineal distance between the two points is about 140 miles, and the dip is consequently, in this direction, about fifteen and a half feet to the mile.

HUDSON RIVER GROUP.

The rocks belonging to this group lie immediately under the Niagara, since we are not able to establish the presence of the Clinton, which in regular sequence forms the intervening strata.

The Hudson River group is well expressed in this county on the three forks of White Water river near Richmond, and from thence southward along the main stream and its tributaries to Abington, in Abington township. Horizontal sections were made from the latter place to Richmond, following the pikes on both sides of the river, a distance of about eight and a half miles. Plate No. 6 is taken on the west side of the river and shows the position of the rocks above the horizon of Indianapolis and the degradation which has taken place along the streams.

Plate No. 7 is taken on the east side of White Water river. This section, going south from Richmond, first strikes the river below the cemetery, Elkhorn creek at its mouth, and again reaches the bed of the river at Abington. It will be observed that the Lower Silurian rocks have the same thickness on the east side of the river at Abington as at Richmond. Between the highest point traversed there and the school-house, No. 4, the total elevation is about the same, that is 240 feet above Indianapolis, or fifty feet higher than Richmond. This difference is due to the removal of the greater portion of the drift at the latter place. The following sections, taken along the river bank at Richmond, exhibit the arrangement of the strata comprising the Hudson River group:

Section near Starr's gas-works:

	Ft.
Drift	4
Buff shaly limestone	90
Bed of river.	

PLATE 6.

Section from Richmond to Abington, Wayne county, Indiana, west of White Water River. Distance 8½ miles.

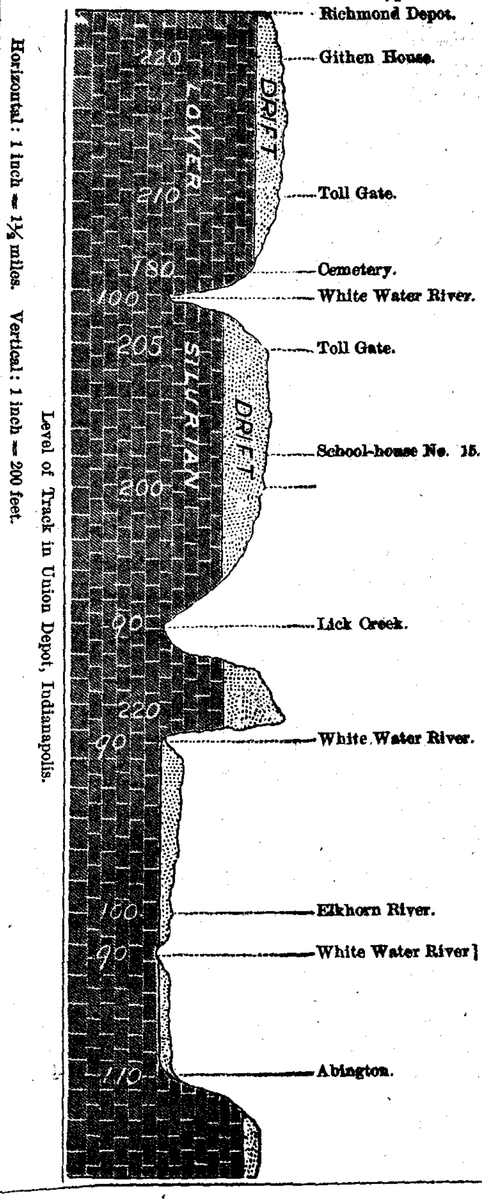
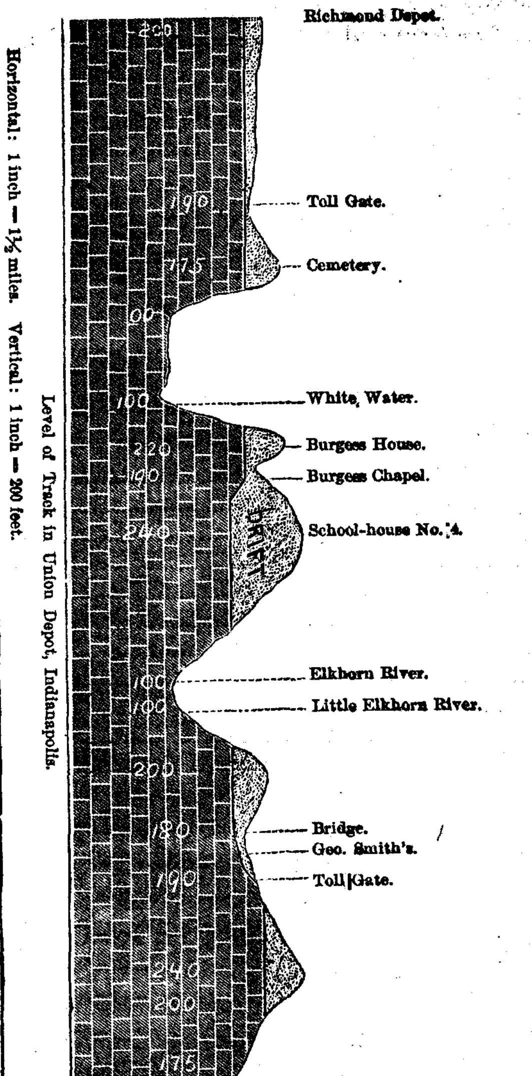


PLATE 7.

Section from Richmond to Abington, east of White Water River. Distance 8½ miles.



The buff shaly limestone of the above section contains an abundance of *Orthis lynx*, *O. biforata*, *O. lynx*, *var. acutilirata*, *Rhynchonella capax*, *Zygospira modesta*, *Strophomena attenuata*, *Chonetes frondosus* and *Petraia corniculum*. Under these beds are bluish argillaceous shale and hard bands of stone, here covered with the debris from above.

Only a few of the most common occurring fossils are here given, as Mrs. Mary Haines, of Richmond, was kind enough to supply me with a complete list of fossils found in the Hudson River beds in this county, so far as they are known, and are represented in her extensive cabinet. This list will be given in full on page 201.

A little further down the river, and at Brinkmire's quarry, the following section is seen, and commences sixty-five feet above the river:

	Ft.	In.
Grayish buff, soft shale	8	0
Bluish gray, soft shale	5	0
Top layer, quarry stone	0	10
Blue stone	2	0
Shale	0	2
Blue stone	0	8
Shale	0	5
Stone	0	4
Shale	0	2
Stone	0	7
Covered	47	0
River.		
	65	2

These beds all contain fossil shells—*Strophomena alternata*, *Rhynchonella capax* and branching species of *Chætetes*. The top layers were especially full of fossils. The stone from the quarry sells at seventy-five to eighty cents a perch.

At the mill-dam just below the city of Richmond, and on the east side of the river, the banks rise abruptly to the table-land, leaving a fine exposure of rock that is highly fossiliferous from top to bottom. The section exhibits:

1.	Thin-bedded, buff-colored limestone, alternating with argillaceous shale, buff and bluish color	20 to 30 ft.
2.	Quarry rock	30 to 40 ft.
3.	Bluish shaly beds	10 ft.
		80 ft.

No. 1 of the above section contains a great abundance of *Petraia corniculum*, small branching *Chætetes* of various species, *Palæophycus simplex, Buthotrephis gracilis, Tetradium fibratum, Orthis occidentalis, O. lynx, var. biforata* and *acutilirata, Rhynchonella capax, Strophomena alternata, Zygospira modesta, Ambonichia radiata, Modiolopsis modiolaris, Cyclonema bilix*, etc.

No. 2 contains *Rhynchonella capax, Strophomena alternata*, etc.

No. 3 shows a great abundance of *Leptæna sericea*, and the slopes are literally covered with the valves of these shells and *Streptorhynchus*, at the water's edge.

In the lower beds Mr. W. D. Schooley, who accompanied me, had previously found a *Calymene senaria*, but they are not common. Following down the stream to the crossing of Elkhorn and Little Elkhorn, the same beds are found in the cuts below the drift. Opposite the town of Abington the country rises very rapidly from the stream to the table-land, and we find the same succession of thin bedded limestones and shale as at Richmond:

	Feet.
Drift, composed of gravel, sand and clay, with a few large boulders here and there over the surface	40
Yellow, schistose limestone, with an abundance of *fucoids, Buthotrephis gracilis, B. succulosus, Chætetes frondosus, C. lycoperdon, Favistella stellata, Petraia corniculum, Orthis occidentalis, O. biforata, Rhynchonella capax, Strophomena alternata, Zygospira modesta, Ambonichia radiata, Cyclonema bilix, Murchisonia bellicincta*	25

	Feet.
Bluish shale and thin bands of limestone, containing a variety of fossils, the most notable of which are *Streptorhynchus planumbona*, *Leptæna sericea*. These species are in the greatest abundance near the water's edge, and literally cover the entire surfaces of two distinct layers of stone. This part is	175
Total	240

I consider *Orthis lynx*, *O. laticosta*, *O. dentata* and *O. acutilirata*, the same as *O. biforata*. This shell has a wide range of variation, being sometimes very gibbous, with rounded hinge line on the sides; in others the hinge line is prolonged into ears. It also varies in the number and character of the longitudinal plates; in some, these are shallow and numerous, in others they are comparatively small and thin. It is not an uncommon thing to find in the same beds specimens of this Orthis with the hinge line extending beyond the margin on one side, making an acute ear, while it rounds off on the other side.

Prof. James Hall justly remarks in regard to this Orthis, Palæontology of New York, p. 133: "This species, like many of the brachiopoda, is influenced by local circumstances, and in its wide geographical distribution presents varieties of forms or types peculiar to different localities dependent apparently upon the condition of the ancient ocean bed."

The variations which they undergo may be considered as due to the environments, and therefore their use to point out a difference in geological time can not be relied upon.

Back of the town of Abington we have the same succession of strata, but the upper beds are covered by drift.

The same beds are also seen on the west side of the river, on the banks of Lick creek, and may be traced from there for two or three miles up the latter stream. In the deep cut of all the streams that flow into Elkhorn creek the Hudson River beds are well exposed, and the rocks are crowded with fossils. It will be noticed also, by reference to the maps, that there are no tributaries entering Elkhorn creek from the north. A few hundred yards below the falls in Elkhorn, this rock is quarried for building purposes. At Mr. Provard's quarry, which lies on the south side of the creek, the stone is in good thickness—bluish-colored and close-grained. The following section shows the succession and thickness of the respective layers:

	Inches.
Friable Niagara stone	15
Two layers, 7 to 8 inches	15
One layer	10
One layer	6
One layer	12
One layer	6
One layer	8
One layer	4
Bed of creek	0

There is a slight covering of earth in places, and the strata has a very gentle dip to the southeast. The stone contains vast quantities of fossils, which are inseparable from the metrix in some of the layers. The third stratum from the bottom is considered the best stone.

Fifty feet below this quarry, on the creek, we have at Clayton Brown's quarry the following section:

Soil and clay, drift	5 ft. 0 in.
Buff magnesian limestone, Niagara epoch	2 ft. 0 in.

Hudson River stone in layers:

One layer	0 ft. to 0 ft. 8 in.
One layer	1 ft. to 1 ft. 3 in.
Shale	0 ft. to 0 ft. 6 in.
Stone	0 ft. to 1 ft. 0 in.
Shale	0 ft. to 0 ft. 6 in.
Stone	0 ft. to 0 ft. 4 in.
Stone	0 ft. to 0 ft. 8 in.
Bottom layer	0 ft. to 2 ft. 0 in.

Johnson's quarry has the same character of rock. The quarrying here is conducted for home consumption; the quality of the stone is fully equal to the best stone found anywhere in this formation. Rough stone sells at twenty-five cents per cubic foot, or three dollars a perch on the ground.

The Hudson River rocks are also seen in considerable force along the east, middle and west forks of White Water river, for short distances above their embouchure. On these streams the bluish, argo-calcarious shale, which underlies the Niagara where the succession is seen in this county, is here from thirty to forty feet thick, and the layers at the water's edge are thickly studded with fragments of *Asaphus megistos, Acidaspis cincinnatiensis*?, *Ceraurus sp.*?, *Dalmanites sp.*?, as well as other forms not sufficiently perfect to enable me to make out their species.

It is noticeable in this county, as well as elsewhere in the State, that the Hudson River beds of equivalent age do not always present the same lithological and palæontological features. On the east fork, where the identical beds with the above are exposed, I was not able to find a single fragment of crustacea, and but very few fossils of any kind. As observed by Mr. S. A. Miller, of Cincinnati, who has made a thorough detailed study of the Hudson River rocks, "the variation in color from blue to brown is due to the various stages of oxidation of the iron which they contain." Shales that are invariably blue when the face is exposed in a mural bluff and fresh surfaces formed, through more or less rapid erosion, are, under other circumstances, browned by the oxidizing influence of the atmosphere.

The following are among the best localities for collecting Hudson River fossils: At Richmond, on the banks of White Water and its branches, and on both banks of the main stream to the southern limits of the county. From the falls of Elkhorn to its mouth. The banks of this stream present a number of admirable exposures, where the fossil contents of the rocks are weathered out and in an excellent state of preservation. The same may be said of the banks of Brush creek, near its mouth.

The close proximity of these admirable localities for collecting fossils, to the city of Richmond, has enlisted the attention of a number of its citizens, and no place of its size in the West can boast of more students of palæontology or exhibit a greater number of fine cabinets of fossils and other objects of natural history. While I do not pretend to give the names of all the collectors, I will mention those who are particularly noted for efficiency and zeal, and when I place the name of Mrs. Mary P. Haines at the head of the list, it is not from an act of courtesy or gallantry, but on account of real merit. Mrs. Haines is an earnest worker in science, and her vast collection of fossils and scientific researches has done much to advance our palæontological knowledge of the Silurian beds at Richmond. Mrs. Haines has very kindly furnished, at my solicitation, a catalogue of fossils in her collection that were collected at and in the vicinity of Richmond. This list is given on page 201. At the time of my visit her collection contained:

Fossils	1,628	
Minerals	1,016	
Land and fresh water shells	760	species.
Marine shells and corals	753	"
Musi	296	"
Hepatica	206	"
Filices	245	"
Algea	200	"
Total	5,104	

Mr. L. B. Case, the efficient secretary of the Indiana Archæological Society, is a man of very marked scientific attainments, and has a very large collection of fossils, minerals and archæological specimens. His excellent cabinet has furnished a number of specimens that have served to extend our knowledge of the diversified forms of extinct life.

Dr. Barr is also a scholar and physician of note and ability. In addition to the labors of an extensive practice, the doctor has not been oblivious to the fascinations with which nature allures her gifted sons to unravel her mysteries, and his well-filled cabinet of fossils attests his zeal in the study of palæontology. Dr. Barr's cabinet has also served to enrich science with many new species.

J. F. Miller, superintendent of the Pan-Handle railroad, has also made a large collection of fossils, minerals and archæological objects.

President Moore, of Earlham College, is a well-known devotee of science and an eminent teacher. He has succeeded in building up at Earlham College one of the most efficient collections of natural history, for study, that is to be found in the West. Prof. Moore made a trip to the Sandwich Islands some years ago, where he collected a great variety of rocks and minerals, illustrating the character of the remarkable volcanic action of Kilawa, a great many kinds of corals and marine shells. This collection was selected with great care, and forms a valuable addition to the college museum.

The geology, palæontology and natural history of the State, is also very complete in this museum.

Mr. J. C. Ratliff, one of the trustees of Purdue University, is also a collector and student of natural history. While more especially devoted to botany, the abundance of fossils, shells and corals that lie exposed upon the surface of the weathered rocks, have not escaped his notice, and his well-selected cabinet of fossils bears witness to his interest in palæontology. The State cabinet has been enriched by numerous fine specimens from his collection.

Mr. J. Shinn also finds leisure from his mechanical operations to make collections of rocks and fossils. His yard contains rockerys made of a vast collection of curious and interesting boulders from the drift and shale of Niagara, *Pentremites oblongus* and Hudson River fossils.

Mr. W. D. Schooley collects fossils of all kinds for sale. He is well acquainted with the best localities, and is a good collector. I am indebted to him for the gift of a number of fine specimens:

LIST OF FOSSILS FOUND IN THE LOWER SILURIAN ROCKS IN THE VICINITY OF RICHMOND, INDIANA.

[By Mrs. Mary P. Haines.]

PLANTS.

Buthotrephis gracilis.......................................Hall.
B. succulosus.......................................Hall.
Paleophycus simplex.......................................Hall.

PROTOZOANS.

a Spongites, one species ....
Stromatocerium rugosum.......................................Hall.

RADIATES.

Aulopora arachnoidea.......................................Hall.
Chætetes (Monticulipora) dalei.......................................E. & H.
" " approximata.......................................Nich'n.
" " pulchellus.......................................E. & H.
" " Ortoni.......................................Nich'n.
" " mammulatus.......................................E. & H.
" " frondosus.......................................D'Orb.
" " delicatulus.......................................Nich'n.
" " gracilis.......................................James.
" " petropolitanus?.......................................Pandu.
" " rhombicus.......................................Nich'n.
Columnipora cribriformis.......................................Nich'n.
Favistella stellata.......................................Hall.
Favosites gothlandica.......................................Lam'k.
Protaria vetusta.......................................Hall.

RADIATES—CONTINUED.

Petraia *corniculum*……Hall.
Stellipora antheloidea……Hall.
Tetradium fibratum……Saff'd.

ECHINODERMS—CRINOIDS.

Glyptocrinus Baeri……Meek.
" Nealli……Hall.
Poteriocrinites Casei……Hall.
" polydactylus……Shu'd.

CYSTIDS.

a Agelacrinites *cincinnatiensis*……Roemer.
Cyclocystites, two species.
Lichenocrinus crateriformis……Hall.
" tuberculatus……S. A. M.
b Lepocrinites Moorei……Meek.
" (un. de.)……

ASTERIDS.

Stenaster grandis……Meek.
Paleaster granulosus ?……Hall.
" sp.

MOLLUSKS—POLYZOANS.

Alecto auloporoides……Nich'n.
" confusa……Nich'n.
" frondosa……Nich'n.
Ceramopora ohioensis……Nich'n.
a Fenestella.
Hippothoa (alecto) inflata……Hall.
Intricaria ?
Ptilodictya Shafferi……Meek.
" emacerata……Nich'n.
Retopora ? sp.

BRACHIOPODS.

Crania laelia……Hall.
" scabiosa……Hall.
Leptena sericea……Sow'by.
Orthis occidentalis……Hall.
" sinuata……Hall.
" subquadrata……Hall.
" biforata, var. acutilirata……Con'd.

BRACHIOPODS—CONTINUED.

Rhynchonella dentata	Hall.
" capax	Con'd.
Strophomena alternata	Con'd.
" alternistriata	Hall.
" alternata, var. loxorhytis	Meek.
" rhomboidalis	Wilckens.
Streptorhyncus filitextus	Hall.
" sulcatus	Verneuil.
" subtentus	Con'd.
" planumbona	Hall.
Shizocrania filosa	Hall.
Trematis millipunctata	Hall.
Zygospira modesta	Say.

LAMELLIBRANCHS.

Ambonychia radiata	Hall.
" (Megaptera) casei	M. & W.
" carinata	Hall.
and two or more other species.	
Anomoladonta gigantea	S. A. M.
" alata	Meek.
Cypricardites sterlingensis	M. & W.
" ventricosa	Hall.
" Hainesi	S. A. M.
" ungulatus	Bill.
Modiolopsis modiolaris	Con'd.
" curta	Con'd.
a " terminalis	Hall.
" concentrica	H. & W.
Orthodesma contracta	H. & W.
" recta	H. & W.
Pterinea demissa	Con'd.
" insueta	Con'd.

GASTEROPODS.

Bellerophon bilobatus	Sow'by.
" Mohri	S. A. M.
Bucania expansa	Hall.
" sp.	
Cyrtolites ornatus	Con'd.
" Dyeri	Hall.

GASTEROPODS—CONTINUED.

a Carinaropsis patelliformis....................................Hall.
Cyclonema bilix....................................Con'd.
" " var. lata....................................Meek.
" " " conica....................................S. A. M.
" " " pyramidata....................................James.
" percarinatum....................................Hall.
Murchisonia gracilis....................................Hall.
" bellicincta....................................Hall.
" perangulata....................................Hall.
Pleurotomaria subconica....................................Hall.
" lenticularis....................................Sow'by.

PTEROPODS.

Tentaculites richmondensis....................................S. A. M.
c Conularia papillata ?....................................Hall.
c " sp.

CEPHALOPODS.

Orthoceras junceum....................................Hall.
" vertebrale....................................Hall.
and other species.
Ormoceras tenuifillum....................................Hall.
Troceras Baeri....................................M. & W.
Cyrtoceras—several sp.
a Endoceras proteiforme....................................Hall.
a Gomphoceras eos....................................Meek.
" sp?

ARTICULATES—TRILOBITES.

Asaphus gigas....................................DeKay.
" megistos....................................Locke.
Calymene senaria....................................Con'd.
Ceraurus icarus....................................Billings.
Delmanites Carleyi....................................Meek.

OSTRACOIDS.

d Beyrichia Chambersi....................................S. A. M.

ANNELIDS.

Ortonia minor....................................Nich'n.

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a In the collection of L. B. Case.
b In the collection at Earlham College.
c In the collection of the Richmond Scientific Association.
d Mr. S. A. Miller's collection, Cincinnati, O.

GLACIAL DRIFT.

Nowhere in the State are the effects of glaciation more apparent than in Wayne county. The north part of the county borders on the very highest land in the State. The water-shed of all the streams that flow into the Wabash on the south, as well as White Water and its tributaries, take their rise from an elevated table-land which occupies a portion of Jay, Randolph and Wayne counties, and probably reaches its greatest elevation within the borders of Ohio. But the entire region where these waters start and flow to the north, west, south and east is so level that one is puzzled to point out any one spot that should be called the comb of the divide. Indeed, it is my opinion that these streams were the outlets of a shallow lake or basin, which has been filled up with sediment. From this divide glaciers poured their frigid streams in several directions. One of the principal found its way to the south, and was instrumental in forming at least a portion of the channel of the West and Middle forks and that of White Water river. Indeed, large granite boulders are found on all parts of the table-land of Wayne county, but they are particularly numerous along the shores of the West fork, just above the falls. The upper surface of the Niagara rocks which form these falls are distinctly scratched and grooved, and the lateral moraines are well defined. The bearing of these grooves is nearly north and south. At Richmond there appears to have been the coalescence of two or more streams, which were instrumental in cutting out the canon through which White Water river flows. The soft and easily weathering shales and bands of stone that form the shores of the river have caused the glacial marks to be obliterated, but the large boulders which still lie along the bluffs, or fallen to the stream by the undermining which has been going on, leave abundant evidence to justify the above conclusion. Large and small boulders are seen on all the high ridges that mark the boundaries of the streams. White Water canon is shown on Plates 2 and 6. On the former it will be seen that Richmond lies in a basin, and this basin has been grooved out by glaciation. About seven miles to the east the drift reaches an elevation of 365 feet, and the top and sides of the hill at Cedar Springs, just beyond the State line, in Ohio, is covered with large boulders, and the entire deposit is 100 feet thick, the lower part being alternations of sand, gravel and boulder clay.

At Jackson's hill, eight miles to the west of Richmond, the drift is one hundred and forty feet thick. On the top there is a number of large boulders, and beneath this we have the usual alternations of clay, sand and gravel, and blue boulder clay. Jackson's hill is on the divide between the waters of Green's fork and Nolan's fork. On the divide between the latter streams and White Water, the drift is ninety feet thick, and in places the large boulders are quite abundant on the surface. In the city of Richmond the drift is only locally represented, and the greatest depth will not exceed twenty feet. At James Starr's gas works the Hudson River rocks form the surface stratum. Plate 4 shows the position of the drift along the turnpike which follows the course of the Middle fork to Middleboro'; it is here about sixty-five feet thick, and the surface has a great many large boulders. Plate No. 3 indicates the position and general depth of the drift along the road from Richmond to Elkhorn falls. Large boulders are numerous on the divide between Elkhorn and Short creek. The valley of the latter creek, where the road crosses, contains a great many boulders which have been washed down from above. The drift along this road is eighty to ninety feet thick. Plates Nos. 5 and 6 show the position of the drift and the eroded river and creek beds. The dividing ridges, on the line of both these sections, contain large boulders which mark the shores of lateral morains.

The material comprising the main body of the drift appears to be laid down with considerable regularity, and the order may be represented by the following section:

Large boulders, surface soil and clay	1 to	3 ft.
Clay, gravel and sand, mixed	10 to	20 ft.
Sand and gravel, containing water, first seam	5 to	15 ft.
Clay and gravel, mixed	10 to	25 ft.
Hard-pan	1 to	2 ft.
Sand and gravel, containing water, second seam	10 to	25 ft.
Clay and gravel	10 to	25 ft.
Hard-pan, with blue clay and small boulders	1 to	5 ft.
Sand and gravel, containing water, third seam	2 to	20 ft.
Stratified rock		140 ft.
Total		280 ft.

Usually there are three horizons of impervious, compact blue clays, mixed with well-rounded boulders from the size of a small gravel to six inches or more in diameter. This boulder clay is very tough, and difficult to dig through, whence it has received the name of "hard-pan." These hard-pans are usually underlaid and overlaid by sand and gravel beds that are strongly charged with water, and from these latter beds the supply of potable water is obtained in wells. Almost throughout the entire region of the drift it is an observed fact, also, that the water from the lower stratum will, when penetrated by a well, rise to the level of the upper stratum, usually ten to twenty feet below the surface. This is a matter of very great interest to towns and cities located on the drift, as it furnishes them with a never-failing supply of wholesome water. While in thickly settled localities the upper water supply may be contaminated by sewage and the contents of privy-vaults which have penetrated to that depth; the lower water reservoirs are protected against these pollutions by the impermeable floors of hard-pan. We have only, then, to obtain the water supply from the lower stratum, and so tube the well as to preclude the possibility of contamination from the streams above. The water so obtained can not, in my opinion, be excelled as a potable water, though, in the common acceptation of the term, it is a "hard water"—that is, it contains calcium carbonate and magnesium carbonate, which decompose the soap by combining with the alkalies, and the grease is set free. This decomposition forms in the water curd of soap. To use such a water at all for laundry purposes, a large quantity of soap is required, since it must be added until the calcium and magnesium carbonates are saturated. In all cases where examined the total quantity of solid mineral constituents in an imperial gallon of water taken from the drift does not materially differ in quantity—no matter from what horizon it comes, so long as it remains free from sewage contamination. The minimum quantity may be stated at twenty-three grains, and the maximum at twenty-nine grains, in a gallon. The upper stream contains the largest amount of carbonic acid and carbonates of the earthy minerals, and the lower one the least quantity of this acid and its salts—it being replaced in a manner by sulphuric acid, combined, in part at least, as calcium sulphate (gypsum) and magnesium sulphate (epsom salts). These salts are undecomposed by boiling; the latter is soluble in three parts of water, and the former does not, when precipitated, form a crystalline mass, but is miscible in water, and aids in preventing the formation of "fur" on steam boilers. For that reason the lower stratum of water is far preferable for use in steam boilers.

In Indianapolis, where well water is largely used in steam boilers, I was long puzzled to account for the fact that at the gas works, where the water supply is taken from the lower stream of water, the boilers are not incrusted, and the same was the case at the old starch factory, while all those who were using the upper seam of water were greatly troubled by the incrustation which formed on the bottom of the boiler and caused them to rapidly burn out. The Indianapolis rolling mill company were using water from the upper seam, and the incrusting of the boilers was so great that new boilers would not last over six months before burning out. This water contains, in different parts of the city, from thirty-six to forty-three grains of solid matter to the imperial gallon, and in some wells as much as 5.46 grains of chloride of sodium. The latter is undoubtedly nearly all derived from sewage infiltration. Being consulted in the matter of the water supply at the rolling mill, I advised them to go down to the second seam, and if that would not serve a better purpose, then go to the lower seam. The latter water at the gas works well contains 25.9 grains of solid matter to the imperial gallon, and the seam is there reached at the depth of ninety-two feet. The well at the old starch works was said to be only forty-three feet deep, and was probably in the second seam of water; the solid constituents in a gallon of the latter is 24.8 grains. For comparison, I will state that the water from White river, when filtered, contains fourteen grains of solid mineral matter in an imperial gallon. This sample was collected above the mouth of Fall creek. The rolling mill company ordered a well to be made; and on reaching the second or middle seam of water at fifty feet, which rose in the inner tube to within twenty-one feet of the surface, a sample was sent to the laboratory for examination. It was simply tested for solid mineral matter, and found to contain 24.6 grains in an imperial gallon. This solid matter was found to be, from frequent analyses made of other waters in the city, composed principally of calcium carbonate, magnesium carbonate, sulphuric acid, some chlorine, a little iron, silica, alumina, and alkalies. The water sent for examination was about as free from mineral salts as any examined from the lower stratum, and the company concluded to make a trial of it in the boilers, but the incrusting was as bad as ever.

Without being able, at the time, to account for the cause, the company were advised to sink their well to the lower seam. This was done, and the water was reached at 83 feet in gravel, sand and small boulders. On analysis it proved to contain the same amount of solid mineral matter, 24.6 grains to the gallon, but it gave no further trouble from fur in the boilers—the precipitated salts are in the condition of incoherent mud, and that is readily blown out through the mud valve. The good behavior of this water in boilers is found to be due to the presence of a large per cent. of sulphuric acid, which is probably combined with magnesium and calcium in proportions that prevent the formation of a solid incrustation. The per cent. of sulphuric acid in the upper water is from 1 to 2.5 grains to the gallon, while the lower seam contains from 4.5 to 5.5 grains. This, then, appears to be the main difference in the water. Now, if the presence of sulphates prevent the formation of boiler incrustation, it is possible that the addition of a small amount of sulphate of soda (glauber salts), or sulphate of magnesia (epsom salts), to waters that contain but a small amount of sulphates, may prevent the formation of fur in boilers. The effect of adding sulphate of soda would be to bring about an interchange of acids to form sulphate of lime and sulphate of magnesia and carbonate of soda. The two latter are quite soluble salts, but the benefits to arise from the addition of sulphate of magnesia is not so clear, since, by an interchange of constituents, there will be formed sulphate of lime and carbonate of magnesia, both sparingly soluble salts. It is possible, therefore, that the beneficial results arising from the presence of sulphates is, in a large measure, due to the physical properties of the respective molecules. Whether able to explain the matter or not, the fact has, time and again, been practically tested that water from the upper and middle streams in the drift uniformly incrust steam boilers, and the solid mineral constituents are principally carbonates with but little sulphates, while water from the lower seam does not incrust the boilers, though the total amount of mineral constituents remains about the same, but the latter contains more than double the amount of sulphates found in the former; and this is true of the water outside, as well as inside, the city limits.

I have dwelt at considerable length on this subject, because the water supply of a country for potable and manufacturing purposes is of very great importance to the people.

I will here give an analysis of water from two wells that have gone down to the lower seam of water, and find no trouble from its use in steam boilers:

	Kingan & Co.'s Pork House. Grains in 1 gal.	Peil & Co.'s Starch Fact'y. Grains in 1 gal.
Insoluble matter	trace.	0.70
Alumina, with trace of iron	2.10	3.15
Lime	8.43	9.85
Magnesia	2.04	1.20
Carbonic acid	6.36	6.24
Sulphuric acid	4.55	5.04
Chlorine	trace	trace
Loss and undetermined	0.32	0.77
Total grains in one gallon	23.80	26.95

The well at the rolling mill only differed from that of Kingan & Co. in having a little more solid matter to the gallon.

The water formerly used at the starch factory gave an immense amount of trouble; it was reached at a depth of about fifteen feet, and contained only 2.1 grains of sulphuric acid to the imperial gallon. At the request of Mr. Peil I made this examination, and advised him to procure his water supply from the lower seam, and since doing so they have had no further trouble from fur in the boiler. The above analysis indicates the character of this water.

The Indianapolis Water Works company have commenced a well that will reach this lower stream of water, and as soon as completed they will be able to supply the same to their customers.

While other cities may have softer water derived from river sources or lakes, these are liable to pollution from surface drainage, and the saving in soap is more than overbalanced by the danger to health. But here, when the supply is obtained from the lower stream, and the upper waters are stopped out, it is hardly possible to find a safer or more wholesome water, or one better adapted for steam purposes.

The streams of water which permeate the drift often find an exit where the beds are worn through by erosion in valleys or ravines, and give rise to springs. Some of these are quite large, and discharge a great volume of water. At some localities these springs, especially when they come from the upper stratum of water, are so largely charged with bicarbonate of lime that there is formed around the discharge great masses of tufa. In Wayne county this is particularly noticeable in the romantic valley of Little Elkhorn creek, near the crossing of the pike leading from Geo. H. Smith's to Richmond, section 31, township 12, range 1, and not far from the mouth of the creek. The water is discharged in a bold stream from the upper bed of gravel and sand, and has built up large blocks of tufa twenty-six feet thick on that side of the valley. These tufa blocks add wildness to the scenery, and the delightful shade cast by the forest trees over the cool water of the spring has made this spot a pleasant resort for picnic parties on hot summer days. George H. Smith has a large artificial pond in front of his palatial farm residence, not far from this locality, that is fed by spring water. Another large spring, breaking out from the drift, is on the north side of Elkhorn creek, on Mr. H. Sulsor's land, by the side of the pike, and is turned into a long wooden trough, from which the passing teams are permitted to quench their thirst. The temperature of the water of these springs is about 52° F. There is a very large spring, that furnishes water-power for a large grist mill, on section 36, township 13, range 1. This spring forms part of a small creek that empties into the East fork of White Water. Above the spring, the branch, which is called Sink creek, disappears beneath the surface and comes up at the spring. The most important springs, in a medicinal point of view, are on Mr. John Hawkins' farm, just east of the city of Richmond. The water breaks out from the junction of the drift and the blue argillaceous shales that form the upper part of the Lower Silurian beds. There are a number of springs on the place, but Mr. Hawkins has only thought proper to inclose three with cement pipes that are about two feet in diameter. They are situated on the south side of the East fork of White Water, and about twenty feet above the bed of the stream and sixty feet below the crest of the hill, at Mr. Hawkins' residence. The springs are only a few feet apart, and arranged in the form of a triangle, °₀°. The ground around is neatly paved, and the overflow of water is carried off in a paved shute. This shute is well lined with a brownish-red gelatinous precipitate of ferric oxide which tells at once the chalybeate character of the water. There is considerable gas bubbling up from the bottom of each spring, but I had no means of collecting it for special analysis at the laboratory. It appeared to be mainly carbonic anhydride and carbonic dioxide. No odor of sulphydric acid could be detected at the spring or in the water shipped to the laboratory for analysis. On the curbing there were vast quantities of fresh water conferva, algæ, diatoms and desmids. The algæ would extend their rich green filaments for several inches beyond the curb into the crystal-clear water. A number of these microscopic plants were collected for examination, and proved to be (*Algæ*) *cosmaria, Oscillatoria, Euastra, Staurastra, Closteria, Pediastra, Spirogyra,* and some undetermined genera, (*Diatomacia*) *Staroneis, Gomphonema, Podosphenia, Nitschzia, Navicula, Pleurosigma, Pinnularia, Eunotea, Fabulria, Surivella, Synedra, Fragillaria, Cocconema, Meridion,* and other genera not determined.

It is a curious fact that desmids more rarely, but diatoms may always, be found in the water that flows through the drift. I have never failed to find them in the three subterranean waters that underlie the city of Indianapolis. They are brought up in driven wells from the lower stream when tubed so as to exclude the upper water.

ANALYSIS OF WATER FROM HAWKINS' MINERAL SPRING, RICHMOND, INDIANA.

Sample collected from the west gum. It imparts an alkaline reaction to litmus paper. An imperial gallon (10 lbs.) contains of solid matter 32.2 grains, consisting of:

	Grains.
Insoluble silicates	0.1900
Ferrous oxide	0.1429
Calcium oxide	10.3800
Magnesium oxide	0.4400
Potassium oxide	0.6600
Natrum oxide	0.2120

	Grains.
Sulphuric anhydride	9.5300
Carbonic anhydride	10.0800
Chlorine	0.4900
Loss	0.0751
	32.2000

Free carbonic acid 5.1643 cubic inches in an imperial gallon.

These bases and acids are probably combined as follows:

	Grains.
Silicates	0.1900
Ferrous carbonate	0.2303
Calcium sulphate	14.0261
Magnesium sulphate	1.9198
Calcium dicarbonate	11.3416
Potassium carbonate	1.4042
Sodium chloride	0.4001
Carbonic anhydride	2.4429
Calcium chloride	0.3862
	32.2148

This is a sulphatic and carbonated chalybeate water; its action is that of a mild tonic, aperient and diuretic and decided alterative.

A qualitative examination of the two other springs on Hawkins' farm showed no perceptible difference in the quality of the water.

The water from Cedar spring, Preble county, Ohio, near New Paris, is similar to the above; it also rises from the same geological horizon, *i. e.*, the blue shales which form the junction of the Upper and Lower Silurian beds in Wayne and Preble counties.

At Hawkins' spring the Upper Silurian has been removed by denudation, and the drift lies immediately on the blue shales.

These springs are located in a very beautiful grove on the second bottom of East fork of White Water, and at the foot of the grassy slope which rises rapidly to the table-land Considerable use is made of the water by the citizens of Richmond, but it is worthy of a more extended celebrity.

There are other springs in the county that break out from the same horizon, which contain a notable quantity of iron. They may be recognized by the reddish-brown gelatinous precipitate which stains the sides of the gums. There are several very large and valuable springs of this character on J. W. Vestal's place, near Cambridge City.

The drift has been of very great use to this county in supplying an endless quantity of gravel suitable for making gravel turnpikes. And probably no county in the State contains so many of these admirable channels of commerce. On Mr. J. C. Ratliff's place the pure gravel bed is from twenty-five to thirty feet thick.

In 1851, when making a cut through the divide, between Noland's fork and Green's fork, for the Richmond and Logansport division of the Pittsburg, Cincinnati and St. Louis railroad, at the depth of about twenty-one feet in the middle of the cut, the workmen struck upon what seemed to them a solid pavement of boulders. The upper part of each boulder appeared neatly dressed on the surface, as though done by the hand of a skilled workman. This pavement extended nearly the entire length of the cut, though towards the ends it was considerably broken up, and finally gave out entirely. It was very thick near the center of the cut, and appeared to dip toward the east, but as the grade of the railroad was forty feet to the mile in the opposite direction, this may not be the correct dip. The width of this pavement of boulders must be considerable, since at the distance of half or three quarters of a mile on the north side four wells had been dug, and in three, at about the same depth beneath the surface, a layer of scratched boulders was encountered. The whole deposit of boulders is in a matrix of hard, blue clay—"hard pan." On the face of these boulders are a number of parallel scratches, the direction being nearly north and south. Many of the boulders are of large size, and nearly all are a bluish colored, crystalline rock, susceptible of receiving a fine polish. One of these boulders measured two feet in diameter and eighteen inches thick, and was as round as a grindstone.*

Scratches, or rather fine parallel striæ, bearing north a little east, and south a little west, are also seen in the bed of Noland's fork, near Centreville, and on rocks of Hudson River age. The face of the rocks are ground down to a level, and the striæ are plainly visible. Indeed, everything leads to the conclusion that the glaciation was carried on in great force in this part of the State.

On Levi Jessup's land, about one mile northeast of Richmond, there is a fine bed of potters' clay exposed in the east bank of the Middle fork of White Water. The following shows the character of the exposure:

	Ft.	In.
Soil	2	0
Sand, with gravel and small boulders	16	0
Yellow plastic clay, burns reddish	0	10
Blue plastic clay, when damp soft and cuts like cheese, unctuous feel, has a little grit, tested with the teeth, burns cream color, lies in thin laminæ of about half-inch thick, dips 3° S. of E.	8	6
Gravel, sand and small boulders	25	0
Bed of creek	0	0
	52	4

Bott, Hammersley & Co. have established a pottery at Richmond for the manufacture of garden and green-house flower-pots and saucers. They use this clay, and the ware has a very agreeable cream color. They also manufacture a

*The above information was furnished by Prof. J. C. Macpherson, county superintendent, Richmond, Ind.

great variety of ornamental hanging-baskets and vases. Mr. Bott is an experienced potter and most excellent workman, and their wares find a market as far south as Texas. They use about six tons of this clay in a week, and produce about 30,000 flower-pots in the same time. The following analyses show the composition of these clays:

UPPER BED—YELLOW CLAY.

	Per Cent.
Loss at red heat	9.50
Silicic acid	44.50
Ferric oxide	16.00
Alumina	6.80
Calcium carbonate	12.30
Sulphuric anhydride	0.20
Chloride of alkalies	3.80
Loss and undetermined	6.90
	100.00

BLUE PLASTIC CLAY.

	Per Cent.
Loss at red heat	12.60
Silicic acid	45.30
Ferric oxide	13.20
Alumina	9.60
Calcium carbonate	12.90
Magnesium carbonate	2.98
Sulphuric anhydride	0.63
Chloride of alkalies	2.30
Loss and undetermined	0.49
	100.00

The yellow clay appears to contain too much calcium carbonate, ferric oxide and alkalies to stand a very high heat.

Clays are found elsewhere in this county in the drift, but none have been tried at the pottery that gave as good results as the above.

ANTIQUITIES.

The high table-lands of this county, and its deep canon-like river vallies, afforded the mound-builders favorable sites for their settlements, and we constantly find the remains of a number of large and interesting earthworks and a great many mounds scattered along the bluffs of the streams. Prof. J. C. Macpherson, county superintendent of schools of Wayne county, has kindly furnished me with a sketch of these ancient works, and as he has given considerable attention to the study of archæology, his report is a very valuable acquisition to our knowledge on this subject, and I take pleasure in presenting it to the public.

OBSERVATIONS ON THE PRE-HISTORIC EARTHWORKS OF WAYNE COUNTY, IND.

[By J. C. Macpherson.]

The surface of Wayne county presents many evidences of occupancy by the mound-builders. Mounds are found in all parts of the county—situated on the uplands and along the courses of the streams. The plowshare has leveled many, and some have been removed in opening roads or the material used in making brick. Twenty-five mounds have been located on a map of the county prepared in connection with the geological report.

The works in this county seem to be a continuation southward from the works along White river in Randolph county, and follow the branches of the White Water. Perhaps, when all the works located in this part of the Ohio Valley are mapped, some systematic arrangement may be discovered.

Three miles north from Fountain City (formerly called Newport), on a rise overlooking the wooded valley of Noland's fork, is a mound seventy-five feet in diameter, (section 19, township 18, range 15 east).

Another is on the farm of Daniel Hough, adjoining Fountain City. A third is said to have been removed in making the principal street of that town.

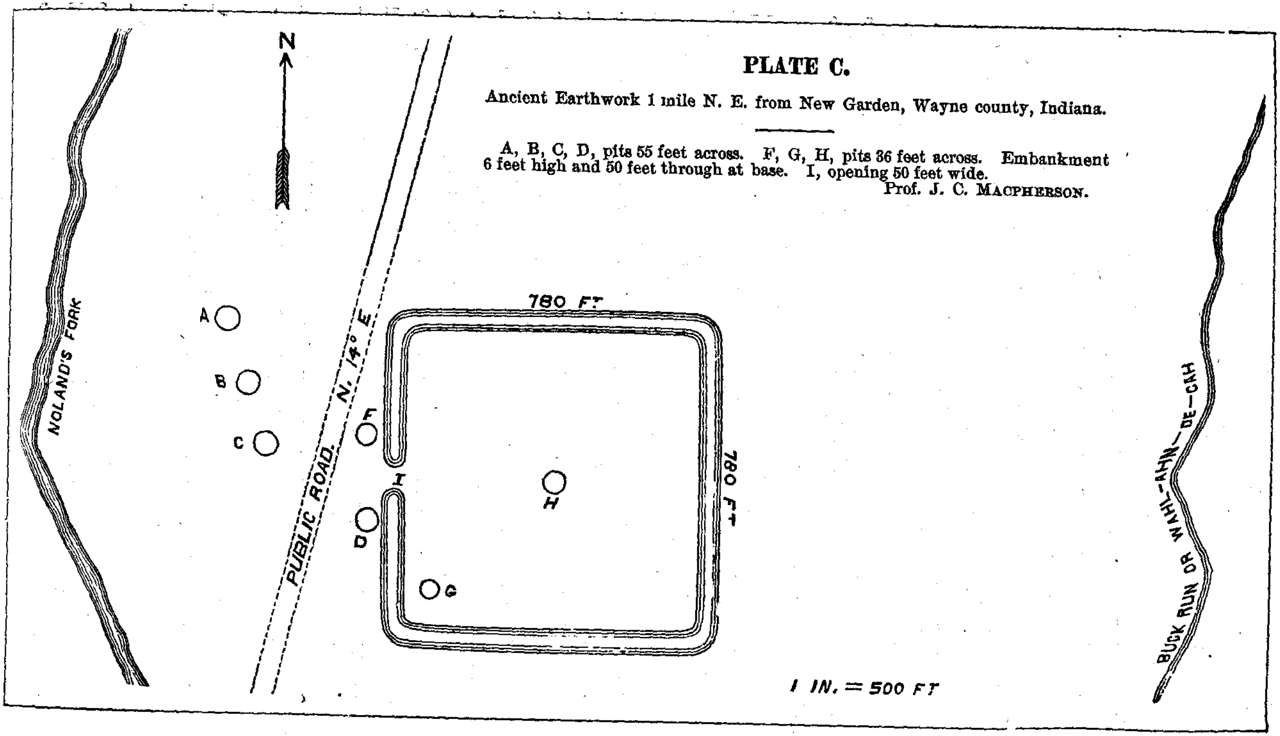
One mile northeast from Fountain City, on level ground, between Noland's fork and a small tributary—Buck run—is an embankment inclosing eleven acres. The figure (Plate C) of this earthwork is a square with curved corners. The length on the inside of the embankment is 780 feet. The

PLATE C.

Ancient Earthwork 1 mile N. E. from New Garden, Wayne county, Indiana.

A, B, C, D, pits 55 feet across. F, G, H, pits 36 feet across. Embankment 6 feet high and 50 feet through at base. I, opening 50 feet wide.

Prof. J. C. MACPHERSON.



embankment has been plowed over for years, yet can be plainly traced. A gateway is discernable on the west side, and hollows are found in the vicinity, which some suppose were made by the builders when collecting material for the embankment. Since the accompanying map was made, a more careful survey has discovered the fact that the direction of the embankment is not due north and south, but at an angle, with the west side nearly parallel with the road.

A large mound stood two miles north from Chester (section 4, township 14, range 1 west). The greater part was removed in making the Arba road. A copper ring was found therein, and is now in the collection at Earlham College.*

Several mounds are situated in the neighborhood of Middleboro. Some have been opened, but no contents worthy of notice have been obtained.

One mile north from Richmond, on the Hoover farm, and in that vicinity, several small mounds were located. In one, when removed, was found a copper ornament.

A mound near Earlham College was opened by President Moore, and the usual contents of mounds found—pieces of pottery, ashes and other evidences of fire.

On the J. C. Ratliff farm a mound was opned, and some small articles, which were at first supposed to be beads, but are now thought to be parched corn, found therein. L. B. Case, of Richmond, has some grains of corn which were found in a jar some distance below the surface of the ground, in the vicinity of that place.

A large mound south from the town of Centreville was deemed of sufficient note to be marked upon an early map of the State, but has since been destroyed.

In the southwestern part of Boston township is a mound hidden away in a "hollow"; and one formerly stood south from Richmond near the Boston pike.

Traces of a mound are to be seen on the farm of James W. Martindale, adjoining Washington. This mound was opened in early times, and charcoal found near the original surface of the ground. A great quantity of arrow-heads have been found around a spring (long since dry) near this mound.

A circular embankment was found near Green's fork, east from Jacksonburg, twenty-five feet in diameter. It was long since plowed down.

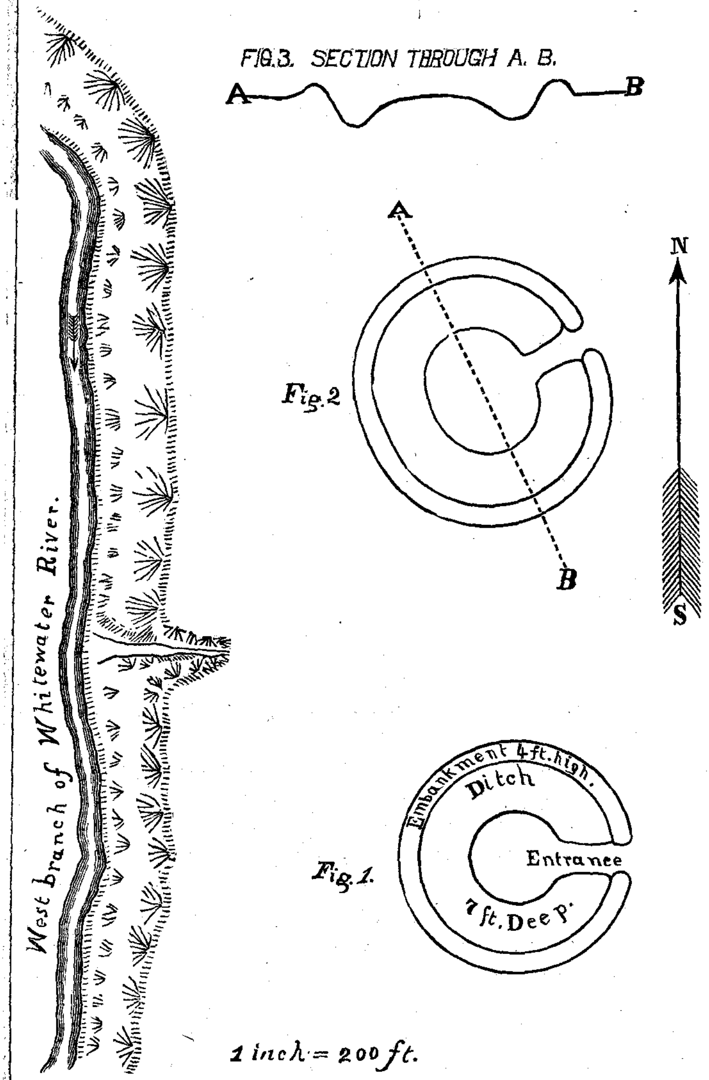
Two mounds are to be seen a short distance northwest from Jacksonburg.

*Judge N. R. Overman informs me that four copper bracelets were found. He has one in his cabinet. He also has three flint implements taken from this mound. E. T. C.

PLATE A.

Ancient Earthworks north from Cambridge City, Wayne county, Ind.

J. C. MACPHERSON.



Overlooking Martindale's creek in Jefferson township (section 18, township 17 north, range 13 east,) is a mound. Also two in the bottom land along West river, at Hagerstown.

Two miles southeast from Milton (section 6, township 15, range 13 east,) is a beautiful mound, fifteen feet in diameter. Forest trees are still standing upon it; also a stump measuring two feet across.

Near the county line, about one mile north of Waterloo, Fayette county, is a mound upon high ground, and about a mile to the southeast, in Fayette county, is a curiously shaped work.

The most notable mounds (Plates A and B) in Wayne county are located on the left bank of the west branch of White Water river, one and a quarter miles north from Cambridge City. They consist of a series of circular embankments, continued over half a mile of ground.

The south circle (Plate A) is in the best state of preservation. The embankment was made of the earth taken from the trench which is on the inside of the embankment. Within, the ground has been made to slope gently from the center to the bottom of the trench, except to the east, where there was left a roadway leading from the center through a gateway in the embankment to the level ground beyond. The embankment is four feet above the surface of the field, and seven feet above the bottom of the trench, and wide enough on the top to allow two carriages to pass each other. The gateway is one rod wide. This circle is made of gravelly soil, while the north circle is composed of a loam, and has yielded more to the destroying influence of plowing. It is not as symmetrical as the other, being more oval in outline.

The class of works to which these belong is described in "Ancient Monuments of the Mississippi Valley," page 47, and are denominated "Sacred Enclosures."

These two circles on Plate A, are about fifteen rods apart, and about the same distance from the bluff of the stream. In the bluff, equally distant from both the circles, is a passage way cut from the top of the bluff to low ground bordering the water, some twelve feet below. This cut is evidently not a water-wash, for along the sides can be seen the earth which was removed in making it thrown up as dirt is thrown up along the sides of a ditch.

The bluff here spoken of is the edge of the first terrace. The rounded margin of the second terrace can be seen a quarter of a mile to the east.

Several hundred feet north from the second of the above described circles is a group of five small circles (Plate B). With one exception these are about sixty feet in diameter, and are now from one to two feet high. The circle nnmbered 3, on Plate B, is at the point of a tongue of higher ground, and affords an outlook over the other works. The embank-

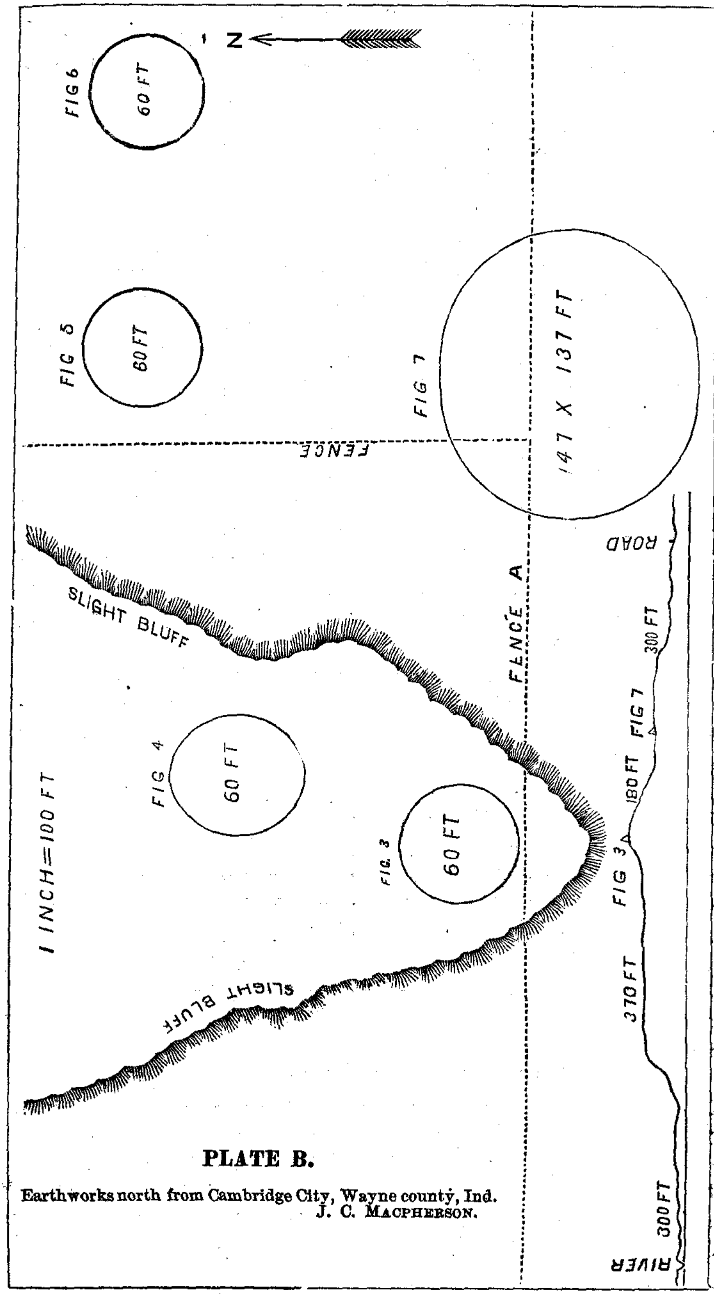


PLATE B.

Earthworks north from Cambridge City, Wayne county, Ind.
J. C. MACPHERSON.

ment of the largest work in this group (numbered 7,) can not be traced on on the south, that part being in a field which has long been cultivated. Trees of large size were, until recently, standing upon the embankments of these works.

Burial places and remains have been found in various localities within the county. A number of years ago, in removing the gravel from a bank in the northwest part of Jefferson township, nine feet below the surface, eight skeletons were discovered. They had been buried in an upright position. These bones were gathered together by the workmen and reburied in a common grave. In constructing the Valley railroad from Hagerstown to Cambridge City, human remains were exhumed; also some at the latter place.

O. Beesom* communicated to the local papers, some twelve years ago, an account of the discovery of a burial place in the extreme southwest corner of the county. Many skeletons were found in a gravel bank, some having been placed in a sitting posture, and some with the head downward.

Recently some twenty or more skeletons were unearthed in a gravel-pit on George Jordan's farm, about two miles northwest from Economy. These bodies seem to have been buried in graves a few feet apart, and six feet below the surface. Some of them were in a sitting position, while others were in various positions.

The discovery of a human skeleton in a mound on the bank of White Water, near Richmond, many years ago, was the occasion for the following lines from the pen of the late John Finley, author of the "Hoosier's Nest," and other poems, and once Mayor of Richmond:

"Year after year its course has sped,
  Age after age has passed away,
And generations born and dead,
  Have mingled with their kindred clay,
Since this rude pile, to memory dear,
Was watered by affection's tear.

* * * * * * * * *

"No legend tells thy hidden tale,
  Thou relic of a race unknown!
Oblivion's deepest, darkest veil
  Around thy history is thrown;
Fate, with arbitrary hand,
Inscribed thy story on the sand."

Stone and flint implements were formerly found in great numbers in this region. Wayne county, like the rest of our State, has suffered in

*Mr. O. Beesom very kindly presented a stone spinner and several stone totems, taken from these graves, to the State cabinet. E. T. C.

being robbed by collectors and traffickers, who have carried away many specimens to grace the museums of other States. But recently more interest has been manifested in the subject of archæology, and the collection at Earlham College, and several private collections, are beginning to assume interesting proportions.

TIMBER.

Wayne county was covered with a dense growth of trees indigenous to this latitude, but now more than half of the land has been cleared for cultivation.

Among the most important trees are black walnut (Juglans nigra), at one time very abundant, especially on a ridge known as black walnut ridge, extending through a portion of Harrison, Jackson and Washington townships.

Poplar (Lyriodendron tulipifera); large, and once very abundant.

White oak (Quercus alba); large, and quite abundant on uncleared land.

Burr oak (Quercus macrocarpa); found on bottom lands.

Black oak (Quercus tinctoria); on upland.

Red oak (Quercus rubra), red beech (Fagus ferruginea) and white beech (Fagus sylvestris); very common, especially on clay slopes.

Buttonwood (Platanus occidentalis); grows along the borders of all the streams.

Shellbark hickory (Carya alba), pignut hickory (Carya glabra), thick shellbark (Carya sulcata), sugar maple (Acer saccharum); still very abundant.

White maple (Acer dasycarpum), red maple (Acer rubrum); common on wet ground and bordering on streams.

White walnut, or butternut, (Juglans cinerea), sweet gum (Liquidamber stryaciflua), slipery elm (Ulmus fulva), white elm (Ulmus americana.)

Wild cherry (Cerasus virginiana), blue ash (Fraxinum quadrangulata), hackberry (Celtis occidentalis), honey locust (Gleditschia triacanthos); on bottom lands.

Buckeye (Æsculus canadensis), cottonwood (Populus canadensis); grows along the streams. Basswood (Tilia americana), and coffee nut (Gymnocladus canadensis).

AGRICULTURE.

The soil of Wayne county has been derived from the disintegration of crystaline rocks lying north of the State, as already stated. The physical features of this soil are various, but usually it is rich in fertilizing elements. No county in the State contains so many good farms, or a more thrifty class of farmers. The fields are kept in admirable order; the homesteads look comfortable, and are surrounded with good stables and barns to give shelter to stock and storage for grain. The land may be called level, and is either river bottom or table-land. The former is mostly sandy loam, well supplied with organic matter, and produces large crops of all kinds of grain, but is particularly suited for corn. The table-land is mostly clay loam; grows corn well, but is generally better adapted for wheat and other small grain.

Clover and grass grows well in all parts of the county. Blue grass is indigenous, and there are many excellent pastures of this grass. The late General S. Meredith, of Cambridge City, was a warm advocate of the cultivation of blue grass and the raising of fine horses and cattle. His blue grass farm at Cambridge City is excellent proof of the value of this kind of pasture, and his herd of blooded short horn cattle were unequalled by any in the country.

Wayne is the largest flax-growing county in the State. The acreage sown in 1877 amounted to about 6,000 acres. The average yield is twelve bushels to the acre, so that the total product amounted to about 72,000 bushels of seed, and about 10,000 tons of flax straw. There are three flax mills in the county: McKennett & Pierce at Hagerstown, I. S. Gary, Jr., at Cambridge City, and Joseph Shilleto at Richmond. The annual value of the materials, lint or fibre and bagging manufactured, is estimated at over $100,000. Mr. Gary has much the largest factory, and turns out alone about one-half of the above amount. The remainder is about equally divided between the Hagerstown and Richmond mills. Flax (Linum usitatissimum) extracts from the soil a large quantity of mineral matter, especially potash and phosphoric acid, which are the most valuable constituents of arable land. It is considered, therefore, one of the most exhaustive crops, when no part of the plant is returned to the land. Neither the pure fibre or the oil contains any of the mineral constituents, but they are to be found in the cake after the oil has been pressed out. In Europe the oil-cake is extensively used for food for cattle, and appears to possess extraordinary fattening properties. This cake should be returned to the soil as manure. It may be ground to a coarse powder, and applied as a top-dressing.

The stem of the flax plant consists of an inner part or core; sometimes hollow, but more frequently solid, and is composed of ligneous matter, surrounded with a bark of fibres united to one another by a gum and covered with a fine epidermis. To separate the linen fibre from the gum and woody matter, after removing the seed, the stems are steeped in a stream of running water for a period ranging from seven to twenty-one days. By this operation they undergo a kind of putrefaction which decomposes the gum and loosens the fibres from one another and from the woody core. The stems are washed and the fibre removed by an operation called "scutching." The fibre is thus removed whole, while the brittle, woody part of the stem is broken into small pieces. The greater part of the mineral matter is removed in the steeping and wash water, and in this state it may be returned to the land. The woody part is generally burned, and the ash should at least be saved and returned to the soil. By the use of these precautions flax may be grown with as little danger of impoverishing the soil as any other crop.

An analysis of the ash of the best quality of flax stems gives the following:*

	Per Cent.
Silica	2.68
Ferric oxide	1.10
Alumina	0.72
Lime	18.52
Magnesia	3.93
Carbonic anhydride	16.38
Sulphuric anhydride	6.83
Phosphoric acid	8.81
Potash	22.30
Soda	14.11
Chloride of sodium	4.58
Loss	0.04
	100.00

Flax straw dried at 100° gives 3.67 per cent. ash.

Nitrogen in the plant, 0.876 per cent.

Flax seed dried at 100° gives 3.05 per cent. of ash, and 0.23 per cent. of nitrogen.*

An analysis of the ash of flax seed gives the following:

	Per Cent.
Silica	1.46
Ferric oxide	0.38
Lime	9.45
Magnesia	16.23
Sulphuric anhydride	1.43
Phosphoric acid	35.99
Potash	32.55
Soda	2.51
Chlorine	trace
	100.00

*Flax analyses from Watts' chemical dictionary.

From this it will be seen that a crop of flax will extract about 300 pounds of mineral matter from an acre of ground, the two most essential being potash and phosphoric acid. About twenty-one pounds of this mineral matter will be found in the seed and 279 pounds in the stems of the plants.

These substances may be returned to the land in barnyard manure, if it is to be had, or in the form of mineral fertilizers, bone-dust, sulphate of magnesia, common salt and carbonate of potash, or fresh wood ashes and sulphate of ammonia.

Flax requires a fine pulverulent loam soil, and is materially injured by the presence of stagnant water held by the subsoil on undrained lands. I would recommend as a suitable fertilizer, for one acre, the following substances, which may be had of the Indiana Fertilizer company, of Indianapolis, with the exception of the salt, for the prices affixed:

Bone dust, 200 pounds, cost	$2 50
Dried blood, 50 pounds, cost	75
Common salt, 100 pounds, cost	40?
Total cost not to exceed	$3 65

A cheap kind of salt may be used, such as the waste from the pork houses; the whole should be intimately mixed with 400 or 500 pounds of dry muck, vegetable mould or ashes, and scattered broadcast over the field. The same fertilizer, with the addition of fifty pounds more of dried blood, will be found to be an admirable top dressing for wheat, and one that will more than repay the cost by the increased product of grain.

As a general thing the soils of Indiana have been gradually losing their fertility by a constant removal of mineral constituents by the crops. The impoverishment from this cause has been carried on to such an extent that it is now absolutely necessary that farmers should turn their attention to the study of the best and cheapest way in which they may be returned. If the savings at the barn from the liquid and solid voidings of stock, and the unconsumed straw or fodder, is not sufficient to make a full return, then let the deficit be made up by a portion of mineral fertilizers. As a test of this matter I would recommend the careful farmer to apply to different plats of ground of equal good or poor quality, but not suffering for want of proper drainage, either natural or artificial, a dressing of barn-yard manure in such quantity as he may deem ample for a good crop, and of equal moneyed value to the mineral fertilizers above recommended. On the other plat let him put the mineral fertilizers in proportions and quantity per acre herein given, and then compare the yield of the two plats. By this means, but not from the single experience of one year, but of several years, he will be able to arrive at the true value of the mineral fertilizer, and whether it can be relied upon to restore to the land the fertilizing properties which have been removed by cropping.

The mineral fertilizers here recommended for an acre of ground will not cost more than the price stated—$3.65; now if this outlay will bring on ground which has received but little if any fertilizers, a crop of flax worth from seven to eight dollars more than the product of unfertilized land, it is plain to see that a handsome interest has been received on the money expended, as well as leaving the land in a better condition than before. I know that I am addressing a good class of farmers in Wayne county, for they raise here eighty to ninety bushels of Indian corn and twenty to thirty bushels of wheat to the acre. This bespeaks for them not only a good natural soil but admirable tillage, and a careful regard to keeping up the land by returning, what can be saved from all available farm sources, back to the soil, and by due regard to a rotation of crops.

Large quantities of timothy, red-top and clover, are grown, and clover is especially cultivated with a view to the improvement of the land. The advantages to be derived from growing and turning under clover can not be denied, but the farmer must not lose sight of this fact, that these benefits are derived from a partial rest which the land receives from the greater needs of the grain crop for the most important mineral food—phosphoric acid. By this rest the atmosphere and waters have time to aid in promoting the better chemical decomposition of the soil, and to render an additional portion of what phosphoric acid remains available to the succeeding crop of grain. Clover and other green crops, when turned under, supply the organic matter and nitrogen which are beneficial to agricultural plants. But they add no mineral matter that did not already exist in the soil. So that, upon reflection, one is compelled to admit that by rotation of crops, that while it enables the farmer to obtain a larger yield of produce, it will not alone prevent the final exhaustion of mineral plant-food, and that it is not possible to keep up land to a normal state of fertility without restoring to it by a direct application in some form of combination, the phosphates and alkalies which have been removed. Then, again, it is not always convenient or profitable to be compelled to raise a crop for the sole purpose of keeping land in heart, and the farmer should be apprised of the fact that he may raise any crop he desires, congenial to our climate, on the same piece of ground, by an annual application of such food as the crop needs for nourishment. This, then, brings the question down to a matter of dollars and cents, in which the increased value of a crop figures against the cost of fertilizers. The solution of this question is within the reach of every farmer.

MANUFACTURES.

Wayne county has long been noted for its extensive manufacturing establishments, especially those for the production of agricultural implements. The Gaar, Scott & Co. Machine Works have long held an enviable reputation for their steam and horse threshing machines, portable and stationary engines, clover hullers, saw-mills, etc., etc.

S. Horney & Co.'s steel plows have found their way into every county in the State, and their good qualities are recognized in all the adjoining States, where they meet with ready sale.

The Hoosier Drill, lately manufactured at Milton, now at Richmond, is one of the best grain, grass and clover-seed drills manufactured in the Union. The Emperor of Brazil, who takes the deepest interest in all kinds of machinery destined to promote the interests of agriculture, saw the Hoosier Drill on exhibition at the Centennial, and purchased one after a thorough examination of it. Dr. Nicolau J. Moreira, Brazilian judge on group IV, "Vegetable products and machinery," a gentleman of great learning, and author of a very important work on the agricultural resources of Brazil, and one more competent to judge of the merits of the machine could not well be found, examined this drill and recommended it to the Emperor. His favorable opinion is highly commendatory of the mechanical skill and genius of the manufacturers.

There are a number of other manufacturing establishments in Richmond, Germantown, Centreville, Cambridge City and Hagerstown, besides those mentioned in this brief notice.

At the dedication of the new works of the Hoosier Drill company, at Richmond, J. M. Westcott, president of the company, gave a brief review of the progress of manufactures in Richmond by decades. From this address I learn that the number of manufactories now in operation at Richmond is 139. The amount of sales for 1877 was $3,315,510, and the wages paid during the same time for labor in these factories amounted to $702,693.

THANKS.

To the citizens of the entire county I am indebted for the most cordial treatment while prosecuting my investigations. Mr. J. C. Ratliff let all business go and traveled with me day after day. Mr. L. B. Case, a most indefatigable student of natural history, Prof. J. C. Macpherson and Mr. M. J. Shinn, also accompanied me on many occasions. These gentlemen are all well acquainted over the county, and familiar with the most important geological localities. I am, therefore, greatly indebted to them for much valuable information and their able assistance. To Mrs. Mary P. Haines I am also under obligations for the privilege of studying her ample collection of fossils and cryptogamic plants collected in the county; notice has been made of this collection, together with a catalogue of the specimens, on page 201 of this report.

Though Dr. O. P. Barr happened not to be at home when I called to see him, I must not omit to mention that he has an admirable collection of fossils collected in the county, and has done much to enrich the science of palæontology by his discoveries.

I must also notice the Hon. William Baxter for the warm interest he manifested in the progress of the survey. Mr. Baxter has an extensive library, and is a great reader and student, as well as energetic business man and prominent legislator.

Hon. John Yaryan, the able representative of the county, also very kindly tendered all the assistance in his power.

James Starr, president of the Richmond Gas-works, was likewise active in showing me what attention he could. Mr. Starr is one of the most enterprising gentlemen in the State; he is known in Richmond as "the great American tree-planter," having set out, within the year, over one thousand trees. He has purchased a large plat of ground in the city, and is ornamenting it with walks, drives, shade-trees and shrubbery, to be open to the people as a public park.

To the press of the county I am also under many obligations for encouraging notices and kind words regarding the progress of the survey.

The following is a list of the ferns, mosses, hepaticæ and lichens collected in Wayne county, Ind., by Mrs. Haines, and furnished by her for publication in this report:

FERNS.

Adiantum pedatum ....L.
Asplenium angustifolium..Mx.
Asplenium thelypteroides..Mx.
Asplenium felix-fœmina..Bernh.
Asple. felix-fœmina, var. Michauxii.
Aspidium acrosticoides..Swtz.
A. acrosticoides, v. incisum.
A. thelyptera..Sw.
A. spinulosum..Will'd.
A. spinulosum, var.
Botrychium virginicum ....L.
Camptosorus rhizophyllus ....Lk.
Cistopteris fragilis..Bernh.
C. bullifera..Bernh.
Onoclea sensibilis..L.
Polypodium hexagonopterum..Mx.
Pteris aquilina ....L.

MOSSES.

Aulocomnion heterostichon..Br. & Sch.
Anomodon rostratus..Sch.
A. tristis.

MOSSES—CONTINUED.

A. fragilis.
A. attenuatus ....Hub.
A. *obtusifolius* ....Br. & Sch.
Atrichum angustatum ....Hood.
At. undulatum ....Beau.
Bartramia *pomiformis* ....Hedw.
B. marchica ....Brid.
Barbula fallax ....Hedw.
B. *cæspitosa* ....Schwaegr.
B. unguiculata ....Hedw.
Bryum argenteum ....Linn.
Bry. caespiticium ....Linn.
Bry. nutans ....Schreb.
Bry. pyriforme ....Hedw.
Bry. pseudo-triquetrum ....Hedw.
Bry. roseum ....Dill.
Ceratodon purpureus ....H. & B.
Climacium americanum ....Brid.
Cylindrothicum seductrix.
Cyl. cladorrhizans.
Cyl. brevisetum.
Cyl. seductrix, var.
Drommondia clavellata ....H. & T.
Dicranium flagellare ....Hedw.
D. scoparium ....Hedw.
D. viride.
Funaria hygrometrica ....Hedw.
Fissidens adiantoides ....Liv.
F. taxifolins ....Liv.
F. subbassilaris.
Grimmia pennsylvanica ....Sch.
Gymnostomum curvirostrum ....Hedw.
Homalothecium subcapillatum.
Hypnum acuminatum ....Beau.
Hyp. boscii ....Schwaegr.
Hyp. cordifolium ....Hedw.
Hyp. cylindrocarpum ....C. Mull.
Hyp. campestre ....Br. & Lch.
Hyp. delicatulum ....Linn.
Hyp. deplanatum.
Hyp. fluitans ....Linn.

MOSSES—CONTINUED.

Hyp. gracile..Br. & Leh.
Hyp. gracile, v. lancastriense.
Hyp. hispidulum..Brid.
Hyp. hians..Hedw.
Hyp. imponeus..Hedw.
Hyp. laetum..Brid.
Hyp. riparium, v. cariosum.
Hyp. rutabulum..Linn.
Hyp. serrulatum..Hedw.
Hyp. serpeus..Linn.
Hyp. serpeus, v. orthocladon.
Hyp. serpeus, v. radicle.
Hyp. salebrosum..Hoff.
Hyp. strigosum..Hoff.
Hyp. tamariscinum..Hedw.
Hyp. varium.
Hedwigia ciliata..Ehrh.
Leucobryum vulgare.
Leskia polycarpa..Hedw.
Leptodon trichomitrion..Brid.
Leucodon julaceus..Hedw.
Len. brachypus..Brid.
Leptodon ohioense.
Leskia denticulata..Sull.
Mnium affine..Bland.
M. cuspidatum..Schreb.
M. rostratum..Schwaegr.
Neckera pennata—small var.
Orthotrichum strangulatum.
Polytrichum formosum..Hedw.
Physcomitrion pyriforme..Brid.
Pylaisea denticulata.
Py. intricata..Hedw.
Py. velutina..Bryol. En.
Platygerium repens..Bryol. En.
Schistidium confertum..Funk.
Trichostomum pallidum..Hedw.
Thelia asprella..Sull.
Thelia hirtella..Sull.
Weisia viridula..Brid.

HEPATICÆ.

Conocephalus conicus...Durn.
Frullania aeolotis...Nees.
F. eboracensis...Leh.
F. virginica.
Aneura sessilis.
Blephoragia ciliaris...Nees.
Chiloscyphus ascendens...H. & T.
Calypogeia trichomanes.
Jungermannia curvifolia.
J. schraderi.
Lophocolea maconni.
L. minor.
L. bidentata.
L. heterophylla...Nees.
Madotheca platyphylla.
M. thuja.
Marchantia polymorpha.
Radula complanata.
Reboulia hemispherica.
Trichocolea tomentalla.

LICHENS.

Cladonia mitrula...Tuck.
Cl. cristatella...Tuck.
Cl. fimbriata...Fr.
Cl. fimbriata v. tubæformis.
Cl. squamosa...Tuck.
Endocarpum miniatum...Sch.
Graphis dendritica.
G. scripta.
Lecanora pallescens...Ach.
Leptogium pulchellum...Nyl.
L. lacerum.
Parmelia caperata...Ach.
P. lævigata.
P. tiliacea...Ach.
P. Borreri...Turn.
P. perforata v. cetrata.
Pannaria nigra.
Physia stellaris...Wallr.
P. speciosa...Ach.

LICHENS—CONTINUED.

P. speciosa, v. hypolenca.
P. obscura, v. agglutinata.
Peltigera canina.
Ramalina calycaris.
Sticta pulmonaria ....Linn.
Sticta glomerifera.
Theloschistos parietinus..Norn.
Usnea barbata...Fr.
U. barbata, v. florida.
U. angulata.

TABLE OF ALTITUDES.

[By Hon. Jesse L. Williams, C. E., Fort Wayne, Indiana.]

Jesse L. Williams, of Fort Wayne, has, at my request, presented for publication in this report an interesting collection of altitudes gathered through a long professional career as civil engineer, beginning with the commencement of the Wabash and Erie canal in 1832. These tables of elevations comprise several hundred points in various localities between the Allegheny mountains and tide water of the Pacific ocean, and between the Ohio river and Lake Superior.

The elevations were ascertained in the course of numerous surveys for canals and railroads under his supervision, and that of other civil engineers, by the more accurate method of the spirit level.

More than half the points are in Indiana—many of them in adjoining States into which our public improvements run—while their scope is so extensive as to give hights of prominent mountain ranges and valleys on each of the five Pacific railroad routes, either constructed or located across the Rocky mountain region.

E. T. Cox, State Geologist.

INDIANAPOLIS, January 1, 1879.

TABLE OF ALTITUDES along line of Wabash and Erie Canal, from Toledo, Ohio, to Evansville, Indiana.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Low water of Maumee river at Toledo—average lake level	Lucas	Ohio	0	573
do do do foot of Maumee rapids	Lucas	Ohio	0	573
do do do head of Maumee rapids, below Providence dam	Lucas	Ohio	59	632
Pool of Providence dam at head of Maumee rapids	Henry	Ohio	63	636
Low water of Maumee at Defiance	Defiance	Ohio	94	667
Surface of Wabash and Erie canal at junction of Miami and Erie, and Wabash and Erie canals	Defiance	Ohio	148	721
do do do at east line of Indiana	Allen	Indiana.	177	750
do do do at Fort Wayne, Indiana, (summit level)	Allen	Indiana.	194	767
Low water of Maumee at Fort Wayne, Indiana	Allen	Indiana.	164	737
Court-house square at Fort Wayne, Indiana	Allen	Indiana.	199	772
Summit, four miles southwest of Fort Wayne—divide between the Maumee and Wabash drainage	Allen	Indiana.	193	776
Railroad track of Pittsburg, Ft. Wayne & Chicago depot, at Fort Wayne	Allen	Indiana.	212	785
*Rock ledge across bed of Little river, three and one-half miles above Huntington	Huntington	Indiana.	171	744
Court-house square in Huntington	Huntington	Indiana.	168	741
Low water of Wabash river at mouth of Little river, two miles below Huntington	Huntington	Indiana.	126	699
do do do Salamonie	Wabash	Indiana.	94	667
Court-house square in Wabash	Wabash	Indiana.	157	730
Low water of Wabash river at mouth of Mississinnewa	Miami	Indiana.	60	633
Court-house square in Peru	Miami	Indiana.	84	657
Low water of Wabash at mouth of Eel river	Cass	Indiana.	10	583
do do at Delphi, below Pitttsburg dam	Carroll	Indiana.	Below 47	526
do do at mouth of Tippecanoe	Tippecanoe	Indiana.	Below 57	516
do do at Lafayette	Tippecanoe	Indiana.	Below 67	506
do do three miles below Clinton	Vermillion	Indiana.	Below 115	458
do do at Terre Haute	Vigo	Indiana.	Below 122	451
Public square in Terre Haute	Vigo	Indiana.	Below 75	498
Summit level, cross-cut canal, the divide of drainage between Wabash and White rivers, twelve miles east of Terre Haute (ground)	Vigo	Indiana	0	573
Surface of canal at mouth of Eel river feeder	Clay	Indiana	Below 18	555
Plane of town at Worthington—junction of Eel river with west fork of White river	Greene	Indiana	Below 49	524
Low water of White river below Newberry dam	Greene	Indiana	Below 117	456
Surface of canal at Petersburg and Patoka summit, in the deep cut	Pike	Indiana	Below 129	444
Low water of White river at junction of east and west forks	Pike	Indiana	Below 177	396
Surface of canal at Dongola and Patoka summit	Pike	Indiana	Below 137	436

Pool of Pigeon creek dam	Gibson	Indiana.	Below 118	385
Plane on which Evansville stands	Vanderburg	Indiana.	Below 190	383
Low water of the Ohio at Evansville	Vanderburg	Indiana.	Below 247	326

*Note.—A singularly shaped granite boulder growing out of this ledge, and rising above the water with a form slightly resembling a saddle, gave to this spot the name of "Saddle Rock," by which it was known to early traders and navigators. Geologists agree that this rocky barrier was once the overfall outlet of the great Lake basin, or inland sea.

TABLE OF ALTITUDES on the Line of the Cincinnati, Richmond & Ft. Wayne Railroad, from Fort Wayne to Richmond.

LOCALITY OF OBSERVATION.	County.	State.	Feet above Lake Erie.	Feet above Ocean.
Low water at Fort Wayne, junction of St. Mary's and St. Joseph rivers	Allen	Indiana.	164	737
Water surface Wabash and Erie canal, summit level at Fort Wayne	Allen	Indiana.	194	767
Railroad track at Fort Wayne, opposite P., Ft. W. & Chi. passenger depot	Allen	Indiana.	212	785
Adams' Station (five-mile switch) ground—intersection with Pittsburg road	Allen	Indiana.	223	796
Summit between Maumee and St. Mary's rivers, ⅛ of a mile north of Adams county line (ground)	Allen	Indiana.	273	846
Low water, St. Mary's river, one mile north of Decatur	Adams	Indiana.	197	770
Track at Decatur (opposite station house)	Adams	Indiana.	234	807
Summit between St. Mary's and Wabash rivers (ground)	Adams	Indiana.	292	865
Low water, Wabash river	Adams	Indiana.	249	822
Summit between Wabash and Salamonie rivers (ground)	Jay	Indiana.	382	955
Low water, Salamonie river, at Portland	Jay	Indiana.	331	904
Summit between Salamonie and Mississinewa rivers (ground)	Jay	Indiana.	480	1053
Ridgeville, railroad crossings	Randolph	Indiana.	420	993
Low water, Mississinewa river at Ridgeville	Randolph	Indiana.	391	964
Summit between Mississinewa and White rivers (ground)	Randolph	Indiana.	522	1095
Low water of White river, near Winchester	Randolph	Indiana.	480	1053
Winchester, at crossing of Bellefontaine railroad (track)	Randolph	Indiana.	515	1088
Summit between White river and Green's fork of White Water (ground)	Randolph	Indiana.	615	1188
Low water of Green's fork of White Water	Randolph	Indiana.	548	1111

TABLE OF ALTITUDES on the Line of the Cincinnati, Richmond and Fort Wayne Railroad, Etc.—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Summit between Green's fork and Noland's fork of White Water, about two-thirds of a mile south of Wayne county line (ground—highest point)	Wayne	Indiana	649	*1212
Low water, Nolan's fork of White Water	Wayne	Indiana	499	1062
Summit between Noland's fork and White Water (ground)	Wayne	Indiana	569	1132
Junction with Cincinnati and Chicago railroad, near Richmond	Wayne	Indiana	396	969
Low water of White Water at Richmond	Wayne	Indiana	312	885
Richmond City (track at passenger depot)	Wayne	Indiana	396	969

* NOTE.—The highest ground in Indiana is found about eight miles southeast of Winchester, in Randolph county, at the source of the White river, White Water and Big Miami rivers—being probably 680 feet above Lake Erie. It is level table-land.

TABLE OF ALTITUDES on the Grand Rapids and Indiana Railroad, from Fort Wayne, Indiana, to Petoskey, Michigan, (Little Traverse Bay).

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Junction with P., Ft. W. & Chi. Railway (track), west of St. Mary's bridge	Allen	Indiana	196	769
Wallin Station, do. do.	Allen	Indiana	288	861
Huntertown, do. do.	Allen	Indiana	256	829
Bruce's Station, do. do.	Allen	Indiana	304	877
Swan, do. do.	Noble	Indiana	332	905
Avilla, do. do.	Noble	Indiana	408	981
Summit between Cedar Creek and Elkhart river, half mile south of Lisbon	Noble	Indiana	444	1017
Kendallville	Noble	Indiana	404	977

Rome lake (so-called). This is an artificial reservoir, in Middle fork of Elkhart, built by the State in 1837, to supply summit level of Erie and Michigan canal	Noble	Indiana	364	937
Wolcottville	Lagrange	Indiana	386	959
Valentine station	Lagrange	Indiana	400	973
La Grange	Lagrange	Indiana	354	927
Lima	Lagrange	Indiana	324	897
State line, between Indiana and Michigan			316	889
Sturgis	St. Joseph	Michigan	360	933
Michigan Central Air-Line railway crossing	St Joseph	Michigan	284	857
Mendon, on the Big St. Joseph river	St. Joseph	Michigan	284	857
Vicksburg—crossing of Lake Huron and Chicago railroad	Kalamazoo	Michigan	298	861
Kalamazoo—Michigan Central railway crossing	Kalamazoo	Michigan	214	787
Crossing of Kalamazoo river	Kalamazoo	Michigan	160	733
Plainwell	Allegan	Michigan	184	757
Martin	Allegan	Michigan	272	845
Wayland	Allegan	Michigan	200	773
Moline	Allegan	Michigan	246	819
Track on Grand river bridge, at Grand Rapids	Kent	Michigan	50	623
Detroit and Milwaukee railroad track at crossing	Kent	Michigan	55	628
North's Mills	Kent	Michigan	52	625
Whitney station	Kent	Michigan	75	648
Childs' mill, on Rouge river	Kent	Michigan	111	684
Rockford station	Kent	Michigan	127	700
Edgerton station	Kent	Michigan	110	683
Cedar Springs	Kent	Michigan	280	853
Summit south of Pierson	Montcalm	Michigan	364	937
Pierson station	Montcalm	Michigan	341	914
Howard, one-fourth mile south of Tamarack creek	Montcalm	Michigan	312	885
Summit, north of Tamarack creek	Mecosta	Michigan	355	928
Morley	Mecosta	Michigan	323	896
Summit, north of Morley	Mecosta	Michigan	416	989
Crossing of Mack's creek	Mecosta	Michigan	366	939
Summit, north of Mack's creek	Mecosta	Michigan	407	970
Pine plane at Big Rapids, east side of Muskegon river	Mecosta	Michigan	346	919
Low water, Muskegon river, at crossing	Mecosta	Michigan	325	898
Surface of ground at Paris, on Muskegon river	Mecosta	Michigan	352	925
Hersey river crossing	Osceola	Michigan	427	1000
Summit between Hersey river and Beaver creek, a branch of Pine river of the Manistee	Osceola	Michigan	697	1270
Beaver creek	Osceola	Michigan	635	1208
Summit between Beaver creek and outlet of Rose lake	Osceola	Michigan	687	1260
Outlet of Rose lake	Osceola	Michigan	599	1172
Summit between middle fork of Pine river, and outlet of Rose lake	Osceola	Michigan	678	1251
Middle fork of Pine river	Osceola	Michigan	634	1207
Summit between Middle and North forks of Pine river	Osceola	Michigan	735	1308

TABLE OF ALTITUDES on the Grand Rapids and Indiana Railroad, etc.—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
North fork of Pine river	Osceola	Michigan	679	1252
Summit between North fork of Pine river and Clam lake	Osceola	Michigan	759	1332
Clam lake	Wexford	Michigan	702	1275
Summit ridge, between Clam lake and the Manistee river, on railroad line	Wexford	Michigan	867	1440
Highest points of this range of hills, further east, estimated at	Wexford	Michigan	1000	1573
Head of Cedar creek, 6,000 feet north of the Manistee range of hills	Wexford	Michigan	677	1250
Cedar creek—first crossing	Wexf rd	Michigan	555	1128
Cedar creek—second crossing	Wexford	Michigan	511	1084
Water surface at Manistee river, at crossing on section 9, township 24, range 9	Wexford	Michigan	329	902
Plain, 7,000 feet north of Manistee river	Gr. Traverse	Michigan	420	993
Water in Fyfe lake	Gr. Traverse	Michigan	440	1013
Summit between Boardman river and the Manistee river	Kalcasco	Michigan	545	1118
Boardman river	Kalcasco	Michigan	438	1011
Summit between Boardman and Rapid rivers	Kalcasco	Michigan	510	1083
Rapid river (surface)	Kalcasco	Michigan	389	962
Plain just north of Rapid river	Kalcasco	Michigan	480	1053
Plain at head of Spring creek, a branch of the Boyne river	Charlevoix	Michigan	*657	1230
Boyne river, five miles east of the head of Pine lake	Charlevoix	Michigan	90	663
Summit between Boyne and Bear rivers	Charlevoix	Michigan	140	713
Outlet of Bear lake (Walloon, so-called)	Charlevoix	Michigan	110	683
Bear river crossing	Charlevoix	Michigan	90	663
Bluff at head of Little Traverse bay, near Petoskey City	Emmet	Michigan	74	647
Surface of Little Traverse bay, (Lake Michigan level)	Emmet	Michigan	12	585

* NOTE—About five or six miles east of this point, on the divide between the Cheboygan, Boyne and Manistee rivers, in township 32, range 4, there are sand ridges, rising to the height of 1,100 or 1,200 feet above Lake Michigan. This is undoubtedly the highest ground in the State.

TABLE OF ALTITUDES on the Fort Wayne, Jackson and Saginaw Railroad, from Fort Wayne to Jackson.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet Above Ocean.
Surface of water in Wabash and Erie canal at mouth of St. Joseph feeder—summit level	Allen	Indiana	194	767
Fort Wayne depot—junction of Muncie and Saginaw railroads, north of St. Mary's river	Allen	Indiana	188	761
North line of Allen county	Allen	Indiana	271	844
New Era station	DeKalb	Indiana	286	859
Eel River railroad crossing (Auburn junction)	DeKalb	Indiana	295	868
Auburn station	DeKalb	Indiana	299	872
Crossing of Lake Shore and Michigan Southern railroad at Waterloo	DeKalb	Indiana	341	914
Summit station	DeKalb	Indiana	428	1001
Pleasant Lake station	Steuben	Indiana	402	975
Angola station	Steuben	Indiana	479	1052
High Point—surface of ground	Steuben	Indiana	513	1086
Fremont station	Steuben	Indiana	482	1055
State line between Indiana and Michigan			500	1073
Montgomery station	Hillsdale	Michigan	462	1035
Low water of St. Joseph of the Maumee	Hillsdale	Michigan	423	996
Reading station	Hillsdale	Michigan	627	1200
High point, one mile north of Reading. In this vicinity is the highest ground in the south half of the State, being the source of the Big and Little St. Joseph, Kalamazoo and the river Raisin	Hillsdale	Michigan	647	1220
Bankers—junction of the D., H. and I. railroad	Hillsdale	Michigan	494	1067
Crossing of Michigan Southern and Lake Shore railroad (old line) at Jonesville	Hillsdale	Michigan	504	1077
Jonesville station	Hillsdale	Michigan	483	1056
Low water in Kalamazoo river, near Mosherville	Hillsdale	Michigan	442	1215
Mosherville station	Hillsdale	Michigan	459	1022
Low water in Horse-Shoe lake	Jackson	Michigan	481	1054
Hanover station	Jackson	Michigan	541	1114
High point, one-half mile north of Hanover	Jackson	Michigan	563	1136
Surface of water in north branch of Kalamazoo—Baldwin's	Jackson	Michigan	429	1002
Baldwin's station	Jackson	Michigan	438	1011
Crossing of Jackson Branch of Lake Shore and Michigan Southern railroad	Jackson	Michigan	362	935
Low water in Grand river—Hayden's mill pond	Jackson	Michigan	357	930
Jackson station—Michigan Central railroad crossing on the Grand river	Jackson	Michigan	358	931

TABLE OF ALTITUDES on Pittsburg, Fort Wayne and Chicago Railway, from Pittsburg to Chicago.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Station at Pittsburg Union depot	Allegheny	Penn	173	746
Lowest point of track, Ohio bottom, just east of Rochester	Beaver	Penn	133	706
Low water of Ohio river at mouth of river				
Track at New Brighton, on Big Beaver river	Beaver	Penn	178	751
Track in summit cut, west of Homewood	Beaver	Penn	482	1055
Track at New Gallilee, on Little Beaver creek	Beaver	Penn	385	958
Track at Leetonia, on Green creek, a branch of Little Beaver	Columbiana	Ohio	444	1017
Track at Salem	Columbiana	Ohio	601	1174
Track at Woodland, two and one-half miles west of Salem	Columbiana	Ohio	673	1246
Track at Mahoning river, two miles east of Alliance	Mahoning	Ohio	487	1060
Track at Alliance	Stark	Ohio	511	1084
Track at Strassburg, west of Alliance	Stark	Ohio	615	1188
Track at Massillon	Stark	Ohio	382	955
Track at Orville, crossing of Cleveland and Mt. Vernon railroad	Wayne	Ohio	486	1059
Track at Smithville, five miles east of Wooster	Wayne	Ohio	550	1123
Track at Killbuck creek, west of Wooster	Wayne	Ohio	279	852
Track at Loudonville	Ashland	Ohio	403	976
Track at Lucas	Richland	Ohio	519	1092
Track at Mansfield	Richland	Ohio	579	1152
Track at Richland station	Richland	Ohio	629	1202
Track at Crestline	Crawford	Ohio	590	1163
Track at Bucyrus	Crawford	Ohio	358	931
Track at Forrest, crossing C., S. and C. railroad	Hardin	Ohio	368	941
Track at Hog creek marsh	Hardin	Ohio	302	875
Track at Lima, crossing D. and M. railroad	Allen	Ohio	207	780
Track at Delphos (surface of Miami canal)	Van Wert	Ohio	209	782
Track at Van Wert	Van Wert	Ohio	212	785
Track at Fort Wayne (in front of passenger depot)	Allen	Indiana	203	776
Track at St. Mary's river bridge, Arcola station	Allen	Indiana	261	834
Track at Summit, one mile east of Cresse	Whitley	Indiana	304	
Track at Columbia City	Whitley	Indiana	264	837
Track at Summit, between Eel river and Tippecanoe river—8,000 feet west of Larwill	Whitley	Indiana	391	964
Track at Warsaw	Kosciusko	Indiana	252	825
Track at Plymouth	Marshall	Indiana	209	782

Surface of Yellow river at Plymouth	Marshall	Indiana	188	761
Track at Summit station, four miles west of Plymouth	Marshall	Indiana	279	852
Surface of Yellow river ten miles above junction with Kankakee	Starke	Indiana	122	695
Surface of English lake (Kankakee river)	Starke	Indiana	91	664
Surface of Kankakee river—ordinary low water—at crossing of P., Ft. W. and C. railroad	Starke	Indiana	94	667
Track at Hamlet station	Starke	Indiana	126	699
Track at Wanatah	Porter	Indiana	159	732
Summit between Wanatah and Valparaizo	Porter	Indiana	186	759
Track at Valparaizo	Porter	Indiana	166	789
Track at Wheeler	Porter	Indiana	94	667
Track at Hobart	Lake	Indiana	51	624
Track at South Chicago	Cook	Illinois	17	590
Surface of Lake Michigan	Cook	Illinois	12	585

LEVELS along Michigan and Illinois Canal and the Illinois River.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Summit level of canal (surface water) ten or twelve miles southwest of Chicago	Cook	Illinois	22	595
DesPlaines river at Joliet	Will	Illinois	Below 30	543
Track at depot in Joliet	Will	Illinois	Below 23	550
Surface of Illinois river at mouth of Fox river, at Ottawa	Lasalle	Illinois	Below 125	448
Surface of Fox river at Elgin, crossing of railroad	Kane	Illinois	Above 127	700
Surface of Illinois river at Lasalle and Peru	Lasalle	Illinois	Below 134	439
Surface of Illinois river at Peoria	Peoria	Illinois	Below 140	433
Surface of Illinois river at Beardstown	Cass	Illinois	Below 150	423
Surface of Illinois river at Naples, at crossing of railroad	Scott	Illinois	Below 155	418
Surface of Mississippi river at mouth of Illinois river	Jersey	Illinois	Below 163	410

TABLE OF ALTITUDES on Fort Wayne, Muncie and Cincinnati Railroad.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Track at crossing of Pittsburg, Ft. Wayne and Chicago Railway	Allen	Indiana	195	768
Track at crossing of Toledo, Wabash and Western (Wabash Railroad)	Allen	Indiana	225	798
Track at Ferguson's station	Allen	Indiana	231	804
Tradk at Wells county line		Indiana	256	829
Track on 8-mile bridge at Ossian	Wells	Indiana	252	825
Track at summit between St. Mary's and Wabash rivers	Wells	Indiana	301	874
Track on bridge across Wabash river	Wells	Indiana	246	819
Track at Bluffton depot	Wells	Indiana	262	835
Track at Worthington crossing	Wells	Indiana	291	864
Track at summit between Wabash and Salamonie rivers	Wells	Indiana	322	895
Track at bridge across Salamonie river at Montpelier	Blackford	Indiana	292	865
Track at Delaware county line		Indiana	365	938
Track at summit between Hartford City and Mississinewa river		Indiana	382	955
Track at Eaton	Delaware	Indiana	340	913
Track on bridge over Mississenewa	Delaware	Indiana	337	910
Track on bridge over White river	Delaware	Indiana	365	938
Track at Muncie station	Delaware	Indiana	375	948
Track at Henry county line		Indiana	443	1016
Track at Springport	Henry	Indiana	256	829
Track at summit between Wabash waters and Blue river	Henry	Indiana	534	1107
Track at Newcastle, on Blue river	Henry	Indiana	472	1045
Track at New Lisbon	Henry	Indiana	536	1109
Track at Wayne county line		Indiana	483	1056
Track at Cambridge City	Wayne	Indiana	384	957
Track at Beeson's	Wayne	Indiana	313	886
Track at Fayette county line		Indiana	308	881
Track at Connersville	Fayette	Indiana	265	838

TABLE OF ALTITUDES on the Pan-Handle Route (so-called) from Chicago, through Logansport to Union City.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Surface of Lake Michigan			12	585
State line between Illinois and Indiana			48	621
Crown Point station	Lake	Indiana	144	717
Cassville station	Lake	Indiana	114	687
Hebron station	Porter	Indiana	144	717
Koutts' station	Porter	Indiana	118	691
Crooked creek, east of Koutts' station	Porter	Indiana	103	676
Lacrosse station	Starke	Indiana	105	678
North Judson	Starke	Indiana	132	705
Gundrum station	Pulaski	Indiana	140	713
Winamac station	Pulaski	Indiana	143	716
Tippecanoe crossing	Pulaski	Indiana	101	674
Star City station	Pulaski	Indiana	136	709
Rosedale station	Pulaski	Indiana	152	725
Royal Centre station	Cass	Indiana	165	738
Gebhard's station, summit between the Wabash and Tippecanoe rivers, 9 miles west of the Wabash	Cass	Indiana	192	765
Logansport station	Cass	Indiana	23	596
Anoka Junction	Cass	Indiana	126	699
Onward station	Cass	Indiana	193	766
Bunker Hill station	Miami	Indiana	230	803
North Grove station	Miami	Indiana	247	820
Amboy station	Miami	Indiana	240	813
Converse station	Grant	Indiana	245	818
Mier station	Grant	Indiana	246	819
Switzer station	Grant	Indiana	266	839
Marion station	Grant	Indiana	241	814
Jonesboro' station	Grant	Indiana	276	849
Hartford City station	Blackford	Indiana	341	914
Ridgeville station, crossing of C., P. & Ft. Wayne Railroad	Randolph	Indiana	424	997

TA LE OF ALTITUDES on Toledo, Peoria and Warsaw Railroad, from State Line of Illinois and Indiana, to Logansport, Indiana.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
State line between Indiana and Illinois	Newton	Indiana	107	680
Kent station	Newton	Indiana	111	684
Goodland station	Jasper	Indiana	148	721
Remington station	Jasper	Indiana	162	735
Wolcott station	White	Indiana	145	718
Reynolds station	White	Indiana	122	695
Surface water of Tippecanoe	White	Indiana	32	605
Monticello station	White	Indiana	102	675
Idaville station	White	Indiana	142	715
Burnettsville station	White	Indiana	136	709
Lake Cecott station	Cass	Indiana	133	706
Curveton station	Cass	Indiana	101	674
Logansport station	Cass	Indiana	23	596

ELEVATIONS on Detroit and Eel River Railroad, from Logansport to Butler.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Track on drawbridge, W. & E. Canal at Logansport	Cass	Indiana	31	604
Bottom of Eel river	Miami	Indiana	115	688
Roann station	Wabash	Indiana	174	747
Bottom Bear Grass creek, tributary to Eel river	Wabash	Indiana	152	725
Laketon station	Wabash	Indiana	186	759
Bottom of Eel river at North Manchester station	Wabash	Indiana	158	721

North Manchester station	Wabash	Indiana	199	772
Bottom of Eel river at Liberty Mills station	Wabash	Indiana	177	750
Bottom of Eel river at Collamer station	Whitley	Indiana	195	768
South Whitley station	Whitley	Indiana	232	805
Bottom of Spring creek at South Whitley station	Whitley	Indiana	218	791
Columbia City station	Whitley	Indiana	264	837
Bottom of Blue river at Columbia City station	Whitley	Indiana	243	816
Cherrubusco station	Whitley	Indiana	319	892
Butler station	DeKalb	Indiana	294	867

TABLE OF ALTITUDES on Louisville, New Albany and Chicago Railroad, from New Albany to Michigan City.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Depot at New Albany	Floyd	Indiana	Below 137	436
Providence station	Clark	Indiana	Below 20	553
Knobs, near Silver creek	Clark	Indiana	Above 144	717
Harristown station	Washington	Indiana	Above 301	874
Salem station	Washington	Indiana	Above 144	717
Smedley's station	Washington	Indiana	Above 304	877
Orleans station	Orange	Indiana	Above 62	635
Mitchell station	Lawrence	Indiana	Above 92	665
White river bridge	Lawrence	Indiana	Below 70	503
Bedford station	Lawrence	Indiana	Above 108	681
Harrodsburg station	Monroe	Indiana	Below 65	508
Bloomington station	Monroe	Indiana	Above 171	744
Gosport station	Owen	Indiana	Below	573
Near Bainbridge station	Putnam	Indiana	Above 382	955
Crawfordsville station	Montgomery	Indiana	Above 171	744
Lafayette depot	Tippecanoe	Indiana	Below 27	546
Wabash river crossing; water at bridge	Tippecanoe	Indiana	Below 59	514
Brookston station	Tippecanoe	Indiana	Above 105	678
Reynolds station	White	Indiana	Above 120	693
Bradford station	White	Indiana	Above 101	674
c[illegible]isville station	Pulaski	Indiana	Above 107	680

TABLE OF ALTITUDES on Louisville, New Albany and Chicago Railroad, etc.—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Medaryville station	Pulaski	Indiana	Above 112	685
San Pierre station	Starke	Indiana	Above 127	700
Kankakee river crossing	Starke	Indiana	Above 87	660
Lacrosse station	Starke	Indiana	Above 102	675

TABLE OF ALTITUDES on Canal Survey, along the White Water Valley, in 1834.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Surface West fork White Water at mouth of Nettle creek	Wayne	Indiana	409	982
Surface ground at court house in Connersville	Fayette	Indiana	272	845
Surface White Water at Brookville, junction with East fork	Franklin	Indiana	47	620
Surface White Water at Harrison, State line between Ohio and Indiana	Dearborn	Indiana	Below 57	516
Surface of high water of Ohio at Lawrenceburg	Dearborn	Indiana	Below 69	504
Surface high table-land between head of White Water and Blue river, sources of Flat Rock, near line between Henry and Randolph counties		Indiana	Above 555	1128

TABLE OF ALTITUDES on Railroad Survey from Terre Haute to Evansville, 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Lebanon—Summit between Bussero creek and the Wabash	Sullivan	Indiana	Below 53	520
Surface of Bussero creek at low water	Sullivan	Indiana	Below 146	427
White river at Robb's; high water	Sullivan	Indiana	Below 161	412
Patoka river at Columbia; high water	Gibson	Indiana	Below 162	411
Door-sill of court house at Princeton	Gibson	Indiana	Below 69	504
Ridge dividing waters of Pigeon creek and the Wabash	Vanderburg	Indiana	Below 104	469
High-water mark of the Ohio at Evansville	Vanderburg	Indiana	Below 190	383

TURNPIKE SURVEY, New Albany to Crawfordsville, made in 1835. Also, some points on line of New Albany and Salem Railroad (now called L., N. A. & Chi.), as Constructed.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Knobs north of New Albany	Floyd	Indiana	Above 357	930
Railroad track at Salem depot	Washington	Indiana	Above 152	725
Summit of ground between Blue river and White river	Washington	Indiana	Above 338	911
Depot at Orleans	Orange	Indiana	Above 64	637
Track at crossing of New Albany & Salem and Ohio & Mississippi Railroad	Orange	Indiana	Above 101	674
Surface of East fork White river; low water	Lawrence	Indiana	Below 104	469
Track at Bedford depot	Lawrence	Indiana	Above 116	689
Surface of Salt creek	Lawrence	Indiana	Below 95	478
Track at Bloomington depot	Monroe	Indiana	Above 180	753
Summit between Clear creek and Jack's defeat	Monroe	Indiana	Above 318	891
Surface of West fork of White river; low water	Owen	Indiana	Below 16	557
Summit between White river and Eel river	Owen	Indiana	Above 202	775

TURNPIKE SURVEY, New Albany to Crawfordsville, 1835, etc.—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Surface of Eel river	Owen	Indiana	Above 149	722
Summit between Eel river and Deer creek	Putnam	Indiana	Above 239	812
Surface of Deer creek	Putnam	Indiana	Above 64	637
Track at National road	Putnam	Indiana	Above 99	672
Crossing of Walnut fork of Eel river; low water	Putnam	Indiana	Above 106	679
Surface of Raccoon creek	Montgomery	Indiana	Above 161	734
Summit between Raccoon creek and Sugar creek	Montgomery	Indiana	Above 379	952

TABLE OF ALTITUDES on Line of Preliminary Survey, made in 1835, from Indianapolis to Lafayette, via Danville and Crawfordsville.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Summit between Eagle and White Lick creeks	Hendricks	Indiana	293	866
Surface of White Lick creek	Hendricks	Indiana	207	780
Surface between heads of White Lick creek and Eel river	Hendricks	Indiana	481	1054
Surface of east fork of Eel river	Hendricks	Indiana	309	881
Surface of west fork of Eel river	Hendricks	Indiana	308	881
Summit between Eel river and Raccoon creek	Hendricks	Indiana	373	946
Surface of Raccoon creek	Montgomery	Indiana	253	826
Surface of Sugar creek, one-half mile from Crawfordsville	Montgomery	Indiana	97	670
Summit between Sugar creek and Wea creek	Montgomery	Indiana	276	849
Surface of Wea creek	Tippecanoe	Indiana	159	732
Surface of Wea creek four miles south of Lafayette	Tippecanoe	Indiana	52	625

RAILROAD SURVEY direct from Indianapolis to Lafayette—Survey in 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Surface of Eagle creek	Boone	Indiana	183	756
Summit between Eagle and Sugar creeks	Boone	Indiana	406	979
Surface of Sugar creek near Thorntown	Boone	Indiana	233	806
Summit between Sugar creek and Wabash river	Tippecanoe	Indiana	262	835

CANAL SURVEY from Indianapolis to Wabash, Wabash county, in 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Surface of ground at court house in Noblesville	Hamilton	Indiana	197	770
Surface of White river at Anderson	Madison	Indiana	176	749
Surface of White river at Muncie	Delaware	Indiana	373	946
Surface of Mississinewa northwest of Muncie	Delaware	Indiana	348	911
Surface of Mississinewa at Marion	Grant	Indiana	238	801
Summit between White river and Mississinewa southeast of Marion, level table land at head of Pipe creek (ground)	Madison	Indiana	319	882

TABLE OF SURVEYS in Various Parts of Indiana, ascertained by the Random Level Party, Preparatory to the Canal and Railroad Surveys, Ordered by the Legislature in 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Surface of White river at Indianapolis	Marion	Indiana	118	691
Summit between Indianapolis, in White river valley, and Franklin, in Blue river valley	Marion	Indiana	242	815
Door-sill of court house in Franklin	Johnson	Indiana	171	744
Surface of Muskatatuck at mouth of Graham's fork	Jefferson	Indiana	Below 10	563
Surface of Pigeon Roost creek at Vienna	Scott	Indiana	Below 2	571
Surface of ground at Collin's gap in ridge between White river and the Ohio	Clarke	Indiana	Below 57	516
Top of knob in road from Salem to Lexington, eight miles west of Vienna	Washington	Indiana	446	1019
Surface of ground in Livonia	Washington	Indiana	214	787
Ridge at crossing of New Albany and Paoli road	Washington	Indiana	307	870
Surface of the Patoka at mill dam above Jasper	Dubois	Indiana	Below 123	450
Surface of East fork of White river at Hindostan	Martin	Indiana	Below 135	438
Summit of Prairie between Anderson and Pendleton	Madison	Indiana	316	889
Surface of Mississinewa on State road from Indianapolis to Fort Wayne	Grant	Indiana	236	809
Surface of Salamonie on State road from Indianapolis to Fort Wayne	Huntington	Indiana	235	808
Surface of Salamonie eight miles above road from Indianapolis to Fort Wayne	Wells	Indiana	250	823
Surface of Rock creek at crossing of road from Indianapolis to Fort Wayne	Wells	Indiana	233	806
Surface of Wabash river at crossing of road from Indianapolis to Fort Wayne	Wells	Indiana	207	780
Surface of Wabash river eight miles above road from Indianapolis to Fort Wayne	Wells	Indiana	219	792

TABLE OF ALTITUDES on Canal Survey from Indianapolis to Evansville, in 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Surface of White river sixteen miles below Indianapolis	Morgan	Indiana	63	636
Surface of White river at mouth of Bean Blossom creek	Monroe	Indiana	Below 22	551
Surface of White river at Bloomfield	Green	Indiana	Below 83	490
Surface of White river opposite Washington	Daviess	Indiana	Below 148	425
Surface of White river at junction of east and west forks	Daviess	Indiana	Below 177	396
Lowest depression in ridge dividing White river and Patoka	Pike	Indiana	Below 104	469
Surface of Patoka river	Pike	Indiana	Below 163	410
Summit between Patoka and the Ohio, six miles east of Princeton	Gibson	Indiana	Below 104	469

TURNPIKE SURVEY from New Albany to Vincennes, in 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Low water of the Ohio at New Albany, just below the falls	Floyd	Indiana	Below 198	375
Ground at court house in New Albany	Floyd	Indiana	Below 125	448
Summit between Big Blue river and east fork of White river	Harrison	Indiana	Above 355	928
Town of Greenville	Floyd	Indiana	Above 208	781
Surface of Blue river	Washington	Indiana	Above 18	591
Paoli court house	Orange	Indiana	Above 48	611
Surface of Lost river	Orange	Indiana	Below 124	449
Low water of east fork of White river at Mt. Pleasant	Martin	Indiana	Below 120	453
Ground in Mt. Pleasant	Martin	Indiana	Above 33	606
Ground in Washington	Daviess	Indiana	Below 59	514
Low water of west fork of White river, west of Washington	Daviess	Indiana	Below 143	430
Summit between White river and the Wabash	Knox	Indiana	Below 000	573

TABLE OF ALTITUDES on Railroad Survey from Indianapolis to Lawrenceburg, in 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Summit between White river and Sugar creek	Marion	Indiana	297	870
Surface of Sugar creek	Shelby	Indiana	193	766
Surface of Blue river at Shelbyville	Shelby	Indiana	188	761
Ground at Shelbyville	Shelby	Indiana	206	779
Surface of Flat Rock creek	Shelby	Indiana	246	819
Summit between Flat Rock creek and Clifty creek	Decatur	Indiana	343	916
Surface of Clifty creek	Decatur	Indiana	308	881
Ground in Greensburg	Decatur	Indiana	393	966
Surface of Sand creek	Decatur	Indiana	362	935
Summit between Sand creek and Salt creek	Decatur	Indiana	506	1079
Surface of Laughery creek	Ripley	Indiana	360	933
Summit between Laughery creek and head of Ripple creek	Ripley	Indiana	450	1023
Sources of Hogan creek	Dearborn	Indiana	445	1018
Head of Tanner's creek	Dearborn	Indiana	462	1035
Main street in Lawrenceburg	Dearborn	Indiana	Below 78	495

RAILROAD SURVEY from Indianapolis to Madison, in 1835.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Summit between the East and West forks of White river	Marion	Indiana	312	885
Surface of Sugar creek	Johnson	Indiana	109	682
Surface of Blue river	Johnson	Indiana	89	662
Town of Edinburg	Johnson	Indiana	104	677
Surface of Flat Rock creek	Bartholomew	Indiana	51	624

Town of Columbus	Bartholomew	Indiana	70	643
Town of Vernon	Jennings	Indiana	88	661
Surface of Muskakatack at Vernon	Jennings	Indiana	48	621
Surface of Graham fork at Vernon	Jennings	Indiana	119	692
Surface of Big creek	Jefferson	Indiana	174	747
Surface of Middle fork of Big creek	Jefferson	Indiana	182	755
Summit between the Muskakatack and the Ohio river	Jefferson	Indiana	327	900
High water mark of the Ohio at Madison	Jefferson	Indiana	Below 101	472

TABLE OF ALTITUDES—Miscellaneous Levels in Indiana and Adjoining States, Collated from Various Sources.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Low water of St. Joseph river at its junction with St. Mary's which two rivers form the Maumee	Allen	Indiana	144	737
Low water of pool of St. Joseph's feeder dam of Wabash and Erie canal	Allen	Indiana	194	763
Low water of St. Joseph river at Leo, above dam	Allen	Indiana	202	775
Low water of St. Joseph river at crossing of Baltimore and Ohio railroad	Allen	Indiana	217	....
Low water of St. Joseph river at crossing of Michigan Southern Air Line railroad at Edgerton station	Williams	Ohio	234	....
Track of Michigan Southern Air Line railroad at Edgerton	Williams	Ohio	266	....
Summit (track) dividing Elkhart and Cedar creek waters on Grand Rapids and Indiana railroad, two and one-half miles southeast of Kendallville	Noble	Indiana	440	....
Summit (track) Air Line Michigan Southern railroad, three miles southeast of Kendallville	Noble	Indiana	445	....
Summit (track) Baltimore and Ohio railroad, on divide between Cedar creek and Elkhart river, one and one-half miles west of Avilla	Noble	Indiana	442	....
Track at Albion station, on Baltimore and Ohio railroad	Noble	Indiana	354	....
Track at Cromwell station, on Baltimore and Ohio railroad (summit)	Noble	Indiana	365	....
Track at Syracuse station, on Baltimore and Ohio railroad	Kosciusko	Indiana	295	....
Surface of Turkey lake, west of Syracuse	Kosciusko	Indiana	291	....
Track of Baltimore and Ohio railroad at Hicksville summit	Defiance	Ohio	276	....
Track of Baltimore and Ohio railroad at Hicksville	Defiance	Ohio	182	....
Low water of Maumee river at Ohio state line	....	Ohio	140	....
Track at Bryan depot, Michigan Southern Air Line railroad	Williams	Ohio	198	....
Track at Adrian depot, Southern Michigan railroad	Lenawee	Michigan	247	....
Track at Osseo depot, Southern Michigan railroad	Hillsdale	Michigan	540	....
Track at Hillsdale, Southern Michigan railroad	Hillsdale	Michigan	520	....

TABLE OF ALTITUDES—Miscellaneous Levels in Indiana and Adjoining States, etc.—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Track one mile west of Jonesville, Southern Michigan railroad—highest point on road	Hillsdale	Michigan	560	
Track at White Pigeon, Southern Michigan railroad	St. Joseph	Michigan	250	
Track at South Bend, Southern Michigan railroad	St. Joseph	Indiana	156	
Marsh a few miles west of South Bend, forming head of Kankakee river, canal survey of 1835	St. Joseph	Indiana	138	
Level table land on the summit between Kankakee and Tippecanoe rivers, through which Stansberry's (U. S. Engineer) canal survey was run in 1829	St. Joseph	Indiana	138	
Surface of Big St. Joseph at mouth of the Elkhart, canal survey of 1835	Elkhart	Indiana	147	
Surface of Fish lake, source of Fish creek, a branch of Little St. Joseph, near south line of Steuben county, canal survey by Stansberry, U. S. Engineer, 1827	Steuben	Indiana	314	
Surface of Pigeon lake, near Pleasant lake station, on Ft. Wayne, Jackson and Saginaw railroad, canal survey, 1827	Steuben	Indiana	382	
Surface of Wolf and Bear lakes, sources of Tippecanoe river, W. J. Ball's canal survey, 1840	Noble	Indiana	330	
General level water shed between Little St. Joseph and Elkhart rivers, canal surveys in 1835 and 1840	Noble	Indiana	400	
Track at Laporte, on Southern Michigan railroad	Laporte	Indiana	250	
Water shed between the Tippecanoe and Kankakee rivers, seven miles north of Winamac	Pulaski	Indiana	137	710
Railroad track at Kokomo (I., P. and C. railroad)	Howard	Indiana	266	839
Railroad track at Muncie (Bee Line railroad)	Delaware	Indiana	386	959
Railroad track at Anderson (Bee Line railroad)	Madison	Indiana	322	895
Railroad track at Pendleton (Bee Line railroad)	Madison	Indiana	273	846
Union depot at Indianapolis	Marion	Indiana	148	721
Track at depot of Terre Haute and Indianapolis railroad at Greencastle	Putnam	Indiana	276	849
Track at depot of Terre Haute and Indianapolis railroad (Vandalia route) at Terre Haute	Vigo	Indiana	74	647
Track of Terre Haute and Indianapolis railroad nine and one-half miles east of Greencastle, highest point on the road	Putnam	Indiana	333	906
Ground at court house in Danville	Hendricks	Indiana	392	965
Ground at Findly (seat of justice)	Hancock	Ohio	208	781
Highest table land between Wabash and Eel rivers at North Manchester	Wabash	Indiana	256	829
Railroad track at Rochester	Fulton	Indiana	217	790
Tippecanoe river near Rochester	Fulton	Indiana	105	678
Ground at court house in Renssalaer	Jasper	Indiana	107	680
East line of Indiana on line of Tiffin and Ft. Wayne railroad	Allen	Indiana	190	763
Bank of Auglaise river on line of Tiffin and Ft. Wayne railroad	Paulding	Ohio	140	713
Crossing of Dayton and Michigan railroad at Leipsic, 46 miles west of Tiffin	Putnam	Ohio	185	758
Summit between Blanchard's fork and Sandusky river		Ohio	215	788

Ground at Tiffin	Seneca	Ohio	180	753
Track of Baltimore and Ohio railroad near Havanna	Seneca	Ohio	315	888
Shelby, on Cleveland and Columbus railroad	Richland	Ohio	545	1118
Greenwich, on Cleveland and Columbus railroad	Huron	Ohio	470	1043
New London, on Cleveland and Columbus railroad	Huron	Ohio	410	983
Wellington, on Cleveland and Columbus railroad	Lorain	Ohio	286	859
Berea, on Cleveland and Columbus railroad	Cuyahoga	Ohio	208	781
Cleveland Bluffs	Cuyahoga	Ohio	90	663
Track of Atlantic and Great Western railroad, eight miles west of Mansfield	Richland	Ohio	802	1375
Track of Atlantic and Great Western railroad at Gallion—crossing Bellefontaine railroad	Crawford	Ohio	590	1163
Bellefontaine depot	Logan	Ohio	642	1215
High table-land a few miles northeast of Bellefontaine; highest ground in Ohio; source of Scioto and Miami rivers	Logan	Ohio	975	1548
Bellefontaine ("Bee Line") Railroad track crossing summit, four milest east of Bellefontaine	Logan	Ohio	773	1346
Youngstown, on the Mahoning river	Mahoning	Ohio	290	863
Ohio and Pennsylvania State line, six miles east of Youngstown	Mahoning	Ohio	252	825
Warren	Trumbull	Ohio	317	890
Atwater	Trumbull	Ohio	560	1133
Summit of land in Atwater township	Trumbull	Ohio	603	1176
Track of Atlantic and Great Western Railroad at Ravenna	Portage	Ohio	530	1103
Track of Atlantic and Great Western Railroad at Talmadge	Summit	Ohio	527	1100
Track of Atlantic and Great Western Railroad at Akron	Summit	Ohio	430	1003
Summit level of the Ohio canal at Akron	Summit	Ohio	395	968
Track of Atlantic and Great Western Railroad at Saville	Medina	Ohio	403	976
Walhalding river, one mile below Killbuck creek, from survey of 1822		Ohio	282	855
Licking summit, divide between the Scioto and Muskingum waters	Fairfield	Ohio	346	919
Low water Ohio river at Pittsburg	Alleghany	Pennsyl'a	127	700
Low water Ohio river at Steubenville	Jefferson	Ohio	59	632
Low water Ohio river at Muskingum	Washington	Ohio	5	578
Low water Ohio river at Scioto	Scioto	Ohio	Below 101	472
Low water Ohio river at Cincinnati	Hamilton	Ohio	Below 133	440
Low water Ohio river at Lawrenceburg	Dearborn	Indiana	Below 139	434
Low water Ohio river at mouth of Wabash river	Posey	Indiana	Below 260	313
Low water Ohio river at Cairo	Alexander	Illinois	Below 282	291
Low water Wabash river at Vincennes	Knox	Indiana	Below 159	414
Summit between Grand river and Saginaw bay, near the source of Shewassee river. (This is much the lowest summit between the two lakes in the State of Michigan)		Michigan	160	733

TABLE OF ALTITUDES—Lowest Summits along Water Shed, between Lake Erie and the Ohio River. See Preliminary Surveys in 1822, Preparatory for Location of Ohio Canals.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Divide between tributaries of Grand river of Lake Erie and the Mahoning waters, five miles northwest of Warren	Trumbull	Ohio	362	935
Divide between sources of Cuyahoga and Tuscarawas rivers, near Akron; summit levil of Ohio canal	Summit	Ohio	404	977
Divide between sources of Black river of Lake Erie and Killbuck creek of the Muskingum	Medina	Ohio	340	913
Divide between sources of Sandusky and Scioto rivers at Tyamochtee summit	Crrawford	Ohio	360	933
Divide between sources of St. Mary's and Big Miami rivers, Loramie's summit, of Miami & Erie canal	Shelby	Ohio	370	943
Divide between the Maumee and Wabash rivers, four miles southwest of Ft. Wayne, being summit level of Wabash and Erie canal, first surveyed in 1826 by United States Engineer	Allen	Indiana	*197	770

* NOTE.—The highest floods of St. Mary's river at the bridge of Pittsburg, Ft. Wayne and Chicago Railroad, as the water backs to the summit of the canal aqueduct, lack but five feet of flowing over this summit into the Wabash and thence to the Ohio. Across this divide was the historic nine-mile portage, over which pack-horses carried the furs, etc., between the small boats on each side. When civilization came the canoes were hauled across on wagons.

POINTS OF GREATEST DEPRESSION in the Crest of Allegheny Mountains, Pennsylvania, from Surveys for Locating Pennsylvania Railroad, in 1848.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Average of 21 gaps, covering a distance of 44 miles, from the divide between the Potomac and Castleman's rivers on the south to the divide between the West branch of Susquehanna and Allegheny rivers on the north				2383

Highest point of the 21 gaps, divide between Potomac and Castleman's rivers, summit of Chesapeake and Ohio canal survey				2759
Lowest depression, Emigh's gap, divide between the Little Juniatta and the Moshannon				2043
Sugar Run gap, through which Pennsylvania Railroad is constructed; ground surface				2283
Track of Pennsylvania Railroad in the mountain tunnel west of Altoona				2154
Crest of the mountain ridge at the divide between the West branch of Susquehanna and Allegheny, on the Bennett's branch line				1650
Railroad track in the mountain tunnel of the Bennett's branch line				1440
Grade of railroad track of Allegheny Valley road along the Allegheny river at the mouth of Red Bank creek, 64 miles from Pittsburg				825
Grade of railroad track at Driftwood, Bennett's branch line				787

TABLE OF ALTITUDES on Detroit and Milwaukee Railroad, from Detroit to Grand Haven.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Detroit river	Wayne	Michigan	2	575
Detroit and Milwaukee and Fr. Junction	Wayne	Michigan	58	631
Grand Trunk Junction	Wayne	Michigan	57	630
Royal Oak	Oakland	Michigan	91	664
Birmingham	Oakland	Michigan	204	777
Summit east of Pontiac	Oakland	Michigan	386	959
East crossing of Clinton river (track)	Oakland	Michigan	359	932
Drayton Plains	Oakland	Michigan	397	970
Clinton river crossing, near Drayton Plains (track)	Oakland	Michigan	392	965
Summit west of Clarkston	Oakland	Michigan	452	1020
Holly	Oakland	Michigan	365	938
Gaines	Genesse	Michigan	284	857
Vernon	Shiawasse	Michigan	195	768
Sheawassee river near Vernon; track on bridge	Shiawasse	Michigan	202	775
Owosso	Shiawasse	Michigan	170	743
Maple river near Ovid; track on bridge	Clinton	Michigan	154	727
St. John's	Clinton	Michigan	195	768

TABLE OF ALTITUDES on Detroit and Milwaukee Railroad, from Detroit to Grand Haven.—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Lost creek; track on bridge	Clinton	Michigan	145	718
West crossing of Maple river; track on bridge	Ionia	Michigan	77	650
Grand river, west of Ionia; track on bridge	Ionia	Michigan	75	648
Saranac	Ionia	Michigan	74	647
Lowell	Kent	Michigan	66	639
Thornapple river; track on bridge	Kent	Michigan	72	645
Summit between Thornapple river and Grand Rapids	Kent	Michigan	221	194
Grand river; track on bridge	Kent	Michigan	57	630
Indian Mill creek; track on bridge	Kent	Michigan	162	735
Sand creek near Berlin; track on bridge	Ottawa	Michigan	107	680
Center creek at Coopersville; track on bridge	Ottawa	Michigan	69	642
Crooked creek; track on bridge	Ottawa	Michigan	41	614
Nunica	Ottawa	Michigan	57	630
Spring lake	Ottawa	Michigan	22	595
Lake Michigan			13	586

TABLE OF ALTITUDES on Marietta and Cincinnati Railroad, from Cincinnati to Marietta.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Low water in Ohio river at Cincinnati	Hamilton	Ohio	Below 133	440
High water in Ohio river at Cincinnati in 1832	Hamilton	Ohio	Below 62	510
High water in Ohio river at Cincinnati in 1847	Hamilton	Ohio	Below 62	510
M. and C. tracks at Plum street depot in Cincinnati	Hamilton	Ohio	Below 50	523

Cincinnati, Hamilton and Dayton railroad tracks in Cincinnati, at crossing of M. and C.	Hamilton	Ohio	Below 61	512
Summit between Mill creek and Little Miami river, near Norwood, 10 miles from Cincinnati	Hamilton	Ohio	52	625
Second crossing of Duck creek, near Madisonville, 13 miles from Cincinnati	Hamilton	Ohio	1	574
Summit at Madeira, 16½ miles from Cincinnati, between two tributaries of Little Miami river	Hamilton	Ohio	187	760
Crossing of Little Miami river at Loveland, 25 miles from Cincinnati	Clermont	Ohio	19	592
Crossing of Little Miami railroad at Loveland	Clermont	Ohio	18	591
Pleasant Plain, 34 miles from Cincinnati	Warren	Ohio	329	902
Blanchester, 40½ miles from Cincinnati, junction of Hillsborough Branch	Clinton	Ohio	402	975
Summit between Little Miami and Scioto rivers, 58 miles from Cincinnati, near New Vienna	Clinton	Ohio	607	1180
Crossing of Paint creek at Greenfield, 74 miles from Cincinnati	Highland	Ohio	320	893
Main street, Chillicothe, at station, 98 miles from Cincinnati	Ross	Ohio	65	638
Crossing of Scioto river, 102 miles from Cincinnati	Ross	Ohio	50	623
Summit between Scioto river and Raccoon creek, 125 miles from Cincinnati	Vinton	Ohio	222	795
Junction of Portsmouth Branch, near Hamden, 127 miles from Cincinnati	Jackson	Ohio	146	719
Summit between Raccoon creek and Hocking river at Marshfield, 151 miles from Cincinnati	Athens	Ohio	251	824
Crossing of Hocking river near Athens, 157 miles from Cincinnati	Athens	Ohio	83	656
Junction of Baltimore Short Line railway, 164 miles from Cincinnati	Athens	Ohio	62	635
Coolville, on Baltimore Short Line railway, 181 miles from Cincinnati	Athens	Ohio	57	630
Torch, on Baltimore Short Line railway, 183 miles from Cincinnati	Athens	Ohio	150	723
Little Hocking, on Baltimore Short Line railway, 187 miles from Cincinnati	Washington	Ohio	62	635
Belpse hotel, on Baltimore Short Line railway, 194 miles from Cincinnati	Washington	Ohio	67	640
Low water in Ohio river at Parkersburg October 1, 1863, (probably not extreme low water)	Wood	West Va.	1	574
High water in Ohio river at Parkersburg in 1832, 132 miles above Cincinnati	Wood	West Va.	51	624
Bridge over Ohio river at Parkersburg	Wood	West Va.	91	664
Crossing of Muskingum river at Marietta	Washington	Ohio	67	640
Low water in Muskingum river at Marietta September 5, 1856	Washington	Ohio	9	583
Hillsborough, at eastern terminus of Hillsborough Branch, extending from Blanchester to Hillsborough, 21½ miles	Highland	Ohio	502	1075

TABLE OF ALTITUDES on Southern Minnesota Railroad, (from the Report of State Survey, 1872).

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Low water in Mississippi river at LaCrosse		Wisconsin		626
Grand Crossing		Wisconsin		638
Rushford				723
Lanesborough				843
Isinour's				900
Fountain				1301
Grand Meadow				1337
Ramsay				1217
Hayward				1250
Winnebago City				1101
Blue Earth river, one mile west of Winnebago City, (water)				1074
Fairmont	Martin			1191
Des Moines river (water)				1290
Heron lake				1371
Graham lake				1413

TABLES OF ALTITUDES on Union and Central Pacific Railroads, from Missouri River to Sacramento.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Track on High bridge across Missouri river at Omaha, 52 feet above high water		Nebraska		1036
Divide between Missouri river and Papillon creek		Nebraska		1148
Papillon creek		Nebraska		1021
Elkhorn bridge		Nebraska		1131

Junction of North and South Platte rivers		Nebraska		2760
Lodge Pole creek		Nebraska		3513
Pine Bluffs		Nebraska		5033
Crow creek		Nebraska		6035
Eastern base of Rocky Mountains, as fixed by the President of the United States, as provided in the Pacific railroad act				6431
Summit of Black Hill range				8242
Western base of Black Hill range				7241
Little Laramie river				7048
Divide between the Little Laramie and Rock creek				7167
Rock creek				6666
Divide between Rock creek and Medicine Bow river				6791
Medicine Bow river				6543
Rattle Snake summit				7123
North Platte river				6475
Divide between North Platte river and Separation creek				6911
Separation creek				6653
Divide of continent—Dodge's pass				7100
Red Desert basin				6659
Bitter creek summit—Williams' pass				6990
Green river, longest branch of Colorado river of the Pacific				6061
Divide between Green river and Black fork				6398
Black fork				6152
Eastern Rim of Utah basin—Reed's pass				7458
Bear river of Salt lake				6676
Wasatch range				6804
Mouth of Weber canon—Devil's gate				4575
Ogden City				4333
Bear river at crossing of railroad				4273
Surface of Salt Lake; (this lake is the lowest depression in the continet between Lodge pole creek and Humboldt river—1,250 miles)				4239
Average of grade lines of railroad, which follows for 25 miles the north shore of lake, about 12 to 16 feet above water				4250
Red Dome pass				4744
Terrace pass				4744
Promontory mountain				4889
Toano mountains, Valley pass				6099
Peoguop pass				6180
Cedar pass				6193
Humboldt wells				5667
Shoshone Point				4668
Humboldt river, being the lowest point between the eastern base of Black Hill range and western base of Sierra Nevada range, a distance of 1,200 miles				3969
Big bend of Truckee river, near Humboldt sink				4104

TABLE OF ALTITUDES on Union and Central Pacific Railroads, etc.—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
On the eastern slope of Sierra Nevada				4819
On the western slope of Sierra Nevada				5849
Summit of Sierra Nevada mountains				7044
Pino station, on western slope of the Sierra Nevada range, near its base				418
Sacramento river near Sacramento City				56

TABLE OF ALTITUDES on Northern Pacific Railroad, from Lake Superior to Puget's Sound.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Lake Superior				598
Junction with St. Paul and Duluth railroad				1080
Summit east of Mississippi river				1300
Mississippi river, ground (Brainerd), 115 miles west of Duluth on Lake Superior				1204
Mississippi river, low water				1144
Crow Wing river, ground				1124
Crow Wing river, low water				1107
Summit, ground				1442
Otter Tail river, ground				1344
Otter Tail river, surface of river				1328
Buffalo river, surface of ground				1149
Buffalo river, surface of river				1139
Red river, ground at Moorhead				888
Red river, high water				876

Red river, low water at Fargo, 252 miles west of Duluth	1842
Grove creek, low banks of creek	933
Summit, ground	1436
Cheyenne river, grade	1228
Cheyenne river, surface of river at Cheyenne	1198
James river at Jamestown	1406
James river, surface of river	1391
Summit, ground	1861
Prairie, flat	1793
Summit, ground	1900
River bottom	1632
Missouri river at Bismarck, 450 miles west of Duluth	1640
Heart river valley	2530
Summit beyond Heart river	2703
Little Missouri	2270
Divide of Glendive's creek	2815
Mouth of Glendive's creek, surface of Yellowstone river	2010
Mouth of Powder river, in the valley of the Yellowstone	2300
Mouth of Big Horn river, in the valley of the Yellowstone	2830
Valley in the valley of the Yellowstone	3080
Medicine Bow creek, in the valley of the Yellowstone	3673
Beaver creek, in the valley of the Yellowstone	3800
Sweet Grass creek, in the valley of the Yellowstone	3956
Big Timber creek, in the valley of the Yellowstone	4076
Cottonwood creek, in the valley of the Yellowstone	4253
Hot springs, in the valley of the Yellowstone	4282
Yellowstone river, in the valley of the Yellowstone, 993 miles west of Duluth	4432
Shield's river, in the valley of the Yellowstone	4446
Bozeman's pass, divide on the belt range	5800
Vicinity of Fort Ellis, head of the Gallatin valley	4883
Vicinity of Bozeman City, in the Gallatin valley	4827
Mouth of Gallatin river—Three forks, or head of Missouri—about 4,300 miles by river from the mouth of the Mississippi, and 1,063 miles west of Duluth	4079
Vicinity of Helena, Montana Territory, foot hills of Rocky mountains, 1,133 miles from Duluth	4280
Summit of Rocky mountains	6000
Mouth of Blackfoot, near outlet of Deer Lodge valley	4464
Missaula, on waters of Clark's fork of Columbia	3300
Cabinet rocks, on waters of Clark's fork of Columbia	2200
Lake Pend d'Oreille; (Clark's fork flows through Lake Pend d'Oreille)	2080
Columbia Plains, on Undulating Columbia Plains	2300
Near mouth of Snake or Lewis river, and near Columbia river	450
Cascades, head of the fall, on Columbia river	50
Cascades, foot, on Columbia river, tide water	0
Kalama, on Columbia river, tide water	0

TABLE OF ALTITUDES on Northern Pacific Railroad, from Lake Superior to Puget's Sound—Continued.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Cowlitz river, a tributary of Columbia river				60
Summit between Columbia river and Puget's Sound				480
Plains, moderately undulating				200
Tacoma, terminus; Commencement bay on Puget Sound, Washington Territory, 2,038 miles west of Duluth				0

TABLE OF ALTITUDES on Atlantic and Pacific Railroad, from St. Louis to San Francisco. From the Surveys of J. Blickensderfer, Engineer.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Union depot at St. Louis		Missouri		486
Jerome—low water in Gasconade river		Missouri		656
Summit of Ozark mountains near Marshfield		Missouri		1482
Springfield—surface of ground		Missouri		1332
Grand river—low water				706
Arkansas river—low water				574
North fork Canadian river—low water				1423
Canadian river—low water				1880
Canon Blanco—summit				6960
Albuquerque—surface of ground				4836
Campbell's pass—surface of ground (continental divide)				7152
Tonto pass—surface of ground				7519

Wallapi pass—surface of ground				3440
Mohaw gap—surface of ground				1475
Colorado river—low water at the crossing of this line at "The Needles," 400 miles from the mouth				355
Piute summit—surface of ground				2579
Perry basin—surface of ground				728
Mohaw river				2400
Soledad pass—summit of Sierra Nevada				3215
San Luis summit—surface of ground in the Santa Luzia range, 236 miles south of San Francisco				1561

ELEVATIONS of Several Passes on the Coast Range.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Pechaco				1302
Big Panoche				2115
San Benito				2821
Worthen Canon				2380
Pollonia				1738

TABLE OF ALTITUDES on Texas Pacific Railway, from Shreveport, Louisiana, to San Diego, California, (1685 miles).

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Shreveport		Louisiana		204
Marshall	Harrison	Texas		390
Terrell, 45 miles west of Marshall	Kaufman	Texas		558
Trinity river at Dallas	Dallas	Texas		481
Fort Worth	Tarrant	Texas		629
Moore's gap	Parker	Texas		1195
Fort Phanton Hill	Jones	Texas		1597
Red fork of Colorado river	Scurry	Texas		2177
Sulphur Springs	Martin	Texas		2847
Sand hills		Texas		2377
Pecos river		Texas		2711
Guadalupe pass (or Hurd's pass)		Texas		4493
Pass through Hueco mountains		Texas		5327
Fort Bliss (El Paso del Norte)		Texas		3800
Continental divide, 100 miles west of the Rio Grande				4900
Pass through Peloncillo range, 145 miles west of the Rio Grande				4446
Rio San Simon				3562
Railroad pass, Chiricahua range, 184 miles west of the Rio Grande				4388
Pimas villages, Gila river, 349 miles west of the Rio Grande				1291
St. Valentine's pass				1517
Fort Yuma, crossing of Colorado river				145
Bed of Dry lake				Bel. 290
San Gorgonio pass				2621
Head of Temecula pass				954
San Bernardo river				20
San Diego				16

MISCELLANEOUS ELEVATIONS in British Possessions, in or near Line of Canadian Pacific Railway, from Lake Superior, Westward.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Lake Superior				598
Fort William, on Thunder bay				603
Lofoden station				1070
Upsala station				1559
English river				1515
Keewatin, in the territory of Keewatin				1092
Selkirk, Manitoba				750
Cartier				849
Sussex, Northwest territory				1048
Livingston, Northwest territory				1612
Assiniboine, Northwest territory				1707
Saskatchewan, Northwest territory, near crossing of South Saskatchewan river				1845
Battleford, Northwest territory				1615
Grizzly Bear, Northwest territory				2145
Edmonton				2413
Root river				2921
Grand Portal, British Columbia				3245
Summit Meadow, British Columbia, highest point on line of the road, about 500 miles east of Pacific terminus				3828
Fraser river, British Columbia				3409
Tete Jaune Cache, British Columbia				2780
Lake Nipigon, north of Lake Superior				850
Lake of the Woods, territory of Keewatin				1042
Lake Manitoba				751
Lake Winnepegosis, territory of Keewatin				770
*Lake Winnepeg				710

* NOTE.—A plausible hypothesis has been suggested by geologists, viz.: That the basin of Lake Winnepeg, now drained into Hudson's Bay, was, at a time far back, but since the Glacial period, an extension of the Minnesota valley, finding its drainage to the ocean through the Mississippi. This idea is adopted by Gen. Warren, U. S. Topographical Engineer, in his report on this region in 1874.

ELEVATIONS along the Minnesota and Red River Valleys.

LOCALITY OF OBSERVATION.	COUNTY.	STATE.	Feet above Lake Erie.	Feet above Ocean.
Water surface at junction of Minnesota and Mississippi rivers	....	Minnesota.	....	695
Water surface of Minnesota river at the Great Bend at Mankato	....	Minnesota.	....	765
Lake Traverse, near the divide between the Minnesota and Red river of the north	....	Minnesota.	....	1000

CATALOGUE AND CHECK-LIST

OF THE

TREES AND WOODY SHRUBS

OF

AMERICA, NORTH OF MEXICO.

COMPILED FROM THE LATEST PUBLISHED AUTHORITIES, FOR THE TENTH ANNUAL REPORT OF THE GEOLOGICAL SURVEY OF INDIANA, BY

JOHN W. BYRKIT,

INDIANAPOLIS, INDIANA, MARCH, 1879.

The whole list was first arranged systematically, as nearly as possible, according to the latest views of Prof. Asa Gray and others, and then numbered from one to the end of the list, which gave to each species its systematic number; after which the following alphabetical arrangement of genera was made for convenience of ready reference, preserving the original number with each species, so we have in the following pages a combined systematic and alphabetically arranged catalogue.

As far as obtainable, the common or local names are given, which are often of value in directing attention to a species in question.

The capital letter A indicates that that species is peculiar to or most widely distributed over the Atlantic States; G makes the same reference to the Gulf States, and P to the Pacific slope. Those not lettered are found in the central area.

475	**Abies alba**		White spruce.
479	**Abies balsamea**		Common spruce.
483	**Abies bracteata**		Leafy-coned fir.
477	**Abies canadensis**		Hemlock spruce.
478	**Abies douglasii**		Douglas spruce.
480	**Abies fraseri**	A	Fraser's spruce.
481	**Abies grandis**	P	Great silver fir.
476	**Abies menziesii**	P	Menzies' spruce.
482	**Abies nobilis**	P	Decorated silver fir.
474	**Abies nigra**		Black spruce.
110	**Acacia latisiliqua**		Broad pod.
83	**Acer circinatum**		Vine maple.
88	**Acer dasycarpum**		Silver maple.
90	**Acer drummondi**		Drummond's maple.
92	**Acer grandidentatum**		Mountain maple.
84	**Acer macrophyllum**		Large-leaved maple.
82	**Acer platanoides**		Norway maple.
86	**Acer pensylvanicum**		Moosewood
89	**Acer rubrum**		Red maple.
87	**Acer saccharinum**		Sugar maple.
85	**Acer spicatum**		Mountain maple.
91	**Acer tripartitum**		Currant-leaved maple.
283	**Achras zapotilla**		Bully tree.
76	**Æsculus californica**	P	Cal. horse chestnut.
79	**Æsculus flava**		Sweet buckeye.
78	**Æsculus glabra**		Ohio buckeye.
75	**Æsculus hippocastaneum**		Horse chestnut.
80	**Æsculus pavia**		Red buckeye.
77	**Æsculus parviflora**		Small buckeye.
40	**Ailantus glandulosus**		Tree of Heaven.
417	**Alnus incana**		Speckled alder.
420	**Alnus maritima**	A	Seaside alder.

418	**Alnus oregona**........................	P	Oregon alder.
419	**Alnus tenuifolia**........................	P	Thin-leaved alder.
416	**Alnus viridis**........................	A	Mountain alder.
149	**Amelanchier canadensis**.............		Shadbush.
58	**Ampelopsis quinquefolia**.............		Virginia creeper.
81	**Amyris floridana**	G	Torch wood.
98	**Amorpha fruticosa.**		
250	**Andromeda ferruginea.**		
246	**Andromeda floribunda.**		
251	**Andromeda ligustrina.**		
249	**Andromeda mariana.**		
247	**Andromeda nitida.**		
248	**Andromeda speciosa.**		
184	**Aralia spinosa**........................		Hercules' club.
245	**Arbutus menziesii**.....................		Strawberry tree.
316	**Ardisia pickeringia**..................	G	
309	**Aristolochia tomentosa.**		
12	**Asimina grandiflora**..................		Large-flowered papaw
11	**Asimina parviflora**..................		Small-flowered papaw
13	**Asimina pygmæa**......................		Dwarf papaw.
10	**Asimina triloba**.......................		Papaw.
263	**Azalea calendulacea**..................		Flame-colored azalea.
262	**Azalea nudiflora**......................		Purple azalea.
261	**Azalea viscosa**		Clammy azalea.
17	**Berberis aquifolium**..................	P	Mahonia.
16	**Berberis canadensis.**		
15	**Berberis vulgaris.**		
59	**Berchemia volubilis**..................		Supplejack.
411	**Betula alba**............................		White birch.
409	**Betula lenta**...........................		Black birch.
410	**Betula lutea**...........................		Yellow birch.
413	**Betula nigra**...........................		Red birch.
414	**Betula occidentalis**..................	P	Western birch.
412	**Betula papyracea**.....................		Canoe birch.
415	**Betula rhombifolia**..................	P	Oval-leaved birch.

281	**Bumelia angustifolia**..................	Narrow-leaved birch.
282	**Bumelia fœtidissima**	Fœtid birch.
279	**Bumelia lanuginosa.**	
277	**Bumelia lycioides.**	
280	**Bumelia oblongifolia**..............	Oblong-leaved birch.
278	**Bumelia tenax.**	
32	**Bursera gummifera**................	Indian birch.
292	**Callicarpa americana**..............	French mulberry.
161	**Calycanthus floridus**..............A	Sweet-scented shrub.
163	**Calycanthus glaucus.**	
162	**Calycanthus lævigatus.**	
164	**Calycanthus occidentalis**........P	
196	**Calyptranthes chytraculia**......G	
405	**Carpinus americana**................	Hornbeam.
352	**Carya alba**............................A	Shagbark hickory.
356	**Carya amara**..........................	Bitternut.
357	**Carya aquatica**......................	Water hickory.
358	**Carya microcarpa**..................	Small-fruited hickory.
359	**Carya myristicæformis**............	Nutmeg hickory.
351	**Carya olivæformis**..................	Pecan nut.
355	**Carya porcina**........................	Pignut.
360	**Carya squamosa**......................	Shellbark hickory.
353	**Carya sulcata**	Western shellbark.
354	**Carya tomentosa**	Mocerknut.
399	**Castanea alnifolia**..................A	
397	**Castanea americana**................	American chestnut.
400	**Castanea chrysophylla** ....P	Golden-leaved chestnut.
398	**Castanea pumila**......................	Chinquapin.
396	**Castanea vesca**........................	European chestnut.
291	**Catalpa bignonioides**..............	Catalpa.
65	**Ceanothus americanus**..............	Redroot.
66	**Ceanothus thrysiflora** ....G	Tree ceanothus.
336	**Celtis crassifolia**....................	Hackberry.
337	**Celtis longifolia**......................	Long-leaved hackberry.
335	**Celtis occidentalis**..................	Western hackberry.

338	**Celtis reticulata**..................P	Small-leaved hackberry.
339	**Celtis tenuifolia.**	
68	**Celastrus scandens**	Bittersweet.
232	**Cephalanthus occidentalis**.....	Button bush.
105	**Cercis canadensis**................	Redbud.
298	**Chionanthus virginica**..........	Fringe tree.
35	**Citrus limetta**.....................G	Lime tree.
34	**Citrus vulgaris** ....G	Bitter orange.
104	**Cladrastis tinctoria**............G	Yellow-wood.
266	**Clethra alnifolia**..................	White alder.
93	**Cliftonia ligustrina**...............	Buckwheat tree.
97	**Clusia flava**.........................G	Balsam tree.
37	**Coccoloba parvifolia** ....G	Small seaside grape.
36	**Coccoloba uvifera**...............G	Seaside grape.
70	**Colubrina americana**	Snake wood.
321	**Comandra umbellata.**	
201	**Conocarpus erecta**..............G	Button tree.
159	**Cercocarpus ledifolius**.........G	Feather bush.
300	**Cordia floridana**.................G	
299	**Cordia sebestena**..................G	
402	**Corylus americana**................	Hazelnut.
403	**Corylus rostrata**	Beaked hazelnut.
193	**Cornus alternifolia**...............	Alternate-leaved dogwood.
189	**Cornus asperifolia**	Rough-leaved dogwood.
185	**Cornus canadensis**	Bunchberry.
192	**Cornus circinata**	Round-leaved dogwood.
186	**Cornus florida**......................	Flowering dogwood.
191	**Cornus paniculata**	Panicled dogwood.
188	**Cornus sericea**	Silky dogwood.
187	**Cornus stolonifera**	Wild red osier.
190	**Cornus stricta**	Stiff dogwood.
143	**Cratægus æstivalis**	Summer haw.
139	**Cratægus apiifolia**................	Parsley-leaved thorn.
138	**Cratægus arborescens**...........	Lance-leaved thorn.
140	**Cratægus coccinea**................	Scarlet-fruited thorn.

137	**Cratægus cordata**		Washington thorn.
142	**Cratægus crus-galli**		Cockspur thorn.
144	**Cratægus flava**		Yellow haw.
145	**Cratægus parvifolia**		Dwarf thorn.
147	**Cratægus rivularis**	P	River thorn.
146	**Cratægus sanguinea**		Red thorn.
136	**Cratægus spathulata.**		
141	**Cratægus tomentosa**		Black thorn.
289	**Crescentia cujete**	G	Calabash tree.
490	**Cupressus nutkatensis**	P	Nootka cyprus.
489	**Cupressus thyoides**		White cedar.
96	**Cyrilla racemiflora**	G	
160	**Cydonia vulgaris**		Quince.
173	**Decumaria barbara.**		
219	**Diervilla sessilifolia**	A	
218	**Diervilla trifida**		Bush honeysuckle.
276	**Diospyros virginiana**		Persimmon.
317	**Dirca palustris**		Leatherwood.
256	**Drimophyllum pauciflorum**	P	California bay.
324	**Drypetes crocea**	G	
325	**Drypetes glauca**	G	Glaucous drypetes.
320	**Elæagnus argentea.**		
199	**Eugenia buxifolia**	G	Box-leaved eugenia.
197	**Eugenia dichotoma**	G	Small-leaved eugenia.
198	**Eugenia procera**	G	Fall eugenia.
72	**Euonymus americanus**		Strawberry bush.
71	**Euonymus atropurpureus**		Burning bush.
323	**Excæcaria lucida**	G	Poison wood.
401	**Fagus ferruginea**		Beech.
341	**Ficus aurea**	G	Small-fruited fig.
342	**Ficus brevifolia**	G	Short-leaved fig.
340	**Ficus pedunculata**	G	Cherry fig.
182	**Fothergilla alnifolia.**		
64	**Frangula caroliniana**	A	Alder buckthorn.
301	**Fraxinus americana**		White ash.

307	**Fraxinus oregona** ....P	Oregon black ash.
308	**Fraxinus pauciflora**.................	Small-leaved ash.
306	**Fraxinus platycarpa**	Water ash.
302	**Fraxinus pubescens**.................	Red ash.
305	**Fraxinus quadrangulata**	Blue ash.
304	**Fraxinus sambucifolia**	Black ash.
303	**Fraxinus viridis**.......................	Green ash.
236	**Gaylussacia dumosa** ....A	Dwarf huckleberry.
235	**Gaylussacia frondosa**..............	Dangleberry.
234	**Gaylussacia resinosa**	Black huckleberry.
108	**Gleditschia monospernum**........	Water locust.
107	**Gleditschia triacanthos**...........	Honey locust.
21	**Gordonia lasianthus**..............G	Loblolly bay.
22	**Gordonia pubescens**...............G	
33	**Guiacum sanctum** ....G	Lignumvitæ.
106	**Gymnoclades canadensis**	Coffee nut.
287	**Halesia diptera**.......................	Two-winged halesia.
286	**Halesia tetraptera**	Four-winged halesia.
180	**Hamamelis virginica**	Witchhazel.
328	**Hippomane mancinella**...........G	Manchineel.
18	**Hibiscus syriacus**	Tree althea.
179	**Hydrangea arborescens.**	
178	**Hydrangea radiata.**	
177	**Hydrangea quercifolia**............	Oak-leaved hydrangea.
271	**Ilex ambigua.**	
269	**Ilex cassine**...........................G	Yaupon holly.
275	**Ilex coriacea.**	
268	**Ilex dahoon**	Dahoon holly.
270	**Ilex decidua.**	
274	**Ilex glabra**................................	Inkberry.
272	**Ilex mollis**	Soft holly.
267	**Ilex opaca**..............................A	American holly.
273	**Ilex verticillata**......................	Winterberry.
9	**Illicium floridanum**.................	Wild anise.
112	**Inga guadalupensis**..............G	Guadaloupe inga.

111	**Inga unguis cati** ....G	Blunt-leaved inga.
172	**Itea virginica.**	
348	**Juglans cinerea**........................	Butternut.
349	**Juglans nigra**........................	Black walnut.
350	**Juglans regia**........................	English walnut.
496	**Juniperus andina**...................G	Rocky Mountain juniper
495	**Juniperus communis**..................	Common juniper.
494	**Juniperus sabina**....................	Creeping juniper.
493	**Juniperus virginiana**................	Red cedar.
254	**Kalmia angustifolia**.................	Narrow-leaved laurel.
255	**Kalmia glauca**	Pale laurel.
253	**Kalmia latifolia** ....A	Mountain laurel.
484	**Larix americana**	Tamarack.
485	**Larix occidentalis** ....P	Western larch.
202	**Laguncularia racemosa** ....G	White mangrove.
265	**Ledum latifolium**.....................	Labrador tea.
243	**Leucothoe catesbæi.**	
244	**Leucothoe racemosa.**	
296	**Ligustrum vulgare**...................	Privet.
313	**Lindera mellissæfolia.**	
312	**Lindera benzoin**	Spicewood.
1	**Liriodendron tulipifera**.............	Whitewood.
183	**Liquidamber styraciflua**............	Sweet gum.
216	**Lonicera ciliata**	Early honeysuckle.
212	**Lonicera flava**	Yellow honeysuckle.
211	**Lonicera grata**.......................	Sweet honeysuckle.
214	**Lonicera hirsuta**	Hairy honeysuckle.
215	**Lonicera involucrata**................	Fly honeysuckle.
217	**Lonicera oblongifolia**...............	Swamp honeysuckle.
213	**Lonicera parviflora**	Small honeysuckle.
210	**Lonicera sempervirens**.............	Trumpet honeysuckle.
345	**Maclura aurantica**	Osage orange.
4	**Magnolia acuminata**.................	Cucumber tree.

5	**Magnolia cordata** ....G	Yellow cucumber tree.
8	**Magnolia fraseri** ....A	Ear-leaved magnolia.
3	**Magnolia glauca** ....A	Sweet bay.
2	**Magnolia grandiflora** ....G	Great-flowered magnolia
6	**Magnolia macrophylla** ....A	Great-leaved magnolia.
7	**Magnolia umbrella** ....A	Umbrella tree.
42	**Melia azedarach** ....G	China tree.
81	**Melicocca paniculata**	Honey berry.
14	**Menispermum canadense**	Moonseed.
344	**Morus nigra**	Black mulberry.
343	**Morus rubra**	Red mulberry.
407	**Myrica cerifera** ....G	Bayberry.
406	**Myrica gale** ....G	Sweet gale.
408	**Myrica inodora** ....G	Candle tree.
94	**Negundo aceroides**	Box elder.
95	**Negundo californica** ....P	Cal. box elder.
205	**Nyssa aquatica**	Water tupelo.
207	**Nyssa capitata** ....A	Ogeechee lime.
204	**Nyssa multiflora**	Sour gum.
206	**Nyssa uniflora**	Large tupelo.
297	**Olea americana** ....G	Devil wood.
315	**Ornus dipetala**	Flowering ash.
404	**Ostrya virginica**	Ironwood.
252	**Oxydendrum arboreum** ....G	Sour wood.
310	**Persea carolinensis** ....G	Red bay.
322	**Phoradendron flavescens**	Mistletoe.
148	**Photina arbutifolia.**	
175	**Philadelphus grandiflorus.**	
176	**Philadelphus hirsutus.**	
174	**Philadelphus inodorous.**	
233	**Pinckneya pubens** ....A	Georgia bark.
456	**Pinus australis** ....G	Yellow pine.
468	**Pinus banksiana**	Northern scrub pine.

463	**Pinus coulteri**	P	Coulter's pine.
461	**Pinus flexilis**	P	Cembra pine.
472	**Pinus insignis**	P	Oregon pitch-pine.
471	**Pinus lambertiana**	P	Sugar pine.
467	**Pinus inops**	A	Jersey scrub pine.
466	**Pinus mitis**		Northern yellow pine.
464	**Pinus muricata**		Small prickly-coned pine
465	**Pinus pungens**	A	Prickly pine.
460	**Pinus ponderosa**	P	Bentham's pine.
458	**Pinus rigida**	A	Northern pitch pine.
469	**Pinus resinosa**		Red pine.
473	**Pinus radiata**	P	Spreading-coned pine.
459	**Pinus serotina**	A	Pond pine.
470	**Pinus strobus**		White pine.
462	**Pinus sabiniana**	P	Prickly-coned pine
457	**Pinus tæda**	A	Loblolly pine.
39	**Pisona aculeata**		Prickly pisona.
109	**Piscidia erythrina**	G	Jamaica dogwood.
334	**Planera aquatica**		American planer.
346	**Platanus occidentalis**		Sycamore.
347	**Platanus racemosa**	P	California buttonwood.
447	**Populus alba**		White poplar.
455	**Populus angustifolia**	P	Narrow-leaved poplar.
453	**Populus balsamifera**		Balsam poplar.
454	**Populus candicans**		Balm of Gilead.
451	**Populus dilatata**		Lombardy poplar.
449	**Populus grandidentata**		Aspen.
450	**Populus heterophylla**		Downy poplar.
452	**Populus monolifera**		Cottonwood.
448	**Populus tremuloides**		Quaking asp.
119	**Prunus americana**		Wild red plum.
114	**Prunus armeniaca**		Apricot.
127	**Prunus caroliniana**	A	Laurel cherry.

120	**Prunus chicasa**		Chicasaw plum.
121	**Prunus cerasus**		Red cherry.
115	**Prunus domestica**		Garden plum.
116	**Prunus insititia**		Bullace plum.
123	**Prunus ilicifolia**	P	Holly-leaved cherry.
118	**Prunus maritima**		Beach plum.
122	**Prunus pensylvanica**		Wild red cherry.
113	**Prunus persica**		Peach.
124	**Prunus pumila**		Dwarf cherry.
125	**Prunus serotina**		Wild black cherry.
117	**Prunus spinosa**		Black thorn.
126	**Prunus virginiana**		Choke cherry.
195	**Psidium buxifolium**	G	Guava.
99	**Psoralea onobrychis.**		
30	**Ptelea trifoliata**		Hop tree.
156	**Pyrus americana**	A	Mountain ash.
155	**Pyrus arbutifolia**		Chokeberry.
154	**Pyrus angustifolia**		Narrow-leaved crab.
150	**Pyrus communis**		Pear.
153	**Pyrus coronaria**		American crab-apple.
151	**Pyrus malus**		Apple.
152	**Pyrus prunifolia**		Siberian crab-apple.
158	**Pyrus rivularis**	P	River crab-apple.
157	**Pyrus sambucifolia**		Elder-leaved mt. ash.
361	**Quercus alba**		White oak.
390	**Quercus agrifolia**	P	Holly-leaved oak.
388	**Quercus ambigua**		Gray's oak.
374	**Quercus aquatica**	A	Water oak.
387	**Quercus banistera**		Bear's oak.
365	**Quercus bicolor**		Swamp white oak.
378	**Quarcus catesbæi**	G	Turkey oak.
371	**Quercus cinerea**	A	Upland willow oak.
379	**Quercus coccinea**		Scarlet oak.

380	**Quercus coccinea,** *var.* tinctoria	Yellow barked oak.
393	**Quercus densiflora** ....P	Dense-flowered oak.
392	**Quercus douglasii** ....P	Douglas oak.
395	**Quercus dumosa** ....P	Small-leaved oak.
377	**Quercus falcata**......	Spanish oak.
386	**Quercus ferruginea**..	Blackjack oak.
389	**Quercus garryana** ....P	Western oak.
385	**Quercus heterophilla**.	Bartram's oak.
376	**Quercus ilicifolia**	Scrub oak.
373	**Quercus imbricaria**	Laurel oak.
394	**Quercus leana** ....P	Lea's oak.
364	**Quercus lyrata** ....G	Southern overcup oak.
363	**Quercus macrocarpa**	Burr oak.
375	**Quercus nigra**	Black oak.
391	**Quercus undulata**...............P	Rocky Mountain oak.
362	**Quercus obtusiloba**................	Post oak.
383	**Quercus olivæformis**	Mossy-cup oak.
382	**Quercus palustris**	Swamp pin-oak.
372	**Quercus phellos**	Willow oak.
366	**Quercus prinus**....	Swamp chestnut oak.
368	**Quercus prinus,** *var.* acuminata	Yellow chestnut oak.
367	**Quercus prinus,** *var.* monticola.	Rock chestnut oak.
369	**Quercus prinoides**................	Chinquapin oak.
384	**Quercus pumila** ....A	Running oak.
381	**Quercus rubra**	Red oak.
370	**Quercus virens**.......................G	Live oak.
62	**Rhamnus alnifolius.**	
61	**Rhamnus catharticus**............	Buckthorn.
60	**Rhamnus lanceolatus**............	Narrow-leaved buckthorn.
63	**Rhamnus purshianus**..	Pursh's buckthorn.
194	**Rhizophora americana** ....G	Mangle.
260	**Rhododendron punctatum** ..A	
258	**Rhododendron catawbiense.**	

257	**Rhododendron maximum.**	
264	**Rhodora canadensis.**	
49	**Rhus aromatica**	Fragrant sumac.
48	**Rhus *copallina***	Dwarf sumac.
43	**Rhus cotinus**	Smoke tree.
47	**Rhus glabra**	Smooth sumac.
50	**Rhus metopium**	Coral sumac.
44	**Rhus toxicodendron**	Poison ivy.
46	**Rhus typhina**	Staghorn sumac.
45	**Rhus venenata**	Poison dogwood.
174	**Ribes aureum**	Missouri currant.
168	**Ribes cynobasti.**	
172	**Ribes floridum**	Wild black currant.
166	**Ribes hirtellum**	Wild gooseberry.
169	**Ribes lacustre**	Swamp gooseberry.
170	**Ribes prostratum**	Fœtid currant.
167	**Ribes rotundifolium.**	
171	**Ribes rubrum**	Red currant.
173	**Ribes sanguineum**	Red-flowered currant.
165	**Ribes speciosum**	Flowering gooseberry.
102	**Robinia hispida**	Bristly locust.
100	**Robinia pseudacacia**	Common locust.
101	**Robinia viscosa**	Clammy locust.
134	**Rosa carolina**	Swamp rose.
133	**Rosa setigera**	Prairie rose.
135	**Rosa rubiginosa**	Sweet brier.
500	**Sabal palmetto**	Cabbage palm.
434	**Salix agrophylla** ......P	Silver-leaved willow.
424	**Salix alba**	White willow.
423	**Salix babylonica**	Weeping willow.
442	**Salix brachycarpa** ......P	Prostrate willow.
421	**Salix cordata**	Common willow.
439	**Salix cuneata** ......P	Velvet willow.

429	**Salix discolor**		Glaucus willow.
446	**Salix exigua**	P	Slender willow.
437	**Salix flavescens**	P	Blunt-leaved willow.
444	**Salix fluviatilis**		River willow.
436	**Salix hookeriana**	P	Hooker's willow.
428	**Salix humilis**		Prairie willow.
422	**Salix longifolia**		Long-leaved willow.
426	**Salix lucida**		Bay willow.
433	**Salix lutea**	P	Western yellow willow.
440	**Salix macrocarpa**		Western pond willow.
443	**Salix macrostachya**	P	Long-spiked willow.
435	**Salix melanopsis**	P	Dusky willow.
425	**Salix nigra**	A	Black willow.
432	**Salix pentandra**	P	Bay willow.
430	**Salix petiolaris**		Petioled willow.
446	**Salix rotundifolia**	P	Round-leaved willow.
441	**Salix sessilifolia**	P	Soft-leaved willow.
431	**Salix speciosa**	P	Long-leaved willow.
438	**Salix stagnalis**		Pond willow.
427	**Salix tristis**		Dwarf gray willow.
230	**Sambucus canadensis**		Blackberry elder.
231	**Sambucus pubens**		Redberry elder.
311	**Sassafras officinalis**		Sassafras.
74	**Sapindus marginatus**		Soapberry.
69	**Schæffera buxifolia**	G	Jamaica boxwood.
488	**Sequoia gigantea**	P	Giant redwood.
487	**Sequoia sempervirens**	P	Redwood.
318	**Shepherdia canadensis.**		
319	**Shepherdia argentea**	G	Buffalo berry.
38	**Simaruba glauca**	G	Bitterwood.
293	**Solanum dulcamara**		Bittersweet.
132	**Spirea ariæfolia.**		
129	**Spirea corymbosum.**		

128	**Spirea opulifolia**		Nine bark.
131	**Spirea salicifolia**		Meadow sweet.
130	**Spirea tomentosa**		Steeple bush.
73	**Staphylea trifolia**		Bladder nut.
24	**Stuartia pentagyna.**		
23	**Stuartia virginica.**		
326	**Stillingia ligustrina.**		
327	**Stillingia sebifera**	G	Tallow tree.
285	**Styrax americana**	A	
284	**Styrax grandiflora**	A	
41	**Swietenia mahogani**	G	Mahogany.
295	**Syringa persica**		Persian lilac.
294	**Syringa vulgaris.**		Lilac.
208	**Symphoricarpus racemosus**		Snowberry.
209	**Symphoricarpus vulgaris**		Coralberry.
288	**Symplocos tinctoria**		Horse sugar.
51	**Stryphonia integrifolia.**		
497	**Taxus canadensis**	A	American yew.
498	**Taxus occidentalis**	P	Western yew.
486	**Taxodium distychium**		Cypress.
290	**Tecoma radicans**		Trumpet creeper.
200	**Terminalia catappa**	G	Indian almond.
314	**Tetranthera geniculata**		Pond spice.
492	**Thuja gigantea**	P	Gigantic arborvitæ.
491	**Thuja occidentalis**		Arborvitæ.
19	**Tilia americana**		Linden, or basswood.
20	**Tilia heterophylla**		White linden.
499	**Torreya taxifolia**	A	Yew-leaved Tor.
332	**Ulmus alata**		Wahoo or winged elm.
330	**Ulmus americana**		White elm.
329	**Ulmus fulva**		Slippery elm.
333	**Ulmus opaca**		Opaque-leaved elm.
331	**Ulmus racemosa**	P	Cork elm.

259	**Umbellularia californica**	P	
241	**Vaccinium arboreum**		Farkleberry.
237	**Vaccinium canadense**		Canada blueberry.
240	**Vaccinium corymbosum**		Swamp blueberry.
242	**Vaccinium stamineum**		Deerberry.
239	**Vaccinium tenellum**	G	Southern blueberry.
238	**Vaccinium vacillans**		Pale blueberry.
227	**Viburnum acerifolium**		Dockmackie.
224	**Viburnum dentatum**		Arrow-wood.
220	**Viburnum lentago**		Sheepberry.
229	**Viburnum lantanoides**		Hobble-bush.
223	**Viburnum nudum**		White rod.
225	**Viburnum molle**		Soft arrow-wood.
222	**Viburnum obovatum.**		
228	**Viburnum opulus**		Cranberry tree.
221	**Viburnum prunifolium**		Black haw.
226	**Viburnum pubescens**		Downy arrow-wood.
53	**Vitis æstivalis**		Summer grape.
54	**Vitis cordifolia**		Frost grape.
52	**Vitis labrusca**		Fox grape.
57	**Vitis indivisa.**		
56	**Vitis riparia.**		
55	**Vitis vulpina**		Muscadine.
103	**Wistaria frutescens.**		
203	**Ximenia americana**		Mountain plum.
25	**Zanthoxylum americanum**		Toothache tree.
26	**Zanthoxylum carolinianum**		Prickly ash.
28	**Zanthoxylum floridanum**		Florida satinwood.
29	**Zanthoxylum juglandifolium.**		
27	**Zanthoxylum pterota**		Bastard ironwood.

GEOLOGICAL REPORT

ON

HARRISON AND CRAWFORD COUNTIES,

INDIANA, 1878.

BY JOHN COLLETT, A. M.

PROF. E. T. COX,

State Geologist:

SIR:—I have the honor herewith to hand you my report on the geology of Harrison and Crawford counties.

I take pleasure in renewing my assurances of high regard and tendering my cordial thanks for information, assistance and kindest courtesy. Trusting in an unwavering continuance of the same, I remain,

Yours very truly,

JOHN COLLETT.

INDIANAPOLIS, 31st December, 1878.

HARRISON COUNTY.

Harrison is one of the extreme southern counties of the State of Indiana. It contains four hundred and seventy-eight square miles, and is bounded north by Washington, east by Floyd county and Ohio river, south by Ohio river, and west by Ohio river and Crawford county. In each case the Ohio river is, as well, the southern boundary of the State, and separates it from the State of Kentucky.

Harrison county was organized in 1808. Corydon, the seat of justice, is one hundred and twenty miles south of Indianapolis. It is pleasantly situated in a picturesque valley at the junction of Big and Little Indian creeks.

A synclinal axis in the underlying rocks, a little north of Ohio river, helps in giving general direction to that stream. The smaller creeks and streams, of comparatively recent age, when they depart from lines of erosion during or prior to the Glacial epoch, follow a westerly or south-westerly direction—the general dip of the rocks.

The principal streams, besides Ohio river, which, in a great arc of a circle, forms the southeast, south and south-west boundaries, are Blue river, forming the general dividing line between Harrison and Crawford counties; Big Indian, Little Indian, Buck and Mosquito creeks. These are usually reliable streams, and form much reliable mill power. These streams pass through narrow valleys or canon-like gorges, at a depth of three hundred to four hundred feet below the highest hilltops, and from one hundred and twenty-five to one hundred and fifty feet below the level of the "barrens" or valley plateaus.

Of equal or greater importance is the subterranean drainage. Perhaps no part of the world exhibits this feature so significantly. The rocky substratum of the county is, as a rule, limestone. The surface is a porous mass of flints, geodes, siliceous fossils and fragments of quartz, the insoluble remains of this limestone dissolved and eroded by atmospheric agencies. The rain-fall is absorbed by this mass as if by a sponge, and quickly conducted to sink-holes and ever-enlarging crevices to underground canals or ducts. The result is a subterranean system of rivers, creeks and brooks, which flow along in midnight darkness, peopled with a peculiar fauna—fishes, crayfishes, worms and beetles, in which the organs of vision, unused for generations and ages, are obsolete. A world of night for the use of sightless life.

This peculiar system, and its depth below the surface, renders the supply of water from wells uncertain, and residences, churches and school-houses are usually supplied with cisterns for securing rainwater for culinary and drinking purposes. At many points the prevailing good health may be attributed to the use of pure rainwater. Another remarkable effect of this drainage is observed in many electrical phenomena, seemingly contrary to the well-known laws of electricity. Lightning rarely or never strikes on the hills or table-lands, but generally or always in deep valleys, and often in basin-shaped sink-holes, from two hundred to four hundred feet below the high hills immediately adjoining or contiguous. Dry, porous earth, filled with air, is a poor conductor. Such is the condition of areas underrun by rivers and streams. The electricity seeks the shortest line to a good conductor by passing through the humid air to one of the underground water-courses.

The water-fall in the northwest part of the county, after a hidden course of eight or ten miles, makes its appearance as a river at Harrison springs, six miles northwest of Corydon. Similar phenomena of remarkable interest were observed at the foot of Walnut valley in the "Blue spouter," in the "Stygean" river, near the mouth of Big Blue river, at Big Blue spring, near Amsterdam, and at Boone's mill cave spring, west of Laconia.

RECENT GEOLOGY.

Recent geology comprises that succession of changes in the earth's surface which have occurred since the formation of the rock-beds in the bottom of the ocean, and their elevation above the surface of that sea. The term *recent*, then, is relative in its meaning. Although the term, by its phenomena, requires a very long period of time, variously estimated from thousands to millions of years, it is but a point or paragraph in the long, long years necessary for the preparation and elevation of the underlying rocks.

Alluvium.—The alluvial "bottoms" or valleys along the banks of the rivers and streams are due to causes now in action. Detritus, derived from wear and tear of rocks and their disintegration by atmospheric agencies, is seized by each brooklet and rainy day wash, hurried along by brook and river and by flood-tide deposited along or upon its banks. By a slow current, and at eddies, a close, impervious clay is deposited; but a stronger current carries in its bosom sand and vegetable matter, which, intermixed with clay, forms that loamy soil characteristic of our streams, and famous for the production of fine crops of cereals, vegetables, fruits, etc. The "bottoms" of this county are of the best, and continually enriched by the annual overflow, are, after a continuous cultivation for nearly one hundred years, without manure, well remunerative to the careful husbandman.

Lacustral Epoch.—This epoch succeeds in age the one above described. During the great ice age—next mentioned—the drainage of the great valley of this continent was from north to south. Northern areas were at an elevation of several hundred feet above their present level, relative to the ocean surface, and at the same time at a much greater elevation than now above areas to the south, causing a rapid flow in that direction. At about the close of the Glacial epoch, a slow oscillation of the crust of the earth occurred. The region of the great lakes, parts of Indiana, Illinois and Missouri, etc., were slowly and continuously depressed, at a rate so much greater than the southern parts of the country, that it worked a practical obstruction in the outlet of the water-shed.

A great fresh water sea resulted, at one time covering the greater part of the interior of the continent, connected with outlying lakes by channels and valleys eroded during the preceding period, driven by the wind, but otherwise currentless rivers or bodies of water. Along the shores somewhat coarse sands were tossed by the waves, while along the shallow bottom fine, impalpable sand and clay were deposited. As will be seen by referring to preceding reports, the animals found in this Loess or lacustral deposit indicate that a warm, subtropical climate prevailed. The Loess always overlies glacial deposits or boulder clay, proving that it was subsequent to that epoch. The resulting soil is apparently a yellowish clay, but is almost wholly siliceous, and when dry or worn by cultivation, is a dull ash-gray. Remainders of the flora of that age and climate survive to this day, and afford an almost sure indication of the Loess soil, as Persimmon (diospyros), Sweet Gum (styraciflua), etc., etc., while the red-gilled lizard and cotton-mouth snake, still tell of perennial warmth. Good examples of the Loess beds are seen on the road from Corydon to Leavenworth, west of Keller's hill, and from Palmyra to Bradford, in the northeastern part of the county. The original deposit was thin, varying from a few inches to about five feet in thickness. Over a great part of the county it has been removed by rainfall, or so distributed as to be scarcely recognizable.

Glacial Epoch.—The Glacial epoch is the next important phenomena in the earth's existence. Its date is variously estimated by physicists. From astronomical data, but of uncertain value, its beginning is fixed at from 500,000 to 700,000 years ago. By other calculations, which seem somewhat more reliable, this epoch is referred to a period commencing 225,000 years since, and ending not less than 175,000 years ago. In all their estimates there may be a considerable margin for error.

The main facts in the glacial theory are unquestionable. An arctic climate prevailed throughout North America. A great sheet or river of ice, propelled by surface inclination, but more by the expansion of a long line of freezing or congealed water, invaded, and in a great degree covered, the basin of the northern lakes, and extended south to about the thirty-ninth degree of latitude. There are few or no evidences of glacial action south of this line, although there are abundant proofs that bergs and broken masses of ice floated after the vernal equinox and during the short arctic summers, bearing with them boulders, gravel, clays and other remains imported from their northern home. Stranded or lodged along this line, the glacier melted and sent great sluice-like rivers, increased by the excessive precipitation incident to a cold climate, in a southerly direction. At first they would seek to follow pre-glacial river channels, but as these were constantly modified, changed or obstructed by the propulsion of boulder clay and sand before the glacier's breast, these sluices were erratic and variable in their courses, wandering, at different periods, over nearly the entire surface of our State, and finally, as the ice slowly retired under the influence of a warmer climate, they became more fixed in their channels, either in geological synclinal axes or along the outcrop of soft rocks or those most liable to disintegrating effects of the elements. The tangible evidences of the glacial age are limited to small detached beds of blue clay, with pebbles of northern origin, and to the transported boulders and pebbles found along Ohio and Blue rivers; but of more importance than these are the waterless channels and cuts hewn out of the Chester sandstone in the west and southwestern parts of the county, at an elevation of seventy to ninety feet above the beds of existing streams. Notable instances may be seen in an old channel around the east base of Greenbrier mountain, near Wyandotte cave, and in the notches cut in the Kentucky hills south of the Ohio, by Blue river, Potato, Indian and Buck creeks.

Pre-glacial Age.—This may perhaps be classified as a novel subject in geological science. But little opportunity has been presented of studying this period, and I have seen nothing written upon it. According to the theory of all geologists, the sub-carboniferous rocks of this county were elevated above the level of the sea soon after the beginning of the Permo-carboniferous period; while a majority, especially those who adhere to the commonly received swamp theory, with its impossible paradoxical alternate elevation and depression of the coal-measure basin, are sure that the whole of this county had emerged from its ocean birthplace (origin) at the beginning of the Coal-Measure epoch. In either case, a great hiatus occurs in nature's record and chronology. The ages and cycles of ages in which the Permian, Cretaceous and Tertiary seas came into existence, culminated with their wondrous life, and passed away, building up great depths of solid rock, offer, in this region, a record so scanty as to unveil but little of their story. The vegetal and animal life of these seas prove conclusively that a tropical climate prevailed in adjoining regions. Many of these graniverous animals and birds were of regal size and strength, requiring abundant food. The small development of brain capacity shows clearly that their methods of existence were easy, and food attainable without strife or effort. We must conclude that somewhat similar aerial conditions existed here during this period.

From analogy, unqualified developments elsewhere, and abundant facts easily seen, this region, upon its emergence above the sea, was a great level plain, sloping gently to the west. Approaching Corydon from the eastern boundary of the county, a great valley is discerned—a nearly level plain —now traversed by many streams, with deep, canon-like beds, but of recent origin, traversing the county from north to south. It is eight to fifteen miles wide, and from two hundred to three hundred feet deep. The eastern bluff is the Knob sandstone of Floyd county, and the western the Chester hills in the western part of the county, along Blue river. A fine view, embracing a large part of this valley, can be had at a single glance from the top of Pilot knob, adjoining Corydon on the south. Words can hardly express the gratification experienced on ascending this point, as the veil faded away which had mystified so many other visitors and students, disclosing that long vision in the history of the past. A succession of such sharp, conical "knobs" or peaks are seen to the northwest, and continue to occur beyond the northern boundary of the county, followed by a similar succession to the south-southeast.

The great valley locally known as "the barrens" is a nearly level plain. In a wild state when visited by the Boones and other hunter pioneers, it was nearly a typical prairie, exhibiting a few knarled and scotched shrubs or "stools," and covered with a luxuriant growth of tall prairie grass, herbs and vines. These were burned after each autumnal frost, preventing the growth of trees and permanent vegetation. The soil is a silicious clay. The subsoil a confused, irregular, disjointed mass of flints, quartz and geodes, from ten to forty feet in depth—in some places approaching or covering the surface as to prove an obstacle to pleasant agriculture, and at a few points in such extreme development as to require their removal and use in building fences, houses, etc. This rubbish is not in natural "place," and no such beds occur in this local geological formation, or any other. They are not imported by water or ice; their origin is local. Looking for their source, we see in the cliffy outlines of adjoining hills that the material of this *debris* is scattered in thin layers, one to fourteen inches in thickness, throughout the beds of St. Louis limestone, the place of which is occupied by this valley. Judging from the isolated sections visible then, these layers, gathered from two hundred feet of St. Louis rocks, would just about equal the amount of the remains here left.

We can but conclude that water, charged with carbonic acid, dissolved and totally removed in a state of solution the whole of this limestone, rejecting the insoluble siliceous material found remaining. This solution is natural, and does not require the erroneous theory of volcanic heat or upheaval. If the water which caused this removal was simply confined rainfall, and without motion, evaporation would have developed great beds of calcic tufa. Such beds do not exist. Theoretically, we may infer that a body of flowing water assisted. This is made certain by the fact that, on ascending Pilot knob and similar eminences near the level of the ancient table-land, the extreme summits still exhibit well-rounded gravel and more angular coarse sand. These can only result from water in motion, and flowing with considerable rapidity—say two to four miles an hour. The northern and northwestern sides of the hills and knobs, as a rule, are precipitous, as if roughly beaten by a current, while in every case a pronounced talus stretches out to the south-southeastwardly. All these definitely assert the existence of a pre-glacial river of great volume, flowing with some current, probably slow, to the southeast. This valley, followed to the south, at present shows little or no fall in that direction; but, with due allowance for the more rapid subsidence of northern areas, it is at once apparent that in the long past there was a time when this, as well as other rivers of Indiana and the northwest, which once flowed to the south, could and would be obstructed, and be compelled to find new outlets of discharges.

Ignoring the bed of the recent Ohio river, this valley crosses that stream between Brandenburg and Westport, at an elevation of two hundred and fifty to three hundred feet above low water, passed by a wide channel, now silted up near Elizabethtown, Ky., into the beautiful Nolin valley, and that of Nolin creek to Green river, accounting for the unusual bottoms of the latter, thus finally reaching the present Ohio river near Newburg. Below this point of junction, as well as above New Albany, the Ohio valley is from one to five miles wide, with well-rounded, gently-sloping bluffs, as naturally occurs by exposure to the elements a very great length of time. Between these points, along the southern line of Harrison, Crawford and Perry counties, the bottoms, exclusive of the river itself, range from nothing to a quarter of a mile in width, while the bluffs, from two hundred to five hundred feet in hight, boldly approach the water's edge; as a rule precipitous or very steeply inclined, and formed of limestone, which, by action of the atmosphere, is quickly sloped or rounded. They very strongly indicate the recent origin of the present Ohio river. On the other hand, the well-rounded and gently-sloping bluffs of the supposed Pre-glacial valley as strongly demonstrate the extreme antiquity of this phenomenon.

The more deeply eroded Glacial of Post-glacial valley of Silver creek, which gives easy access to the Indianapolis and Jeffersonville railroad to the deep Ohio valley opposite Louisville, and its tributaries, in all cases, cuts or crosses the more ancient predecessor of Pre-glacial age, and the extreme depth of erosion beneath the city of Louisville of one hundred and seventy-five feet below the present bed rock of the falls of the Ohio, show conclusively a great change in conditions, if not probable oscillation, in the level of the earth's crust.

This subject merits extended study, and is here thus curtly mentioned for the purpose of inviting such attention and investigation as will demonstrate the theory here set up, or otherwise account for the facts noted.

Grassy, Brushy, Hancock and Ripperden valleys may possibly date back to this age. They are valley-like depressions, ranging from three to ten square miles in extent, from two hundred to four hundred feet below the adjacent ridge lands; immense basins without visible outlet streams, with walls of living limestone, yet well sloped and gently rounded by the healing hand of nature. They were the caverns of an early age, hollowed by underground rivers until, as has sometimes been known, the roof has fallen in, and the calcareous *debris*, removed by ages of rainfall, discharged by still lower cavernous conduits.

The Flat woods, from north to south, along the eastern side of the great valley, is a marked feature in the recent geology of this district. The soil, when unmodified by modern action, is dark and mucky, like the northern prairies, underlaid with yellow and white clay, with partings of sand and rounded, water-worn gravel. While possibly of lacustral origin, it may probably be referred to the flood plain of the river of the ancient valley.

The beds of glass sand and kaolin marked on the map seem directly connected or caused by the agency which spread out this alluvial deposit, and similar beds on its continuation in Nolin valley in Kentucky.

GENERAL DESCRIPTION.

Details gathered from isolated localities, grouped together, give the following

CONNECTED SECTION.

QUATERNARY AGE.

Present Epoch.

	Ft.		Ft.	In.
River and creek alluvium	2	to	205	00

Lacustral Epoch.

	Ft.		Ft.	In.
Loess	0	to	5	00

GLACIAL PERIOD.

Glacial Epoch.

	Ft.		Ft.	In.
Soft white and blue clays	0	to	7	00
Fine pebbles and sand	0	to	2	00

PRE-GLACIAL EPOCH.

	Ft.		Ft.	In.
Alluvial flood plains	0	to	18	00
Local insoluble residuum of flints, geodes, etc.	0	to	35	00

CARBONIFEROUS AGE.

Coal-Measure Period.

	Ft.		Ft.	In.
Conglomerate sand rock	0	to	19	00
Place of coal A	0	to	0	02
Coarse, irregular bituminous shale	3	to	5	00

SUB-CARBONIFEROUS PERIOD.

Chester Group.

	Ft.		Ft.	In.
Kaskaskia limestone	5	to	20	00
Chester sandstone	35	to	70	00
Thin-bedded lithographic limestone	40	to	20	00
Carbonaceous shale (coal bone)	1	to	0	00

St. Louis Group.

	Ft.		Ft.	In.
Gray or blue (sometimes argillaceous) limestone, with massive buff layers	20	to	25	00
Argillaceous limestone, flint balls and partings.	15	to	25	00
Oolitic beds	0	to	15	00
Argillaceous limestone with balls and flint partings	50	to	40	00
Brown cherty limestone with clay beds	30	to	50	00
Heavy-bedded gray limestone	20	to	25	00
Gray limestone with clay partings (sharks' teeth bed)	25	to	30	00

Keokuk Group.

	Ft.		Ft.	In.
Gray or brown limestone	8	to	22	00
Buff argillite, with small geodes	16	to	14	00
Encrinital limestone and geodes	4	to	12	06
Blue and gray banded shales, somewhat calcareous	4	to	18	00
Buff argillaceous limestone, with Burlington fossils	6	to	4	00
Blue gray calcareous shales	20	to	5	06

Knobstone Group.

	Ft.		Ft.	In.
Ferruginous sandstone and shales, with beds of shaly argillite	150	to	125	00
Heavy sandstones and siliceous shales	200	to	135	00
Blue pyritous shales, with clay iron stones	175	to	150	00
Argillaceous impure limestone	2	to	6	00

DEVONIAN AGE.

Hamilton Group.

	Ft.	In.
Black slate in bores	110	00
Gray and black hydraulic limestone	30	00
Siliceous limestone	22	00

SILURIAN AGE.

Upper Silurian.

	Ft.	In.
Niagara and Clinton limestone in bore at Corydon	90	00

Lower Silurian—Cincinnati Group.

Limestone and shale in Corydon bore......................	267	00

PALEOZOIC GEOLOGY.

The order of succession and average thickness of the rocky formations of this county are given in the foregoing Connected Section. The rocks of each group vary so constantly in character, thickness of special layers and components, that it would be difficult, if not impossible, to surely determine them by stratigraphic study. Each age is, however, represented or indicated by a peculiar suite of fossils, according to the different conditions of the ocean bed in which the rocks were formed. By the fossils—known words interpreting the book of nature—the records are read and the horizon of the rocks determined; hence the importance of the extended list of fossils hereinafter given.

COAL-MEASURES.

Commencing with the highest and most recent rocky deposit in the western side of the county, we find there beds of bituminous or pyritous shales marking the place of coal A, the lowest coal seam in this State, capped by a few feet of Conglomerate Sandrock, named "Millstone Grit" by the English geologists. It is so near the rim of the basin that, as is always the case, it is here barren—without coal. This horizon is remarkable for the abundance of well-preserved stems and fruits characteristic of the Coal-measures. No other point visited in this State offers a more intererstıng study than Keller's hill, southwest of Corydon, and thence westerly to Blue river. It is, perhaps, unnecessary to say that no workable seams of coal exist in this county, and search in that direction will prove fruitless.

CHESTER GROUP.

The upper member of this group is a dark blue or gray limestone, somewhat variable in color and character. Its surface conformed to the uneven bed of the ocean, in which it was deposited, and indicates by wave-like inequalities the deep sea currents which inaugurated the age of coal, bringing with it from some rocky shore the overlying coarse sands and pebbles of the Conglomerate.

The fossils are generally Sub-carboniferous, as pentremites, corals, bryozoans, crinoids, etc., although a few Coal-measure fossils give promise of the coming life.

Next in succession below this are the beds of siliceous shales and shaly sandstones passing into ledges of massive sandstone and grit stones. At such localities the stone is of excellent quality. Blocks of any usable size may be easily split or squarely broken. The grit stones have proved equal to the best, under the severest test. The few fossils are, as a rule, strictly of the Coal-measures. Thin-bedded, argillaceous limestones succeed at many points, having the appearance of lithographic stone, and were it not for small inequalities and "glass seams" it would prove of great value. No bed sufficiently perfect was seen to promise great value, but it is possible, if not probable, that a good bed may be discovered. A pretty constant feature near the base of this stone is a thin parting of black slaty "coal bone." As no fossils have been observed within several feet above and below this parting, it has been adopted as an easily observed line between the Chester and St. Louis groups, although more favored observers may hereafter discover that it is not absolutely correct from a palæontological standpoint. The

Chester rocks build up the hills and wall the valleys in the western and southwestern parts of the county, and are the surface rock of this region, with the exception of the small area of Coal-measure rocks before mentioned.

ST. LOUIS GROUP.

The rocks of this group are principally limestones, more or less argillaceous, with beds of clay between the strata, containing flint-balls, geodes, etc. These materials indicate the deposits of a quiet sea, traversed by gentle currents with water of such purity as to allow the life of animals which can not survive an addition of impurity or earthy matter. The argillaceous beds show that the conditions were not favorable to their life, and but few fossils are found in them

At intervals throughout this group, trough-like depressions or synclinal axes are found perpendicular to or at a marked angle with the rim of the basin, in which shells and calcareous remains of the many animals which flourished in this age were carried by the gentle currents which flowed from north to south along the shore line or rim of the basin. These remains, coarsely broken, ground together by the ever-restless waves of the sea, became cemented together by pressure and chemical action, and form the common limestone for burning and for rough masonry. When the comminution was more perfect, the remains were reduced to fine powder, and a considerable amount of lime was dissolved and held in solution; the product is the fine-grained quarry limestone so well and favorably known over Owen, Monroe, Lawrence and Washington counties, and at Breckenridge in Harrison county. But at extended periods the ocean currents were of such power that large amounts of lime so held in solution were borne along to the south until, in still stations or by chemical action, the lime was deposited, almost chemically pure, in the shape of myriads of minute concretionary balls, so minute as to resemble the delicate roe of a fish. These little spheres, closely compacted and cemented with calcareous matter, form the famous "white oolitic" stone, so grandly represented in this county. Its qualities and characteristics will be further considered under the head of "economic geology." The horizon of the oolitic seams at different localities, ranging from ten to seventy feet above the base of the group, and sometimes deposited in thin strata, is repeated two or more times.

The flint balls are at localities on Indian and Buck creeks, and generally in the southern part of the county in great abundance. This region furnishes a solution of the vexed question, "Where and how did the Indians make their arrow and spear points, knives, awls, spades, etc.?" The quantity is unlimited. A stranger will soon have his attention called to black, sphere-shaped balls, from one inch, or less, to twenty inches in diameter, on almost every hillside. He will soon wonder at their peculiar fracture, when exposed, perpendicular to the plane of deposition, although somewhat irregular. Tested with a hammer, it will soon be discovered that, although easily broken, the cleavage is not sufficiently straight and in the direction of the blow to give artistic results. The Indians, from facts here observed, knew the law—that it was necessary to open deep trenches to the unexposed beds to secure such specimens as might be chipped into useful shapes by the dexterous hand of the professional arrow-maker. On repeated tests it was found that flints, fresh from their natural beds in the earth, could be split, even by one not an expert, with much precision into such angular prisms as are always found among the remains of these ancient people. Trenches from four to ten feet deep, and from one quarter to one half a mile in extent, indicate the long, patient toil of these people in search of this, to them, most valuable mineral.

The animal life of this age was varied and vigorous. Brachiopods were most abundant; crinoids and pentremites opened and closed their appendages like sensitive buds and branches of vegetation; corals wove their delicate tracery of lace-work, while smaller shells, though ranging down to microscopic size, and so fragile that the tenderest wave would crush the tiny home of its owner, are all ornamented as if for dress parade before their great Creator.

The vertebrate life of this epoch was not extensive. A few families of fishes, mostly sharks, survive from the Devonian age of war. They came armed with buckler, stiff spines and cutting fangs, ready for a life of battle. Their business was defense or destruction. Riven and broken or worn teeth tell the story of the deadly struggles of these descendants of a warrior race.

This group is sometimes known as the Cavernous Limestone. It is well known that water, falling through the air and flowing over the surface of the earth, absorbs gases which slowly dissolve the solid limestones. Seeking a lower level, it finds a crevice, and passes, drop by drop, to deeper strata, enlarging the outlet. This process, long continued, forms large, funnel-shaped basins called "sink holes," which are a constant feature wherever the rocks of this group approach the surface. These sink holes gather the surface water, sometimes holding it in ponds and lakelets until, in passing through and between the solid limestones, a small outlet is first found, which is constantly enlarged by the process above mentioned until, by the lapse of ages, brooks grow to creeks and creeks to rivers, tunneling their tortuous subterranean way for miles, absorbing nearly all the surface drainage. The flow, as a rule, is on the line of dip. When lower lines of drainage are found, the upper ones are abandoned, and partly silted up or obstructed. Such unused channels are the famous caverns of the world, including Wyandotte, Pitman and Borden's caves.

In the course of time much or all the evidences of the ancient river are removed or covered over. Water percolating through "sinks" in the roof, charged with lime in solution, by evaporation deck the walls and roofs with a snowy film of white spar, garnishing every projecting point with icy pendants grandly beautiful and attractive.

About seventy feet above the base of the St. Louis limestone occurs a dark calcaro-bituminous hydraulic rock of great economical importance. It exhibits a thickness of thirty to forty feet in the extreme southern part of the county, thinning to two feet near Elizabeth and Bridgeport. It will be more fully considered in local details and economic geology.

KEOKUK GROUP.

The Keokuk rocks outcrop along Ohio river and tributaries in the eastern part of the county, as far south as a point opposite Rockhaven, Kentucky, and in the deep valley of Little Indian creek and its branches, near Lanesville. The thickness of the beds range from fifty to eighty feet. They consist of dark-gray limestones, weathering brown, with partings or divisions from a few inches to eight or ten feet of soapstone, or indurated clay, often containing a great number of geodes. The limestone, on disintegration, forms a ruddy, ochreous clay, so colored from a quantity of iron contained in the stone, and which is believed by Dawson and other eminent geologists to indicate either a near shore line or the inflow of a river containing earthy impurities. The geodes, so characteristic of the Keokuk epoch, are round balls of crystalline quartz, with mammillated exterior, but white within, and often containing crystals of spar (calcite) of great beauty. Many, if not all, these geodes owe their origin to the remains of animal or vegetable matter, which, by decay, left cavities in their matrix, which were filled with water having silica in solution. On evaporation of the water the silica was crystallized, and as substances expand in the process of solidification, so the casts are often, not always, so enlarged as to form a grotesque exaggeration of the original mould. Sponges are the most common geodized fossils, and corals, crinoids and brachiopods are frequently met with. Life was abundant, as may be seen by the list of fossils further on in this report, many of which are well preserved. Fish remains are not unfrequent, and indicate, by their dental remains, great vigor and aptitude for eating and fighting. Pentremites, crinoids and star fishes seem to have reigned in this sea. Their remains indicate great size and beauty. A crinoid stem was observed over four feet long, with feathery branches attached its whole length, plastered upon the Keokuk rocks opposite and above Rockhaven.

BURLINGTON GROUP.

The lower member of this bed is a buff or greenish-gray argillite. Stratigraphically, it occupies the horizon of the Burlington group of Illinois and Iowa, and although fossils of the Burlington group are quite numerous, yet Keokuk fossils are still more abundant; therefore, until more decisive evidence as to the existence of synchronous conditions corresponding with those so remarkable in the geology of the States just named, we may still retain such beds in the Keokuk group.

KNOBSTONE GROUP.

The Knobstone shales and sandstones are the lowest rocks here visible. They are seen along the high bluffs of Ohio river, developing a total thickness from the top to the

Black Slate, in the adjoining county of Floyd, of 416 feet. Dipping rapidly to south and west, it passes from view below the surface of the river at Brown's Landing, at mouth of Mosquito creek. This group consists almost wholly of buff, blue or green pyritous shales. Wedge-shaped plates and thick bands of sandstone occur in the upper and middle members of the deposit, some of good workable extent and quality. It is equivalent to the Waverly sandstone of Ohio, and some of the quarries have furnished stone of such quality as to induce extensive use for piers, guard banks, etc.

The pyritous nature of the shale causes rapid decomposition on exposure. The result is a fine plastic clay, which at once yields to the action of water, almost of moisture; hence, whenever exposed, the surface of the country underlaid by rocks of this age presents a wonderful succession of sharp, conical knobs, from ten to four hundred feet in hight, of singular beauty and symmetry. As seen from a commanding eminence, when covered with grass, they look like the tents of an army of silent giants. One view from the high knob at New Albany is of interest and beauty. The "Belle riviere," bearing busy steamers on its bosom, proudly dashes over the Falls and passes to a dim line in the distance; the cities of Louisville, New Albany and Jeffersonville, thronged with stirring life, cluster around the Falls. The abandoned site of historic Clarksville and the remnant of Corn island, with its prehistoric relics, recall the chronicles of pioneer days and a lost race; while off in the distance the Kentucky hills rise up against the sky as if by mirage. Bayard Taylor, after experiencing all that is beautiful and grand in foreign travel, pronounced this one of the most interesting and attractive landscapes that had come before his eyes.

The name "Knobstone" was applied by Dr. David Dale Owen in his Geological Report on Indiana, more than forty years ago, and, although other names have been proposed, it is retained as a matter of justice to the distinguished father of western geology, and because the name so expressively describes the peculiarities of the group.

DEVONIAN AND SILURIAN FORMATIONS.

The Devonian and Silurian rocks are not visible in the county. They have been reached by boring for salt at Corydon, the record of which was so carefully kept as to give a very accurate and recognizable measure of the strata at that distance within the basin, and indicating, with many other facts observed, that strata thicken as they dip and recede from the rim of the basin. This law is almost without exception throughout the Indiana section.

The following list of fossils is believed to be full; years have been spent in collecting by the many energetic geologists about the "Falls," to whom thanks are due for assistance and favors. Special acknowledgments are due to Mr. George K. Green, of New Albany, whose energy and success as a collector is so well known. Many of the most perfect specimens were obtained from his collection. The list has been submitted for revision and arrangement to the eminent palæontologist of the American Museum in Central Park, New York, Prof. R. P. Whitfield, to whose patient kindness my heartiest thanks are given.

It will be observed there are many species and even genera unpublished, a duty which Indiana owes to science, and that should be discharged by full palæontological reports profusely illustrated. It is especially the duty of the State, by such publication, to enable her own citizens and the rising generation to recognize the fossils peculiar to the State, without the heavy expense of buying costly works of other States now almost inaccessible.

LIST OF FOSSILS

OF THE

CARBONIFEROUS FORMATION

FOUND IN THE

COAL MEASURES, CHESTER, ST. LOUIS, KEOKUK AND KNOBSTONE GROUPS,

OF

HARRISON COUNTY, IND.

CARBONIFEROUS FORMATION.

COAL-MEASURE SYSTEM.

CONGLOMERATE SANDROCK.

PLANTÆ.

ALGÆ.

Genus CAULERPITES, Sternberg.

Caulerpites (resembling) **marginatus**.........Lesquereux.

Genus CHONDRITES, Sternb.

Chondrites colletti...Lesquereux.

LYCOPODIACEA.

Genus STIGMARIA, Brongniart.

Stigmaria ficoides...Brongniart.
— (resembling) **undulata**...............Goeppert.
— **stellata**...Goeppert.

Genus SIGILLARIA, Brongniart.

Sigillaria, 2 sp. inedt.

Genus LEPIDODENDRON, Sternb.

Lepidodendron, 4 sp. inedt.

Genus LEPIDOPHYLLUM, Brong.

Lepidophyllum brevifolium .... Lesqx.
— (like) **imbricata** .... Sternb.

EQUISETACEA.

Genus CALAMITES, Guettard.

Calamites cannæformis .... Schlotheim.
— 2 sp. inedt.

Genus CORDAITES, Unger.

Cordaites borassifolius .... Sternb.
— **angustifolius** .... Lesqx.

FRUITS.

Genus TRIGONOCARPUM, Brong.

Trigonocarpum olivæformis .... Lindley & Hutton.
— **triloculare** .... Hildreth.
— 2 sp. und.

Genus CARPOLITHES, Sternb.

Carpolithes fasciculatus .... Lesqx.

FILICITES.

Fronds and terminal spikes, indt.

ANNELIDÆ.

This list includes only the fossils from the Conglomerate Sand Rock which was deposited in a sea traversed by currents from south-southwest, of sufficient power to transport coarse sand, pebbles, *etc.*; conditions under which animal life would hardly exist, and all remains be worn out and obliterated by abrasion.

SUB-CARBONIFEROUS SYSTEM.

CHESTER GROUP.

PLANTÆ.

ALGÆ.

Genus CAULERPITES, Sternb.

Caulerpites marginatus..............................Lesquereux.

Genus CHONDRITES, Sternb.

Chondrites colletti..............................Lesqx.

LYCOPODIACEA.

Genus LEPIDODENDRON, Sternb.

Lepidodendron, worn, imperfect trunks.

Genus SIGILLARIA, Brong.

Sigillaria (like) **reniformis**..............................Brong.

Genus STIGMARIA, Brong.

Stigmaria ficoides..............................Brong.

ANIMALIA.

PROTOZOA.

FORAMINIFERA.

Genus FUSILINA, Fischer.

Fusilina cylindrica..............................Fischer.

RADIATA.

CŒLENTERATA.

Genus SYRINGOPORA, Goldfuss.

Syringopora ramulosa ?..............................Goldfuss.

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis spinulosa ....Edwards & Haime.

Genus CYATHOPHYLLUM, Goldfuss.

Cyathophyllum, 2 sp. undt.

Genus LOPHOPHYLLUM, Edwards & Haime.

Lophophyllum proliferum?....................McChesney.

ECHINODERMATA.

CRINOIDEA.

PLATYCRINIDÆ.

Genus PLATYCRINUS, Miller.

Platycrinus (like) **subspinosus**................Hall.

Genus DICHOCRINUS, Munster.

Dichocrinus cornigerus.........................Shumard.
— **sexlobatus**..........................Shumard.

CYATHOCRINIDÆ, Miller.

Genus POTERIOCRINUS, Miller.

Poteriocrinus bisselli..........................Worthen.
— **chesterensis**.....................Meek & Worthen.

Genus ZEACRINUS, Troost.

Zeacrinus intermedius..........................Hall.
— **armiger**.............................Meek & Worthen.
— sp. inedt.

Genus EUPACHYCRINUS, M. & W.

Eupachycrinus boydi..........................M. & W.

Genus AGASSIZOCRINUS, Troost.

Agassizocrinus conicus.........................Owen & Shumard.
— **conoideus.**
— **dactyliformis**.................Troost.
— **pentagonus**...................Worthen.

BLASTOIDEA.

Genus PENTREMITES, Say.

Pentremites godoni............................De France.
— **pyriformis**............................Say.
— **globosus**............................Say.
— **obesus**............................Lyon.
— **sulcatus**............................Rœmer.
— **symmetricus**............................Hall.

MOLLUSCA.

MOLLUSCOIDEA.

Genus CYCLOPORA, Prout.

Cyclopora polymorpha............................Prout.

Genus ARCHIMEDES, Le Sueur.

Archimedes swalloviana............................Hall.

Genus SYNOCLADIA, King.

Synocladia biserialis............................Swallow.

BRACHIOPODA.

Genus DISCINA, Lamarck.

Discina (like) **nitida**............................Phillips.

Genus STREPTORHYNCHUS, King.

Streptorhynchus crenistriatus............................Phillips.
— **crassus**............................M. & W.

Genus CHONETES, Fischer.

Chonetes granulifera............................Owen.

Genus PRODUCTUS, Sowerby.

Productus (like) **cora**............................D'Orbigny.
— **punctatus**............................Sowerby.
— **altonensis**............................N. & P.
— **semireticulatus**............................Martin.

Genus SPIRIFER, Sowerby.

Spirifer increbescens..Hall.
— **leydyi**..Norwood & Pratten.
— **striatus**..Miller.
— **setigerus**..Hall.

Genus SPIRIFERINA, D'Orbigny.

Spiriferina kentuckensis..Shumard.

Genus ATHYRIS, McCoy.

Athyris sublamellosa..Hall.
— **subtilita**..Hall.
— **ambigua**..Sowerby.

Genus EUMETRIA, Hall.

Eumetria (Retzia) **vera**..Hall.

Genus RHYNCHONELLA, Fischer.

Rhynchonella osagensis..Swallow=
— **uta**..Marcou.
sp. inedt.

Genus TEREBRATULA, Llhwyd.

Terebratula bovidens..Morton.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus AVICULOPECTEN, McCoy.

Aviculopecten, sp. undt.

Genus ALLORISMA, King.

Allorisma, sp. undt.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras nebrascensis..Meek.

Genus Bellerophon, Montfort.

Bellerophon (like) **carbonarius**................Cox.
— **hiulcus** (?)........................Sowerby.
— sp. undt.

CEPHALOPODA, Breynius.

Genus Orthoceras, Breynius.

Orthoceras, sp. indt.

Genus Nautilus, Breynius.

Nautilus sp. indt.

PTEROPODA.

Genus Conularia, Miller.

Conularia missouriensis........................Swallow.

CRUSTACEA.

Genus Phillipsia, Portlock.

Phillipsia, sp. ?

VERTEBRATA.

PISCES.

Genus Aspidodus, Newberry & Worthen.

Aspidodus crenulatus..............................N. & W.

ST. LOUIS GROUP.

PLANTÆ.

LYCOPODIACEA.

Genus LEPIDODENDRON, Sternberg.

Genus SIGILLARIA, Brongniart.

Genus STIGMARIA, Brongniart.

All the specimens of the above-named genera found in this group were water-worn, crushed and broken, with specific characters wholly obliterated.

ANIMALIA.

PROTOZOA.

SPONGIDÆ.

Genus PALÆACIS, Haime.= SPHENOPOTERIUM, Meek & Worthen.

Palæacis cuneatus..................................M. & W.
— **enormis**..................................M. & W.

Genus SPONGIA, Linnæus.

Spongia, 3 sp. undt.

FORAMINIFERA.

Genus ROTALIA, Lamarck.

Rotalia baileyi..................................Hall.

RADIATA.

CŒLENTERATA.

Genus AULOPORA, Goldfuss.

Aulopora gigas..................................Rominger.
— sp. ?

Genus SYRINGOPORA, Goldfuss.

Syringopora ramulosa? .... Goldfuss.
— **multattenuata** .... McChesney.

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis elliptica .... White.
— **spinulifera** .... Hall.=?
— **spinulosa** .... E. & H.
— **centralis** .... E. & H.
— 3 sp. inedt.

Genus LOPHOPHYLLUM, E. & H.

Lophophyllum, sp. ? undet.

Genus CYATHOPHYLLUM, Goldfuss.

Cyathophyllum, 2 sp. undt.

Genus LITHOSTROTION, Lhwyd.

Lithostrotion canadense .... Castlenau.
— **proliferum** .... Hall.
— **mamillatus** .... Herzer.

Genus AMPLEXUS, Sowerby.

Amplexus, sp. undt.

ECHINODERMATA.

CRINOIDEA.

PLATYCRINIDÆ.

Genus PLATYCRINUS, Miller.

Platycrinus saffordi .... Troost.
— sp. undt.

Genus DICHOCRINUS, Munster.

Dichocrinus simplex .... Shumard.
— **ficus** .... Cassedy & Lyon.
— **pisum** .... Meek & Worthen.
— **lineatus** .... M. & W.
— **constrictus** .... M. & W.

ACTINOCRINIDÆ.

Genus ACTINOCRINUS, Miller.

Actinocrinus calyculus .... Hall.
— sp. indt.

Genus BATOCRINUS, Casseday.

Batocrinus icosidactylus .... Casseday.
— **irregularis** .... Casseday.
— **asteriscus** .... M. & W.
— **inæqualis** .... Hall.
— 2 sp. indt.

Genus ERETMOCRINUS, L. & C.

Eretmocrinus, sp. indt.

CYATHOCRINIDÆ.

Genus CYATHOCRINUS, Miller.

Cyathocrinus, 2 sp. indt.

Genus POTERIOCRINUS, Miller.

Poteriocrinus missouriensis .... Shumard.
— sp. ?

Genus ONYCHOCRINUS, L. & C.

Onychocrinus whitfieldi .... Hall.

Genus ZEACRINUS, Troost.

Zeacrinus armiger .... M. & W.

BLASTOIDEA.

Genus PENTREMITES, Say.

Pentremites conoideus .... Hall.
— **koninckianus** .... Hall.
— **varsouviensis** .... M. & W.
— **obliquatus** .... Rœmer.
— **laterniformis** .... Owen & Shumard.
— **quadrilateralis ?** .... Hall. ?
— **subconoideus** .... M. & W.

ECHINOIDEA.

PERISCHOECHINOIDÆ.

Genus ARCHÆOCIDARIS, McCoy.

Archæocidaris norwoodi .... Hall.
— **agassizi** .... Hall.
— **wortheni** .... Hall.
— 2 sp. inedt.

Genus LEPIDESTHES, M. & W.

Lepidesthes colletti (plates) .... White.

Genus MELONITES, Owen & Norwood.

Melonites (Palæchinus) **multiporus** .... Owen & Norwood.

MOLLUSCA.

MOLLUSCOIDEA.

BRYOZOA.

Genus FENESTELLA, Lonsdale.

Fenestella shumardi .... Prout.
— 2 sp. undt.

Genus SYNOCLADIA, King.

Synocladia biserialis .... Swallow.

Genus POLYPORA, McCoy.

Polypora halliana .... Prout.

Genus ARCHIMEDES, Le Sueur.

Archimides wortheni .... Hall.
— **swalloviana** .... Hall.

Genus STICTOPORA, Hall.

Stictopora (Ptilodictya) **serrata** .... Meek.
— — **carbonaria** .... Meek.
— — sp. inedt.

Genus Coscinium, Keyserling.

Coscinium michelinia .... Prout.
— **asterium** .... Prout.
— **wortheni** .... Prout.
— **escharoides** .... Prout.
— **tuberculatum** .... Prout.

Genus Trematopora, Hall.

Trematopora sp. ?

BRACHIOPODA.

Genus Orthis, Dalman.

Orthis dubia .... Hall.
— 2 sp. indt.

Genus Streptorhyncus, King.

Streptorhynchus crenistriatus .... Phillips.

Genus Chonetes, Fischer.

Chonetes, sp.?

Genus Productus, Sowerby.

Productus (like) **cora** .... D'Orbigny.
— **tenuicostus** .... Hall.
— **punctatus** .... Sowerby.
— **semireticulatus** .... Martin.
— **altonensis** .... N. & P.

Genus Spirifer, Sowerby.

Spirifer lateralis .... Hall.
— **pseudolineatus** .... Hall.
— **subcardiformis** .... Hall.
— **suborbicularis** .... Hall.
— **rostellatus ?** .... Hall.
— **fultonensis** .... Worthen.
— **tenuicostatus** .... Hall.

Genus Spiriferina, D'Orbigny.

Spiriferina spinosa .... Norwood & Pratton.

Genus ATHYRIS, McCoy.

Athyris royissi..L'Eveille.
— **subquadrata**..Hall.
— **hirsuta**..Hall.
— **planosulcatus**.................................Phillips.
— **trinuclea**..Hall.

Genus EUMETRIA, Hall=RETZIA, King.

Eumetria verneuiliana................................Hall.
— **vera**...Hall.
— sp. indt.

Genus RHYNCHONELLA, Fischer.

Rhynchonella subcuneata...........................Hall.
— **grosvenori**...Hall.
— **mutata**..Hall.
— **ricinula**...Hall.

Genus TEREBRATULA, Llhwyd.

Terebratula formosa...................................Hall.
— **turgida**...Hall.
— **inornata**...McChesney.
— 2 sp. ined.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus AVICULOPECTEN, McCoy.

Aviculopecten, sp. undt.

Genus MYALINA, Koninck.

Myalina keokuk...Worthen.
— sp. ined.

Genus ALLORISMA, King.

Allorisma sinuata ?...............................McChesney.

Genus CONOCARDIUM, Bronn.

Conocardium cuneatum ....Hall.
— **carinatum** ....Hall.
— **constrictum** ....Hall.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras uncum ....Meek & Worthen.
— **nebrascense ?** ....Meek.
— sp. ined.

Genus EUOMPHALUS.

Euomphalus spergenensis ....Hall.
— **planispira** ....Hall.
— **planorbiformis** ....Hall.
— sp. ined.

Genus CYCLONEMA, Hall.

Cyclonema leavenworthana ....Hall.

Genus NATICOPSIS, McCoy.

Naticopsis shumardiana ....Hall.

Genus MURCHISONIA, D'Arc & Vern.

Murchisonia insculpta ....Hall.
— **vermicula** ....Hall.
— 2 sp. indt.

Genus PLEUROTOMARIA, De France.

Pleurotomaria wortheni ....Hall.
— **concava** ....Hall.
— sp. ined.

Genus BULIMELLA, Hall.

Bulimella, 2 sp. undt.

Genus BELLEROPHON, Montfort.

Bellerophon sublævis ....Hall.
— **marcouanus ?** ....Geinetz.

Genus DENTALIUM, Linnæus.

Dentalium primarium..............................Hall.
— **venustum**..............................M. & W.
— sp. undt.

Genus CHITON, Linnæus.

Chiton carbonarius..............................Stevens.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia missouriensis..............................Swallow.

CEPHALOPODA.

Genus ORTHOCERAS, Breynius.

Orthoceras expansum..............................Meek & Worthen.
— 2 sp. indt.

Genus NAUTILUS, Breynius.

Nautilus, (casts) indt.

Genus TEMNOCHEILUS, McCoy.

Temnocheilus niotense..............................M. & W.
— **coxanum**..............................M. & W.

Genus GONIATITES, De Haan.

Goniatites, sp. inedt.

ARTICULATA.

ANNELIDÆ.

Genus SPIRORBIS, Lamarck.

Spirorbis annulatus..............................Hall.

CRUSTACEA.

Genus Cythere, Muller.

Cythere carbonaria ....Hall.

Genus Phillipsia, Portlock.

Phillipsia seminifera...................................Morrison.
— sp. inedt.

VERTEBRATA.

PISCES.

Genus Trigonodus, Newberry & Worthen.

Trigonodus minor......................................N. & W.

Genus Antliodus, N. & W.

Antliodus minutus......................................N. & W.

Genus Chomatodus, Agassiz.

Chomatodus selliformis (sp. nov.)..............Newberry.
— **angustus** (sp. nov.) ....Newberry.
— **pusillus**..................................N. & W.
— **obliquus** (sp. nov.).................Newberry.

Genus Lisgodus, St John & White.

Lisgodus affinis (sp. nov.)............................Newberry.

Genus Orodus, Agassiz.

Orodus colletti (sp. nov.) ....Newberry.

Genus Helodus, Agassiz.

Helodus lævis (sp. nov.) ....Newberry.
— **coniculus** ....Newberry & Worthen

Genus Thrinacodus, St. J. & W.

Thrinacodus bicornis (sp. nov.).....................Newberry.

Genus Deltodus, Newberry & Worthen.

Deltodus grandis...N. & W.
— **cinctus** (sp. nov.).................................Newberry.

KEOKUK GROUP.

ANIMALIA.

PROTOZOA.

SPONGIDÆ.

Genus PALÆACIS, Haime.=
SPHENOPOTERIUM, Meek & Worthen.

Palæacis obtusus..................................M. & W.

SPONGIA?

Genus and species inedt.

RADIATA.

CŒLENTERATA.

Genus AULOPORA, Goldfuss.

Aulopora gigas..Rominger.

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis dalii..Edwards & Haime.
— **spinulifera**..............................Hall.

Genus LOPHOPHYLLUM, Edwards & Haime.

Lophophyllum proliferum?.....................McChesney.

Genus AMPLEXUS, Sowerby.

Amplexus fragilis.......................................White & St. John.

ECHINODERMATA.

CRINOIDEA.

PLATYCRINIDÆ.

Genus PLATYCRINUS, Miller.

Platycrinus planus...................................O. & S.
— **lodensis**.......................................H. & W.
— **discoideus**..................................O. & S.
— **halli**...Shumard.

Genus DICHOCRINUS, Munster.

Dichocrinus ficus .... C. & L.
— **lineatus** .... M. & W.
— **striatus** .... O. & S.
— **simplex** .... Shumard.
— **expansus** .... M. & W.

ACTINOCRINIDÆ.

Genus ACTINOCRINUS, Miller.

Actinocrinus indianensis .... L. & C.
— **biturbinatus** .... Hall.
— **agassizi** .... Troost.
— **ramulosus** .... Hall.
— **bronteus** .... Hall.
— **lowii** .... Hall.
— **nashvillæ** .... Troost.
— **magnfica** .... Troost.

Genus STROTOCRINUS, Meek & Worthen.

Strotocrinus perumbrosus .... Hall.

Genus AGARICOCRINUS, Troost.

Agaricocrinus wortheni .... Hall.
— **tuberosus** .... Troost.
— sp. inedt.

CYATHOCRINIDÆ.

Genus CYATHOCRINUS, Miller.

Cyathocrinus magister .... Hall.
— sp. indt.

Genus BARYCRINUS, Wachsmuth.

Barycrinus hercules .... N. & W.
— **hoveyi** .... Hall.
— **pentagonus** .... Worthen.
— **spectabilis** .... M. & W.
— **magister** .... Hall.
— sp. indt.

Genus POTERIOCRINUS, Miller.

Poteriocrinus indianensis .... M. & W.
— sp. indt.

Genus SCAPHIOCRINUS, Hall.

Scaphiocrinus decadactylus..................Meek & Worthen.
— **unicus**..................Hall.
— **æqualis**..................Hall.

Genus ZEACRINUS, Troost.

Zeacrinus troostianus..................M. & W.
— **ramosus**..................Hall.
— sp. indt.

Genu FORBESOCRINUS, De K. & Le H.

Forbesocrinus meeki..................Hall.
— **wortheni**..................Hall.
— **shumardi**..................Hall.
— **ramulosus**..................Hall.

Genus TAXOCRINUS, Phillips.

Taxocrinus shumardi..................Hall.

Genus SYNBATHOCRINUS, Phillips.

Synbathocrinus dentatus..................O. & S.
— ? **robustus**..................M. & W.
— **swallovi**..................Hall.
— **wachsmuthi**..................M. & W.

Genus GRAPHIOCRINUS, De K. &. Le H.

Graphiocrinus, sp. indt.

BLASTOIDEA.

Genus PENTREMITES, Say.

Pentremites wortheni..................Hall.
— **pyramidatus**..................Hall.
— **woodmani**..................M. & W.
— **conoideus?**..................Hall.
— **lineatus**..................Troost.
— **burlingtonensis**..................M. & W.

ECHINOIDEA.

PERISCHOECHINOIDEA.

Genus Lepidesthes, Meek & Worthen.

Lepidesthes sp.? (detached plates).

Genus Archæocidaris, McCoy.

Archæocidaris wortheni............................Hall.
— **agassizi**..............................Hall.
— **norwoodi**.............................Hall.
— sp. ined.

Genus Melonites, Owen & Shumard.

Melonites multiporus?.........................O. & S.
— sp.?

Genus Oligoporus, Meek & Worthen.

Oligoporus nobilis.................................M. & W.

ASTEROIDEA.

Genus Onychaster, Meek & Worthen.

Onychaster flexilis..................................M. & W.

Genus Evactinopora? Meek & Worthen.

Evactinopora sexradiata.........................M. & W.
— **grandis**.......................................M. & W.

EDRIOASTEROIDEA.

Genus Agelacrinus, Vanuxem.

Agelacrinus squamosus........................Meek & Worthen.

MOLLUSCOIDEA.

BRYOZOA.

Genus Fenestella, Lonsdale.

Fenestella shumardi.................................Prout.
— 2 sp. undt.

Genus Polypora, McCoy.

Polypora discoideus?

Genus ARCHIMEDES, Le Sueur.

Archimides oweniana .... Hall.
— **reversa ?** .... Hall.

Genus PTILOPORA, McCoy.

Ptilopora prouti .... Hall.

Genus STICTOPORA, Hall,
? loq. PTILODYCTIA, Lonsdale.

Stictopora carbonaria .... Meek.
— **serrata** .... Meek.

Genus COSCINIUM, Keyserling.

Coscinium asterium .... Prout.
— **elegans** .... Prout.
— **escharoides** .... Prout.
— **michelinia** .... Prout.
— **wortheni** .... Prout.

Genus TREMATOPORA, Hall.

Trematopora, sp.?

Genus ORTHIS, Dalman.

Orthis dubia .... Hall.
— **michelina** .... L'Eveille.

Genus STREPTORHYNCHUS, King.

Streptorhynchus crenistriatus .... Phillips.

Genus CHONETES, Fischer.

Chonetes logani .... Norwood & Pratton.
— **planumbona** .... Meek & Worthen.

Genus PRODUCTUS, Sowerby.

Productus (like) **cora** .... D'Orbigny.
— **punctatus** .... Sowerby.
— **semireticulatus** .... Martin.
— **vittatus** .... Hall.
— **alternatus** .... N. & P.

Genus SPIRIFER, Sowerby.

Spirifer striatus..Miller.
— **keokuk**..Hall.
— **fastigiata**..Meek & Worthen.
— **suborbicularis**..M. & W.
— **subcuspidatus**..Hall.
— **neglectus**..Hall.
— **grimesi**..Hall.
— **lateralis**..Hall.
— **pseudolineatus**..Hall.

Genus ATHYRIS, McCoy.

Athyris lamellosa..L'Eveille.
— **royissa**..L'Eveille.
— **incrassata**..Hall.

Genus RHYNCHONELLA, Fischer.

Rhynchonella mutata..Hall.
— sp. ined.

Genus TEREBRATULA, Llhwyd.

Terebratula hastata..Sowerby.
— **inornata**..McChesney.

Genus CAMAROPHORIA, King.

Camarophoria subtrigona..Meek & Worthen.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus AVICULOPECTEN, McCoy.

Aviculopecten indianensis..Meek & Worthen.
— **winchelli**..Meek.
— sp. ined.

Genus MYALINA, De Koninck.

Myalina keokuk..Meek & Worthen.

Genus PINNA, Linnæ.

Pinna subspatulata..................................Meek & Worthen.

Genus LITHOPHAGA, Lamarck.

Lithophaga lingualis..................................Phillips.

Genus CYPRICARDELLA, Hall.

Cypricardella nucleata.......... ....Hall.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras equilateralis ....Hall.
— **fissurella**..................................Hall.
— **uncum**..Meek & Worthen.
— **infundibulum** ....M. & W.
— sp. inedt.

Genus PLEUROTOMARIA, DeFrance.

Pleurotomaria shumardi ....M. & W.
— sp. indt.

Genus BELLEROPHON, Montfort.

Bellerophon, sp. indt.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia subcarbonaria.......................... Meek & Worthen.
— **micronema** .... M. & W.

CEPHALOPODA.

Genus ORTHOCERAS, Breynius.

Orthoceras expansum..................................Meek & Worthen

ARTICULATA.

CRUSTACEA.

Genus PHILLIPSIA, Portlock.

Phillipsia bufo ....Meek & Worthen.
— **portlocki** ....M. & W.

VERTEBRATA.

PISCES.

Genus PETALODUS, Owen.

Petalodus knappi, (sp. nov.) ....Newberry.

Genus ANTLIODUS, N. & W.

Antliodus similis ....Newberry & Worthen.

Genus ORODUS, Agassiz.

Orodus ornatus ....N. & W.
— **elegantulus** ....N. & W.

Genus DELTODUS, N. & W.

Deltodus spatulatus ....N. & W.

BURLINGTON GROUP.

In the lower Keokuk beds, although fossils of that age predominate, yet as all indications point to the synchronism of these strata with the Burlington Group in Illinois and Iowa, the following list of fossils found in Harrison and Clark counties is parenthetically added. Many of them are exclusively Burlington.

Platycrinus halli, (plates and stems) ....Shumard.
— **discoideus**..............................Owen & Shumard.
— **planus**.................................Shumard.
Dichocrinus striatus..............................O. & S.
— **lineatus**...................................M. & W.
Actinocrinus unicornis.........................O. & S.
Synbathocrinus wachsmuthi..................M. & W.
— **dentatus**...............................O. & S.
Zeacrinus ramosus...................................Hall.
— **troostianus**............................M. & W.
Strotocrinus perumbrosus......................Hall.
Pentremites burlingtonensis..................M. & W.
Productus burlingtonensis.
— **flemingi**...................................Sowerby.
Spirifer grimesi......................................Hall.
Orthis michelina.....................................L'Eveille.
Athyris incrassata...................................Hall.

KNOBSTONE GROUP.

PLANTÆ.

ALGÆ.

Genus CAULERPITES, Sternberg.

Caulerpites (resembling) **marginatus**........Lesqx.

Genus CHONDRITES, Sternb.

Chondrites colletti..................................Lesqx.

ANIMALIA.

RADIATA.

CŒLENTERATA.

Genus AULOPORA, Goldfuss.

Aulopora gigas..Rominger.

Genus Zaphrentis, Rafinesque.

Zaphrentis, 2 sp. indt.

Genus Lophophyllum, E. & H.

Lophophyllum proliferum?..................McChesney.
— 2 sp. inedt.

ECHINODERMATA.

CRINOIDEA.

Actinocrinus cassedayi..........................Lyon.
Forbesocrinus wortheni..........................Hall.
Synbathocrinus wortheni..........................Hall.
— **swallovi**..........................Hall.
Catillocrinus bradleyi..........................Meek & Worthen.

MOLLUSCA.

MOLLUSCOIDEA.

BRACHIOPODA.

Genus Orthis, Dalman.

Orthis michelini..................................L'Eveille.

Genus Chonetes, Fischer.

Chonetes logani..................................Norwood & Pratten
— **planumbonum**..........................M. & W.

Genus Streptorhynchus, King.

Streptorhynchus keokuk..........................Hall.

Genus Productus, Sowerby.

Productus magnus..................................Meek & Worthen.
sp. ined.

Genus SPIRIFER, Sowerby.

Spirifer carteri......................Hall. (See Syringothyris.)
— **peculiaris**......................Shumard.
— **mucronatus**......................Conrad.
— **marionensis**......................Shumard.
— **aspera**......................Hall.

Genus SPIRIFERINA, D'Orbigny.

Spiriferina (resembling) **kentuckensis**......Shumard.

Genus SYRINGOTHYRIS, Winchell.

Syringothyris textus......................Hall.

Genus LEIORHYNCHUS, Hall.

Leiorhynchus quadricostatus..............Vanuxem.

Genus TEREBRATULA, Llhwyd.

Terebratula calvini......................Hall & Whitfield.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus MYALINA, Koninck.

Myalina keokuk......................Worthen.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras uncum......................Meek & Worthen.
— **infundibulum**......................M. & W.
— sp. indt.

Genus PLEUROTOMARIA, DeFrance.

Pleurotomaria, 2 sp. indt.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia newberryi................................Winchell.

ARTICULATA.

ANNELIDÆ.

Annulated vermiform markings. Vermiform fucoides.

VERTEBRATA.

PISCES.

Bones and teeth of fishes, not determined.

SCHOOL OF MINES, COLUMBIA COLLEGE,
NEW YORK CITY, DEC. 10, 1878.

PROF. JOHN COLLETT,
Assistant State Geologist,
Indianapolis, Ind.:

DEAR SIR:—I find among the specimens of fish teeth, which you have sent me, the following species:

1. Aspidodus crenulatus, N. and W. (op. cit. p. 93, pl. VIII., Figs. 3 to 11,) Chester limestone, Grayson county, Kentucky.

2. Trigonodus minor, N. and W. (op. cit. p. 93, pl. VIII., Figs. 7, 7 a,) St. Louis beds, Harrison county, Ind. Prof. John Collett.

3. Antliodus minutus, N. & W. (op. cit., p. 43, pl. III., Figs. 3, 3 a,) St. Louis group, Harrison county, Ind. Prof. John Collett.

4. Chomatodus selliformis, n. sp. Tooth quadrangular, with salient angles; one inch or more in length, by a quarter of an inch wide and high, crown surface showing a rounded, triturating edge, bordered on one side by a slightly excavated, smooth, enameled surface; on the other by a flattened face marked by four broad enamel plaits; root forming a thin, roughened wing.

The collection contains numerous fragments of this interesting tooth, which at first sight resembles the quadrangular, transverse tooth of some of the Rays. On closer examination, however, it will be seen that it was set obliquely on the jaw, so as to make one of its angles serve for contusing or triturating food. In its general plan of structure it is not unlike many other species in the ill-defined genus Chomatodus, in which the teeth sometimes present a cutting edge; at others a flat, triturating surface. Doubtless some of these diversities of form have generic value, but the subdivision of the group can only be intelligently done by those having a large amount of material for study. A section of the tooth before me is, in one attitude, almost precisely the shape of the backless chairs so much used among the ancients, a resemblance which suggested the name. St. Louis beds, Harrison county, Ind. Prof. John Collett.

5. *Chomatodus angustus*, n. sp. Teeth of medium size, largest 30 millimeters long by 11 millimeters high; crown surface narrow, flat or obliquely excavated, 4 millimeters long, coarsely punctate throughout; the body of the tooth is constricted in the middle, expanded below and terminates inferiorly in a sharp, central edge.

In a general way this resembles the other flat-topped species of Chomatodus, such as *C. molaris*, *C. angulatus*, etc., but differs from any yet described in the symmetry of its section. The upper surface is plain or slightly excavated, and about twice as wide as the constricted middle portion of the tooth which supports it; below the middle it again expands symmetrically and terminates in an edge which is central, instead of lateral, as in *C. molaris* and other species. Not uncommon in the St. Louis beds of the lower carboniferous limestone in Harrison county, Ind. Prof. John Collett.

6. *Chomatodus obliquus*, n. sp. Teeth small or of medium size, largest 20 or 30 millimeters long by 8 to 10 in hight; crown triangular in section with a sub-acute edge above, from which the enameled surface declines at an angle of 45° to a lateral edge, beneath which the tooth is much constricted, but expands again into a rounded, irregular

ridge, which borders the acute terminal margin. The opposite side of the tooth is concave vertically, but nearly plain; is enameled above and shows faint enamel folds along the middle. In general form this species resembles that last described, but differs notably in having one side of the enameled crown raised into an acute edge. St. Louis beds, Harrison county, Ind. Prof. John Collett.

7. *Lisgodus affinis*, n. sp. Teeth very broad, 4 millimeters high and broad, crown elliptical in outline, compressed, with an obtuse, arched upper edge, inclined backward, and in worn specimens roughened by the exposed calcigerous tubes; enamel fold continuous around the base of the crown; strong and double; root tongue-shaped, narrower than the crown, rounded below where it is deflected backward. This little tooth is evidently closely allied to that described by Mr. St. John in the Rep. Geo. Sur. Ill., Vol. VI., p. 366, pl. 10 a, figs. 16 a, 16 b, but the crown is less conical and the root more rounded. St. Louis beds, Harrison county, Ind. Prof. John Collett.

8. *Orodus colletti*, n. sp. Teeth small, maximum breadth about one inch; crown consisting of several low, pointed cones, of which one, central or sub-central, is largest; three are marked with divergent raised lines, which are elegantly beaded, and one or two more delicately beaded lines pass over the crown in the interval between the conical prominences, root thick and strong, pitted on the sides, flattened below. This elegant little species resembles *O. ornatus*, cited above, but will be at once distinguished from it, and from all others hitherto described, by the elegant beading of the raised lines. St. Louis beds, Harrison county, Ind. Prof. John Collett.

9. *Helodus lævis*, n. sp. Teeth small, 20 to 25 millimeters long, 4 to 5 broad and high; outline linear, slightly

curved; crown surface arched from front to rear; uniformly smooth and polished, but finely punctate; root as high as crown, flat below and on the sides, as broad as high, slightly oblique. This species, seen from above, resembles smaller specimens of *H. angulatus*, N. and W. (op. cit. Vol. II., p. 83, pl. V., Figs. 9, 9 a,) but differs strikingly from that in its broad, flat, angular, slightly oblique root. St. Louis beds, Harrison county, Ind. Prof. John Collett.

10. Helodus coniculus, N. and W. (op. cit. p. 75, pl. IV., Figs. 19, 19 a,) St. Louis beds, Harrison county, Ind. Prof. John Collett.

11. Thrinacodus bicornis, n. sp. A single specimen of a minute tooth, with excavated, spatulate base, and two recurved denticles, occurs in the collection, and it plainly belongs to the same genus with that described in the Illinois Report under the name of *Diplodus incurvus*, which Mr. St. John subsequently, and very properly, placed in his genus *Thrinacodus.*

The form of the base and denticles and the tissue of the teeth are the same in both, and the only perceptible difference is that the specimen under consideration has but two denticles. This may prove to be but an exhibition of the variety of forms which is so frequently seen in the dentition of a single individual among plagiostomus fishes; but until proof of identity with the described species is produced it will be better to consider them as distinct. St. Louis beds, Harrison county, Ind. Prof. John Collett.

12. Deltodus grandis, (?) N. and W. (op. cit. Vol. II., p. 100, pl. IX., Figs. 9, 9 a,) St. Louis limestone, Harrison county, Ind. Prof. John Collett.

13. Deltodus cinctus, n. sp. Tooth of medium size, spatulate in outline, with rounded angles; much arched in both directions, thick and strong; greatest breadth, 25 millimeters; length, 55 millimeters; upper surface marked transversely by a series of shallow sulci which curve downward and terminate in the lateral margins, causing these to be slightly crenulated. In the middle portion of the crown these furrows are about five millimeters apart; near the lower margin they more closely approximate, and are somewhat irregular; surface uniformly enameled, and rather closely punctate.

This species somewhat resembles *D. undulatus* and *D. cingulatus* (op. cit., pp. 98, 99), but differs from the first in its narrower form, arched surface, and in having the undulations over all parts of the crown surface. The tooth of *D. cingulatus* is narrower in outline, and the transverse sulci, by which it is cingulated, are much broader. St. Louis limestone, Harrison county, Ind. Dr. Knapp.

14. Petalodus knappi, n. sp. Tooth of medium size; a little broader than high; vertical length, 28 millimeters; breadth of crown, 30 millimeters; root semi-circular, marked with obscure, vertical and radiating ridges and furrows, by which the lower edge is obscurely crenulated; crown long, elliptical in outline, with rounded angels; vertical hight on concave surface, 15 millimeters; enamel folds at base distinctly marked; convex face of crown marked centrally by a prominent transverse ridge formed by a single enamel fold, which is bent abruptly downward at the extremities.

This species bears a general resemblance to *P. linguifer*, N. & W. (op. cit. p. 37, pl. II., fiig. 4), having, like that, a rounded, tongue-like root, and a low and transversely broad crown; but it differs from that species in its shorter root, which is just half the entire hight of the whole tooth, and in the absence of a point at the center of the cutting edge, visible in unworn specimens of that species. A number of specimens of this species occur in the collection; two entire ones from the Keokuk beds, Bono, Lawrence county, Ind., collected by Dr. Knapp; others from Clark and Harrison counties, obtained by Prof. John Collett.

15. Antliodus similis(?) N. & W. (op. cit. p. 41, pl. II., figs. 10, 10a.) Keokuk beds, Harrison county, Ind. Prof. John Collett.

16. Orodus ornatus, N. & W. (op. cit., p. 65, pl. IV., fig. 7.) Keokuk beds, Harrison county, Ind. Prof. John Collett.

17. Orodus elegantulus, N. & W. (op. cit., p. 64, pl. IV., figs. 6, 6a.) Keokuk beds, Harrison county, Ind. Prof. John Collett.

18 Deltodus spatulatus, N. & W., Geo. Sur. Ills., Vol. II., p. 100, pl. 9, fig. 7. Keokuk limestone, Harrison county, Ind. Dr. Knapp.

To the foregoing catalogue I add the following notice of some enormous and specially interesting fish teeth recently obtained from the Sub-carboniferous limestone of Indiana:

ARCHÆOBATIS, nov. gen. Dentition flat and pavement-like; teeth of large size, thick and massive, in several rows, the different series arched and increasing in size from behind forward; under surfaces somewhat excavated to fit the curvature of the cartiliginous jaw; upper third of teeth formed by a coat of enamel, transversely corrugated and punctate.

The teeth, on which the above description is based, have the general form of those of *Psamnodus,* but they are many times larger, and are distinguishable from them by the beautifully regular corrugation of the enameled surface like that of the teeth of Rhina. A number of teeth, found in juxtaposition, show that the dentition was much like that of the living Rays, especially *Mylorbatis;* and there can be little doubt that they represent the oldest and most gigantic members, yet known, of the Ray family.

19. Archæobatis gigas, n. sp. Teeth numerous, nearly flat, forming rows from front to rear, and diminishing in size from the second tooth backward; all quadrangular in form, with the longest diameter transverse; largest specimen six inches wide, by four inches from front to rear; thickness of the largest teeth, one inch and a half. The corrugation of the surface is strong, and very regular, resembling that on the teeth of *Rhina ancylostoma*, and doubtless had the same function—to prevent objects from slipping while being crushed. From the Lower Carboniferous limestone (St. Louis beds), Greencastle, Ind.; collected by Rev. H. Herzer.

From the Coal-Measures of Vermillion county, Ind., I have received specimens of the remarkable spines of two species of *Edestes*, which, with others obtained from Mr. Alexander Butters, of Carlinsville, Ills., show much more of the structure and mode of growth of these peculiar organs than was known before. The species referred to are *Edestes heinrichii*, N. (op. cit., Vol. IV., p. 350, pl. I., figs. 1a, 1b.) (Of the latter species a better figure is given on pl. 1, Vol. IV., but is credited wrong on the fly-leaf to *E. vorax*, Leidy, a larger and quite different species.)

Numerous spines of both these species have come into my hands in such a state as to show that they were partially decomposed before fossilization. The numerous segments which are united to form the massive spines being easily separated one from another. I also have a young spine from *E. heinrichii*, from Vermillion county, Ind., which is composed of the single and first formed segments. It is complete, and in a beautiful state of preservation. Its outline is spatulate, and the narrower end bears a single, triangular, enameled, coarsely crenulated denticle, about an inch on the base, and half an inch high. The enameled portion of this denticle extends over and caps the summit of the spine. The other specimens which I have, show that other segments were added in succession, each one sheathing the previously formed ones, and extending beyond them far enough to carry a new denticle on the extremity. When complete, there were ten or twelve of these placed in succession along the upper margin of the spine, constituting a saw, of which the teeth are one and a half inches high—equilateral triangles in outline, about half an inch thick at the center, thinning down to an acute and coarsely crenulated edge before and behind.

In *E. minor* the spine is much compressed, and two and a half inches wide to the base of the denticles, which rise obliquely to the length of one and a half inches above this; they are narrower and more curved than those of *E. heinrichii*, of which the spine is thicker, straighter and larger, reaching the length of a foot or more.

Taken altogether, these are perhaps the most peculiar defensive organs known among the class of fishes, and among the most formidable. Though first described as jaws set with triangular, crenulated, shark-like teeth, there can be no question but that they are spines, analogous in their functions to the defensive fin spines worn by so many of the ancient sharks. The absence of an articulating surface at the base shows that they belong to cartilaginous fishes of the shark family, and were implanted in the integument of the body without connection with the skeleton. Their perfect bi-lateral symmetry shows that they were worn on the median line, but where on that line is not yet known, since all other portions of the fish—soft parts and cartilaginous skeleton—have disappeared. From their mode of growth, additions being constantly made to the distal extremity, instead of the base—as is the case in the growth of most such organs—it is evident that all but the denticles were constantly or generally covered with integument, and nothing but the cruel saw-edge was exposed. If planted as an appendage to the posterior dorsal fin, or near the tail, where the flexibility of the body would be considerable, this formidable organ might be directed by the will of the possessor, and used with destructive effect upon his foes.

A great number of fragments of teeth of *Petalodus* and *Cladodus* are contained in the collection which you sent. They represent several species, but all are too imperfect for description.

Yours truly,

J. S. NEWBERRY, M. D.

LOCAL DETAILS.

To the foregoing general description of the Connected Section of the rocks, and the list of fossils by which they are identified, details will now be added for local information.

Corydon is the seat of justice, and commercial center of the county. It was founded by General Harrison, (afterward President of the United States,) about the year 1808, and presents many evidences of its early date—as large shade trees in some of the lawns, and the rows of trees planted along Indian creek to protect the banks, now presenting an unique appearance as they guard and protect the boundaries of farms, and evincing an age of improvement not elsewhere seen in the State. An air of permanent thrift prevails, indicating a well-founded prosperity; but, save the residences of the earliest period, and the utter destruction of their park-like grounds, are almost sad reminders of the past.

In 1813 Corydon became the seat of government of the

Territory of Indiana under Gov. Posey, and subsequently from 1816, when this State was organized, until 1825, it was the capital of Indiana.

The "ancient capitol" of the State was erected by the county for a court-house, in 1811. It is forty feet square, two stories high, and built of blue limestone in irregular courses, from four to ten inches thick. The window sills are of a buff or yellow stone, quarried at Salisbury, which comes from the quarry so soft that it may be hewed with an ax or cut with a hand-saw, but which hardens on exposure to the air.

In this pioneer period some of the most enterprising soldiers of the Revolution and of the War of 1812, with cadets representing the bravest energy of the Eastern States, became citizens of Harrison county. Mention is almost invidious, but among the many who came was the tall soldierly patriot—General Posey—friend and companion of Washington. Familiar with the views, plans and maxims of his great friend, he imitated closely all that was pure and noble in his character.

Gov. Jennings, with a *personnel* like Agamemnon, walked "a king of men," honest, pure, with heroic courage for the right, lives in history a peer of the noblest in patriotism.

Harbin Moore, a meteor of brilliant thought and speech, and princely in courtly elegance of manners and conversation.

The Boones, unrivalled in pioneer daring that never quailed before their savage enemies, and "in whose lexicon there was no such word as fail."

The classic Harrison—a true friend, kind neighbor, gallant soldier, magnanimous conqueror, victor on every battle-field, sagacious statesman and President of the Republic, held unchallenged the highest human title—"an honest man."

Such were the early models who deeply impressed their character on their descendants. The effects survive in the deeds and actions of the generations to this day, and give origin to the enviable appellation so often bestowed on the county of "Patriotic Harrison."

Ignoring the valleys of the streams, as Big and Little Indian creeks, we find the great "Barrens" plain, already mentioned, spread out from 140 to 160 feet above town.

It extends to north, northwest, east and southeast, or from the northern boundary of the county to Ohio river. The plain thus established slopes gently to the southeast, contains hundreds, or rather thousands, of "sink-holes," on its surface; and the soil, as already mentioned, consists of an immense mass of insoluble residuum of the materials composing the St. Louis limestone, degraded and removed to a depth of 250 or 300 feet, giving existence to the great Pre-glacial valley. By this process, and exposure to rain water charged with gases, the lime is almost wholly removed, consequently injudicious cropping soon removes the small alkaline remainder, and the crops are unsatisfactory until lime or some other fertilizer is applied.

The "Barrens" are so-named from the fact that when first visited by white men there were no trees on such areas as had been swept by autumnal fires; but, on the contrary, could offer only a wild growth of annual weeds, prairie grass and low "stool brush." Since the fires have been prevented by settlements, farms, etc., some fifty years ago, quite a forest has sprung up, and the former prairie plains are crowded in places with a young growth from twelve to eighteen inches in diameter.

Immediately west of town is the commanding hill named "Pilot Knob." In an early day it was a landmark by which white and savage hunters and travelers determined their position and route. The knob is 290 feet high above town. An ancient river bench was observed at the hight of 140 feet, and a lacustral bench or terrace at 160 feet above Indian creek.

SECTION OF PILOT KNOB.

	Ft.
Soil	2
Laminated Chester sandstone	14
Heavy ferruginous sandstone	11
Compact argillaceous limestone, with chert	15
Argillaceous limestone and buff shales	30
Buff shales, with plates and bones	25
Gray St. Louis limestone, with chert, bryozoans and lithostrotion	10
White oolitic limestone	9
Massive, blue, clinky, St. Louis limestone and cherty shales, partly covered to Big Indian creek	176
	292

At the base of this section is a dark bituminous limestone, which, by false bedding and included vegetable matter, shows that a great tidal disturbance occurred in the Sub-Carboniferous sea. Fossils were not abundant, and in some of the rocks wholly absent. The limestones in the knob were sharp and angular, but the hard, ferruginous sand rock at the top was rounded, planished and moulded on the edges, indicating that a violent current of water of great volume had, in the beginning of the time when it was above ocean level, and subject to ærial influences, eroded a way around this hill-top, and that degradation alone would not account for the phenomenon. Again, the abrupt water-worn declivity on the northern face, with a well-rounded pebbly talus to the southeast, plainly showed the direction from which the great current of water came, and toward which it flowed.

Half a mile north of Corydon, on the southeast quarter, section 25, township 3, range 3 east, stone was being quarried for the piers of the new bridge, giving the following exhibit:

SECTION AT JUDGE SLAUGHTER'S QUARRY.

	Ft.	In.
Slope, shale and chert (covered)	30	0
Blue limestone, in beds 12 to 18 inches thick	8	0
Thinly laminated limestone	16	0
Bituminous limestone, with annulated vermiform fucoidal? markings	2	6
Carbonaceous slate in Indian creek	0	4
	56	10

The product, although hard to work, was obtained in good blocks, and, judging from past experience, will prove durable.

During the petroleum excitement a well was commenced at Corydon in September, 1871, and bored to a depth of 1200 feet, in the fall of 1873, at a cost of $5,451.

I am indebted to Major Thomas McGrain, one of the officers of the Corydon Artesian Well company, for the following accurate statement of material passed through.

The geological determinations are made, as a rule, from well-known and easily recognized strata, which outcrop within the county or in adjoining territory, measuring from an average of many outcrops when stratigraphy alone was relied upon. The starting point was a known exposure, while the Knobstone shales and sandstones, and the Black Slate, did not admit of error from their well-known character:

SECTION OF CORYDON ARTESIAN SALT WELL.

	Ft.	Ft.
Soil and fluviatile drift	12	.....
Blue St. Louis limestone	36	48
Blue St. Louis limestone, with saline sulphur water	9	57
Gray limestone, with clay partings	66	123
Soapstone	5	128
Limestone	3	131

	Ft.	Ft.
Siliceous shale (sandstone?)	4	135
Blue limestone, Keokuk	15	150
Limestone, with geodes and chert	40	190
Gray limestone	40	230
Knob shale and soapstone, "Bloom of Oil"	136	366
Knob shale and soft sandstone	18	384
Knob shale and hard sandstone	9	393
Knob shale and soft sandstone	18	411
Knob shale and tough sandstone	106	517
Knob shale and soapstone with carburetted hydrogen gas	33	550
Knob siliceous shale and sandstone	24	574
Knob shale and soft sandstone	9	583
Knob sandstone, light colored	12	595
Knob sandstone and shale, gas	57	652
Devonian Black Slate, Genesee shale with strong brine, gas and petroleum.		
Dark limestone	113	765
Hard sandstone?	24	789
Siliceous limestone, reported	29	818
Upper Silurian argillaceous limestone	15	833
The same, harder and darker	46	879
The same, with sulphur water and little gas	21	900
The same, dark limestone, harder	6	906
The same, very hard (chert)	12	918
Lower Silurian, soft blue stone	24	942
The same, harder	44	986
The same, softer, sulphur water	2	988
The same, very hard	30	1018
The same, dark, hard stone	182	1200

This section, with the exposure at Pilot Knob, gives a connected section of nearly fifteen hundred feet, and, besides the importance of so long a section over usually inaccessible strata, shows the gradual thickening of strata as they dip deep below the surface, and, *vice versa*, a thinning out as they approach the rim of the basin which is so well exhibited in the Sub-Carboniferous and Coal-Measure strata in the central and western parts of the State.

The capacity of the well was tested by pumping, and gave a little show of oil, enough gas to use in part for fuel, and, for two hours at a time, a two-inch stream of brine, strong enough to yield one and a quarter pounds of salt per gallon.

The White Sulphur well, Zenor & Co., proprietors, is half a mile east of Corydon. The grounds are well fitted up for the comfort and pleasure of visitors, with arrangements for using the water in any desired way. An analysis by T. E. Jenkens, M. D., of Louisville, shows the total salts in a wine gallon to amount to 450.88 grains, consisting of bi-carbonate of soda, bi-carbonate of magnesia, sulphate of soda, sulphate of magnesia, sulphate of lime, chloride of sodium, chloride of magnesium, chloride of calcium, and silica with carbonic and sulphydric acids. The efficacy of this water is well known and appreciated by hundreds of invalids who have been benefitted by its use. It has been found especially effective in chronic dyspepsia, rheumatism, gout, neuralgia, dumb ague and other malarious affections, scrofula, skin, kidney and female diseases. Cures, almost magical in their results, are vouched for by those who have been raised from beds of suffering. The town is healthy, the scenery romantic and full of the natural wonders of cave, spring and stone life. Wide views may be enjoyed. Excellent piked roads for drives, with Kintner's hotel, which is equal to the best.

Many natural springs of great volume breaking out at the fair grounds, and the reported "bottomless blue spring," on the pike in the eastern part of town, indicates the cavernous condition of the underlying rocks. Wells sometimes pierce these hidden streams of water, from which the usual ghostly blind fish and crustaceans are drawn. The well of B. P. Douglas is a museum of cave life.

Two steam mills, one water mill, several manufacturing establishments, drug, hardware and dry goods stores, with well appointed stocks, indicate the thrifty business and commerce of the county seat.

Martin's knob, two miles south of town, is one of the highest points in the neighborhood, giving a grand view along and across the great valley plain. The northern and northeastern faces are bare and abrupt, with talus to south and southwest, containing water-worn, rounded gravel from local rocks.

SECTION OF MARTIN'S KNOB.	Ft.
Soil	10
Chester sandstone	30
Chester limestone and chert	60
St. Louis limestone and clay, with good oolitic stone, partly covered	196
Blue bituminous limestone	14
	310

On land of Clark Highfill, two miles west of town, on section 25, township 3, range 3 east, is a fine outcrop of oolitic limestone, and easily accessible. The following was observed:

SECTION AT HIGHFILL'S OOLITIC QUARRY.	Ft.
Chester sandstone	35
Chester limestone	40
St. Louis gray limestone	20
White oolitic limestone	10
Cherty argillaceous shale, plates of limestone	80
	185

Big Indian creek, at its confluence with Little Indian, flows off with a current of two and a half to three miles an hour, with a breadth of thirty to sixty feet, and depth of one to two feet, largely increased by spring and winter floods, and somewhat reduced by summer droughts. It passes through a wild, narrow gorge or canon, with steep, precipitous bluffs, from one hundred to two hundred feet high, and little or no valley "bottoms." If long exposed, the limestone bluffs would have been rounded by action of air and rain to gentle slopes, and the valley widened; but that not being the case, we know that the valley and stream are of recent origin, compared with the surrounding well-rounded knobs and hills and the very gentle slopes about the more ancient Pre-glacial river valley and the old, sunken areas of Brushy, Grassy and Ripperden valleys. The origin of this, as well as every similar phenomena, may be attributed to the cavernous nature of the St. Louis rocks through which its course lies. The stream is now seeking another route and lower level for a short distance below town, on section 2, township 4 south, range 3 east, known as "Sink of Indian creek." In dry times the water gradually sinks for days to the lower new channel, then suddenly disappears with a whistling sound and forcible suction, which lasts for only a few minutes. After an unexplored subterranean passage of eight or ten miles, it again makes its appearance from the "Blue hole" or "Rise of Indian creek."

Within the distance above mentioned, samples of fair to poor lithographic stone were observed at several outcrops. The white oolitic limestone was seen at a few localities, marked on the map, varying in thickness from one to nine feet. At numerous exposures the argillaceous bed, beneath the oolitic limestone, was seen crowded with flint-balls. One of the ancient flint quarries, locally known as "Indian silver mines," and of importance to students of the Stone Age, will be further treated under the head of Archæology.

Ascending Big Indian creek on the west bank, on section 5, township 4, range 3, at the residence of Frederick Cline, which was found to be 460 feet above Blue river, 577 feet above Ohio river and 357 feet above Corydon, the following strata were seen:

SECTION AT CLINE'S.

	Ft.	In.
Sandy soil	20	0
Red, ferruginous, conglomerate sandstone	18	0
Gray and red Kaskaskia limestone, with *Productus*, *Spirifera*, *Archimedes*, etc	12	0
Red and blue Chester shales and sandstone	40	0
Hard gray Chester limestone	16	0
Sulphurous argillite	4	0
Black, slaty "coal bone"	0	4
Bright, resinous coal in brook	0	2
St. Louis limestone in brook	0	0
	110	6

At another locality on the same tract the Kaskaskia limestone is rich in Chester fossils, in fact an almost complete suite of the fossils of this group might be collected here.

From the residence of Levi Cline, on the same section, and at about the same elevation, Pilot and Martin's Knobs could be seen and identified; and dimly, sixteen miles to the east, can be seen the bluffs of Floyd county, also, a range of hills in Kentucky, twenty-two miles to the south. In Levi Cline's well, twenty-one feet deep, near the bottom, a thin parting, indicating the place of coal A, was observed, but no remarkable seam of coal can be found here. Sections very similar to the foregoing were observed on lands of L. Cline, F. Windle and Philip Snyder.

On the farm of Rev. Jacob Keller, section 32, township 3, range 3, is an outcrop of the lower Coal Measures and Chester beds, of great interest. The following section includes the space by barometric measurement to the level of the creek at Corydon, four and a half miles east.

SECTION AT KELLER'S HILL.

	Ft.
Loess soil	2
Conglomerate sandrock	10
Dark carbonaceous shale, place of coal A	20

	Ft.
Heavy grit stone	15
Soft sandstone	7
Blue Kaskaskia limestone, with Chester fossils	25
Argillaceous limestone, with chert	15
White limestone	6
Slope to sink	20
Space by barometer to creek at Corydon	240
	360

Mr. Ezra Keller, while pursuing his studies in geology, has gathered at this locality, which is wondrously rich, a remarkable collection of Coal Measure fossils, including great trunks of *Lepidodendron*, forked, strangely strangulated, from two to two and a half feet in diameter, but short and stumpy, as if of such weak or herbaceous growth as to forbid tall, erect stature. *Stigmaria* of different species, *Knorria*, with ferns and fruit-like seeds of Coal Measure plants, a stony herbarium of the age of coal. His collection includes, also, almost a complete set of Chester and St. Louis fossils.

The Coal Measure strata continue west, increasing with the dip in thickness in a great trough to Blue river. On section 34, township 3, range 2 east, the river has barely escarped a steep, almost inaccessible bluff.

SECTION AT ROTHROCK'S CLIFF, BLUE RIVER.

	Ft.
Soil and fluviatile drift	60
Laminated soapstone	14
Massive quarry sandstone, conglomerate	8
Soft ferruginous sandstone	11
Place of coal A	0
Shale and fire clay	7
Chester limestone and siliceous shales	120
St. Louis limestone, covered to Blue river	180
	400

The massive sand rock is easily quarried, breaking in great cubes, as if cut by hand, from two to eight feet square, and larger, and from evidence of exposure, is of unlimited endurance; as a grit stone it is first-rate, and should command the attention of manufacturers desiring very large grindstones. Beds of excellent paving stones are exposed in the lithographic member of the Chester group.

Borden's cave, on section 36, adjoining the above, is a new discovery, and of unrivalled beauty.

A friend who lately visited this interesting and new discovery, kindly furnished us with the following:

"BORDEN'S CAVE.

"The cave contains four rooms, each differing from the rest in the shape and number of its formations. The first room is about fifty feet high, and contains many stalactites, which are slender, tolerably clear, and from two to five feet long. The stalagmites are, also, numerous and beautiful; the stalactitic folds on the sides of the room depend in masses that, no doubt, weigh many tons. The most noted formations in the second story are: 1. Very white, clear stalagmites, covered with points of calc spar, that give them the appearance of being covered with frost. 2. A mass of broken stalagmites that have fallen from the walls of the room; this mass attracts much attention from those who do not understand the process of its formation. 3. A large branching stalagmite in the left side of the room.

"A large pile of rocks, resembling Jug rock in Martin county, partly separates the second and third rooms. Beyond it is a shelving rock, twenty-five feet long and ten feet wide, that contains, probably, 5,000 stalactites, from an inch to two feet long, and from one-fourth of an inch to two inches thick. Some of these stalactites have been broken off, perhaps, by an earthquake, and as they fell they lodged among others, and have been cemented to them in many different positions.

"The fourth room is entered by ascending a ladder. It is smaller than the others, and the most interesting object it contains is a huge stalagmite, eight feet high. One half of it has been removed by a small stream of water, so the present specimen is only a part of what was formerly there.

"Mr. Borden has labored industriously to improve the cave. He has made and put in place a ladder fifty-four feet long, by which the cave is entered, and also put up three smaller ones at places inside. He has graded some of the rough places, and is at present engaged in opening a narrow channel through which there is a strong current of air. The cave is worth a visit from all who enjoy subterranean rambles."

The Blue Spouter is a geyser-like spring in Walnut valley, a quarter of a mile east of Blue river. A circular hole, filled to overflowing with clear blue water, gives discharge to the great cavernous region adjoining. During and after a wet season the water rushes out with a roaring violence, sometimes spouting up four or five feet above the basin, in a column four or five feet in diameter, silvered with foam, and carrying out the fish peculiar to the open streams of that region, indicating a connection with some of them at no great distance.

Rhodes' cave, on section 29, township 3, range 3, near the road from Corydon to Harrison valley, has its entrance, almost like a well, in a corn field. The door is eight by twelve feet. A rapid descent over angular, fallen rocks, leads by a passageway, seven to ten feet high, to the lake, ninety-three feet below the surface. The lake is fed by permanent springs, and never diminishes much, if any, in size. It is reported to have a measured depth of over forty feet. A small spring, dripping from the limestone walls, fringes the south side with clusters and sheaves of slender stalactites, and falls into a basin-shaped stalagmite. The lake contains a great many white, blind fishes and crayfishes, but the floor and water was so muddy from a late rain that none could be taken at the time of our visit. Swarms of bats, very social in their habits, resort to the cave, arranging themselves, in summer months, in family circles of six or eight. In winter they hybernate here, hanging by the feet to the roof, with heads down, in great clusters of thousands, remaining in a semi-torpid condition until the warmth of spring recalls them to active life.

The cool, dry air of the cave has high antiseptic properties, preserving fruit, fresh meat, etc., in perfection.

On section 30, adjoining, on land belonging to Messrs. Rhodes, Rothrock and 'Squire Hausenfluck, six miles west of Corydon, is a massive band of Coal-Measure sandstone, which is reached with very little or no stripping. The natural cleavage breaks it into blocks and columnar masses four to six feet square on the end and ten feet or more in length. On the exposure was seen hundreds of cubes, almost mathematically true, four to five feet square, and a column twenty-three feet long and four by five feet transversely. The stone may be readily split or broken by workmen to any required size or shape. Exposed in and on Blue river during the ages required to erode a valley 400 feet deep, it still presents sharp, square corners and edges, indicating remarkable resistance to the action of the elements through indefinite time. It is a superior gritstone, and, tested at a Louisville edge-tool factory, was found equal to any they had used. Suitable grits may be had of any practicable dimensions. The quarry is on the summit of the table-land, 400 feet above Blue river. The product may be rolled down the steep bluff to the river without danger of breaking. The point offers favorable conditions for a mill site, with a great abundance of cheap material for the construction of a permanent dam, with good water power.

The bar of Blue river at this point, by barometer, is 102 feet lower than Corydon, and 480 feet above the ocean.

Passing from the top of the hill near P. P. Sonners', down Hickman's brook to Blue river, the following was observed:

SECTION AT HICKMAN'S BROOK.	Ft.
Sandy loam	40
Heavy sandstone	50
Blue Chester limestone	20
Argillaceous limestone and shale	30
Banded limestone	20
Heavy limestone	30
Limestone (covered to brook)	230
	420

In the rocky bed of the brook, besides a variety of common St. Louis fossils, there was observed many specimens of *Lithostrotion proliferum*, solitary, and in clusters some of which were over two feet in diameter; amorphous geodes, and coarse chert, filled with bryozoans, indicated the upper member of the St. Louis limestone.

Harrison valley is a rich sunken area, once owned by President Harrison when Governor of Indiana Territory. Every locality and plat of land calls up some historic reminescence of its original owner; one plat is known as the "Governor's field," another as the "General's meadow." The valley is almost a grand amphitheater walled by limestone hills, wrought by time into a gentle slope. In the middle of the level central area is a basin rimmed with a natural stone wall, scarce two feet high, filled with pure clear water. The ebullition in the center of the basin shows in ordinary times a great flow of water. In flood times a furious torrent, ten to fifteen feet in diameter, rolls up three to six feet above the surface level, and flows in a wondrous river one hundred feet wide, and ten to fifteen deep. Even in seasons of protracted drought the flow is reported as a constant stream, thirty feet wide and eight inches deep. From the spring to Blue river, a few hundred yards distant, there is a fall of eight feet, and the power is used to run a saw mill. In the earliest times a distillery was located near the great fountain, cold water being pumped thence.

By ascertaining the location of summer showers in the adjoining regions, and the character and color of the soils, whether yellow, red, brown or black, and carefully noting the color of the water at the time, in the great Harrison fountain, it has been ascertained that the drainage is from the "Barrens" and valley areas, eight to ten miles north and northwest.

Interesting and beautiful as the valley view is, and no tourist has seen America without seeing this spring, it was far more beautiful and attractive robed in nature's garb of forest, vines and sward; a favorite resting place to the mystery-loving savages, it at once attracted the attention of the pioneer General from economic, as well as other reasons. Mills were a necessity, and to insure a rapid influx of friends and defenders, for every man and woman must be at once farmer and soldier, mills must be erected at such localities where they could be built quickly and at the least expense, so the Governor secured the valley, and in 1805–6 erected a mill, and employed himself, between campaigns, as a farmer and actual miller. Persons now living in the vicinity remember, when boys, being sent to mill on horseback with a sack of corn or wheat, which General Harrison would receive with his own hands and carry to the hopper.

The old residence is gone; some shrubbery remains, and the orchard planted by the American Cincinnatus survives in vigorous growth and fruitage—the trees, now seventy years old, are from two to two and a half feet in diameter.

In Bogard's valley, a short distance north on section 18, township 3, range 3, the noted "Bogard spring" flows out of the east bluff and gives origin to a brook three feet wide and two to four inches deep. After heavy rains, white, sightless fishes and crayfishes, are cast out by the violent torrent. Close by is a "Reformed" church, with the significant dates on the gable, 1538–1861.

By reference to Table of Altitudes hereinafter given, it will be seen that the tops of the hills and table-lands of the Chester group, in the southwest and western part of the county, attain a hight of nine hundred and fifty to nine hundred and sixty feet above the ocean, or the western bluff of the Pre-glacial valley is almost identical in level, although of widely different geological position with that of the eastern bluff, which is also near the Floyd county line, nine hundred and sixty feet above same datum plane. In this valley, as before said, is the "Barrens" plains, ten to fifteen miles wide, and from two hundred and fifty to three hundred feet deep, cut out of solid St. Louis and lower Chester limestones. The Barrens being from one hundred and thirty to one hundred and sixty feet above Corydon and the present recent streams.

The Chester Group region being capped with sandstone, which is not affected by the elements, but is only worn by attrition or erosion, is very hilly or almost mountainous. At Buckhardt's, about one mile east of Winnsboro, a fine, thick bed of snow-white oolitic limestone was observed, with the following strata:

SECTION AT BUCKHARDT'S, (FRENCHTOWN, ONE MILE EAST OF WINNSBORO).

		Ft.
Covered (clay soil)		39
Heavy bedded Chester sandstone		10
Argillaceous limestone		15
Argillaceous limestone, with bands of chert		25
Flaggy limestone, with argillaceous St. Louis limestone.		40
Massive gray limestone		20
Oolitic limestone	4 to	8
Gray limestone and clay		50
		207'

In the soil at the upper part of this section were found many well-preserved fossils of the Kaskaskia and upper members of the Chester Groups, especially *Pentremites pyriformis, Zaphrentis spinulosa,* axes of *Archimides,* with abundance of crinoid stems.

Near the base of the hills in this vicinity, one to two miles east of southeast from Winnsboro, especially on the land of Amos Burger, northwest quarter section 7, township 3, range 3, is found the thin coal and coal bone which characteristically occurs near the base of the Chester and top of the St. Louis Groups.

Frenchtown is an unique village, established by the Buckhardt (Bogard) family, who induced the settlement at this point of some fifty families from *La Belle France.* The citizens are quiet, industrious, and retain the courtesy characteristic of their nation. Many cultivate vineyards and make wine. Some of the vineyards are productive and profitable.

Going north there is a descent of 220 feet to Brushy valley. It contains many sinks, which receive and conduct the rainfall to the hidden brooks and rivulets which discharge so grandly at the Harrison spring, before described. The valley is level or gently undulating, with considerable black, mucky soil, indicating a pond or lacustral origin.

The hilly bluffs are rounded and gently sloped in such a way as to indicate an age reaching back to an early period in Quaternary times. Many well-improved farms and home-like residences were noticed.

SECTION AT BRUSHY VALLEY.	Ft.
Clay soil	10 to 20
Chester sandstone and limestone	110
St. Louis Group	95
	225

Hancock's valley is very similar in character, but more undulatory. The land produces good crops of corn, wheat, oats and grass. As a result, the farmers appeared prosperous and happy in their well-appointed homes.

Palmyra is a well located village on the New Albany and Vincennes turnpike, surrounded by a level or gently undulating plateau of well cultivated land, with fine pastures and meadows, interspersed with funnel-shaped sinks and residual beds of chert (locally called "niggerheads") occasionally showing on the surface; but these "Barrens" peculiarities are, as a rule, pretty deeply covered with lacustral or alluvial loam. Many of the "sinks" have been puddled, forming permanent water pools for stock, fish, etc., and adding to the beauty of the landscape; others, with good subterranean drainage, are silent, empty amphitheatres. The vicinity is noted for reliable crops of corn and wheat and superior product of grazing and meadow lands. Fruit is abundant. The orchards are highly productive, the trees being annually loaded with apples and peaches of excellent quality.

Palmyra lake, on land of Jonathan Tarr, is a picturesque sheet of water—a mirror in a setting of emerald verdure. It still retains in its vegetation, survivors of the old Lacustral age or Loess loams, as persimmons on the banks, and *Nelumbium* and *Nymphœ* in the water. The area of this lake is estimated at twelve to fifteen acres, and the depth at fourteen feet.

It is the favorite resort of muskrats, wild ducks and geese; thrushes, in great numbers, nest on bushes growing in the shallow borders, and, with sagacious foresight, building just above the permanent water line. Yellow catfishes, fourteen inches long, have been caught here. After heavy rains the lake overflows and gives origin to a small streamlet, the water from which is swallowed by a sink, and is afterwards discharged at Kinney's big spring on Blue river, near Fredericksburg.

The old Indian trail from Louisville, via Paoli, to Vincennes, passes by the south side of the lake, and many arrow points and flint chips show that this was a favorite resort of the aborigines.

The depth of the Loess beds increase passing southeast on the pike. The orchards were loaded with bright, luscious fruit. Especial mention may be made of the orchards of W. B. Harper, and of many well improved farms.

The elevated region at the northwest corner of the county, surrounded in every direction by deep valleys, is noted for healthfulness, and especially for freedom from malaria. The vegetation characteristic of the Loess, as persimmon, gum and fruits, was preserved. In this vicinity are beds of white glass sand used at the works at New Albany. Similar beds of sand are found along the whole of the eastern edge of the black mucky region, locally known as the "Flat woods," which I have provisionally referred to as the flood plain of the pre-glacial river. The beds are not continuous, but in pockets, and are not restricted to the Indiana side of the Ohio river, but, where reported or observed, extended along the equivalent ancient depression across the State of Kentucky in the direction of Nolin valley and Nolin fork of Green river. In many places it is a massive rock, with much stratification and false bedding; ordinarily, by exposure, it has passed from this condition to that of loose sand. A close examination shows that it is later than the adjacent rocks, and seems to show that part of the materials are not earlier than the beginning of the Glacial epoch; for, with fragments and fossils from the Chester, St. Louis and Keokuk groups, were found small well-worn pebbles, alternating with beds of clay and sand, that could only have been transported by water having some current, say two to four miles an hour, and as the hardest of the fragments indicated a northern origin, the current must have been from north to south. Fine beds of sand, although when of considerable extent carrying impurities, were noticed on S. 34 and 35.

Descending from the higher Loess plateau to the village of Bradford, the peculiar debris of the "Barrens" was observed with a deep red soil, highly ferruginous.

New Salisbury is on the line of the proposed Louisville, New Albany and St. Louis railroad. An argillaceous, magnesian stone occurs here in good quarry beds, mentioned by Dr. D. D. Owen, in the first Indiana Geological Report, as having been used for window caps and sills in the Corydon court house. It comes from the quarry so soft that it may be hewed with a common broad axe, but hardens on exposure so as to be suitable for building purposes. It fairly withstands exposure to weather, but will not bear much wear and friction. Door-steps to residences were seen at Corydon, from this quarry, which had been in use over forty years.

From New Salisbury, Indian creek valley is bounded on each side with broad, gently undulating "barrens," dotted with the characteristic "sinks," and composed, beneath the surface, of fragments of broken chert, irregular geodes, and nuggets of quartz which, when fresh from their beds, generally present worn or partly rounded angles, as if at some time exposed to running water. This residual bed is from thirty to forty feet thick, and the siliceous fragments are as three or four parts to one of clay.

King's Cave, about four miles east of Corydon, on the New Albany turnpike, is interesting and easily accessible. A spring or small stream of water is the key to this excavation, the chisel which tunneled and hollowed out this narrow cavern. At low water it would pass through a four-inch orifice, and is constant in seasons of drought; after a rain a torrent pours out of the gothic doorway six by three feet. This beautiful doorway, much older than the present entrance, is inaccessible except by ladder; above, a dome-shaped portico is well rounded to lines of beauty. The vestibule is sixty feet long, twelve feet wide, and five to ten feet high, with a rippling brook at one side. Beyond, the roof becomes lower, and at places is but two and a half to three feet high. Half a mile from the entrance is a lake thirty feet long, of no great width or depth, containing blind fish and crustaceans; bats, 'coons and muskrats frequent the cave for rest and hibernation. The grand hall near the lake is reported to be one hundred and twenty feet long, sixteen feet wide, and eight feet high, with many beautiful stalactites. Beyond the lake the roof is so low that progress can be made in a stooping posture only, or by crawling.

A noted quarry bed of buff oolitic limestone overlies and surrounds the cavern. It is equivalent to the other St. Louis quarry stones of Lawrence, Monroe and Owen counties, being composed of marine animal remains, finely comminuted and well cemented together. It comes soft from the quarry bed, and hardens on exposure. It is reliable, first-class building material, and needs only means of transportation to insure a good demand. The following strata are seen:

SECTION AT KING'S CAVE.

	Ft.
Soil and slope	35
Argillaceous limestone	22
Laminated limestone	20
Buff quarry limestone (good)	12
Blue argillaceous limestone	9
Calcareous argillite	7
	105

Yocum's Cave, on the south side of Little Indian creek, in southwest quarter, section 25, township 3, range 4, is full of attractions, and is a labyrinth of winding passages. It has been but partially explored, and to a distance of about half a mile.

On the Myers farm north of the pike, and part of the same section, was seen an outcrop of the St. Louis beds, full of well preserved fossils. The shells were mostly silicified, and the locality is almost equal to the famous fossil beds at Spergen hill. This outcrop closely overlies the top of the Keokuk group.

Lanesville is a prosperous village, nestled in the deep valley of Little Indian creek. The citizens are mostly Germans, and, with many mechanics, are a self-supporting, self-reliant community. When first visited by explorers it was a favorite resort of our savage predecessors. Colonel B. Gresham points out the location of five Indian villages at this point. It was even then famous for its little saline spring or seep. This attracted the attention of General Harrison, when a surveyor, who opened a primitive well and tested the water. It was afterwards owned by Dennis Remington and Dr. James Lane, father of General Lane, in whose honor the village was named. A few years ago the old pioneer fixtures, a hollow tree "gum," were removed, and, although covered with mud, were found in good condition after a burial of half a century.

At that time it was found that one gallon of the brine would, on evaporation, yield three-quarters of a pound of salt. Another lick, both in the Keokuk beds, occurs on the land of Uriah Davis, in the west part of town. The small amount of brine will prevent the profitable production of salt; nor is there a probability of an increased supply of brine by boring.

The valley bluffs of Little Indian creek are composed of gray oolitic limestone, containing a wonderful variety of St. Louis fossils. No point in the State visited by the writer can so nearly furnish a complete suite of fossils of this group, and this is largely due to the untiring search and skill of George K. Green, to whom credit has already been given for his researches in the palaeontology of this and neighboring localities. In the bed of the creek, and in a branch half a mile north of town, the Keokuk rocks are exposed from nine to thirty feet in thickness. The St. Louis exposures on Panther creek are rich in well preserved fossils, but, in their collection, care and patient industry are required.

SECTION AT LANESVILLE.

Slope covered	70 to 30 ft.
Argillaceous limestone, with plates of chert	41 ft.
Warsaw division—equivalent of Spergen hill beds—with silicified fossils and fish teeth	21 ft.
Gray limestone, with fish teeth	9 ft.
Thick bedded blue limestone—Keokuk	10 ft.
	111 ft.

Half a mile north of town is a bed of buff magnesian argillite similar to that quarried at New Salisbury. Soft in the quarry, it hardens on exposure. Here it is about seventy feet above the Keokuk limestone.

At the west end of the pike bridge over Little Indian creek, half a mile east of town, is a notable bed of fossils. A gray, rough limestone twelve feet thick contains a remarkable number of fish teeth. In an exposure of sixty feet about three thousand specimens are reported to have been found, comprising at least twenty species. All the teeth are well preserved, still retaining the well worn enamel. Some of the defensive spines were of such size as to indicate animals of great strength and warlike character.

In the orchard of Iverson Lynn, a little over a mile east of town, is a fossil locality, which, while rich in many characteristic St. Louis forms, presents an anamoly not occurring elsewhere. Pentremites, as their name indicates, should have five sides or ambulacral spaces; but eleven specimens have been collected here having but four sides, for which the provisional specific name of *quadrilateralis* has been suggested by Prof. Hall.

Ascending the steep southern bluffs of Little Indian creek, we soon enter upon the rich, black soil of the "flat woods." The timber is entirely different from that of the "Barrens" and hill lands, consisting of hickory, beech, poplar, walnut, ash, white, red, black, burr and post oak, linn, sugar, etc. The amount and long continuance of ancient eroding currents of water may be inferred from the existence of the Husung cave on this nearly level plateau. Also, the big spring on the farm of George Henry, section 1, township 4, range 4, which, although on a level loamy plain, pours up, filling a basin thirty feet in diameter with clear, cold water, discharging a stream two feet wide and two inches in depth. On the adjoining farm of Conrad Bickell the following section was found in digging a well through fluviatile deposits.

SECTION IN "FLAT WOODS."

	Ft.	In.
Black soil	1	6
Yellow clay and gravel	15	0
Gravel and sand	8	0
Plastic blue clay	4	0
Sand to limestone	4	0
	32	6

Statements of experience in digging other wells show that similar fluviatile deposits occur characteristically in the flat woods district of this county, and inquiries subsequently made as far south as Elizabethtown, in Kentucky, showed that the same or similar causes have produced the same results, only on a deeper and larger scale.

Middletown is just east of the eastern boundary of the Barrens, and on a higher level. It is a growing village; the citizens generally German or of German descent, industrious, thriving and economical. The village is surrounded by a rich, prairie-like plain, divided into good-sized, well arranged farms, yielding choice fruits and wheat, and fair crops of corn and hay.

Farmers pay attention to the cultivation of clover and the grasses, which explains their agricultural prosperity. The soil is a buff or ash gray loam with considerable sand, and is from ten to twenty feet deep, resting upon beds of loose chert, geodes, etc., characteristic of the barrens, and is clearly of lacustral as well as fluviatile origin. Sink holes are a constant feature, and many of them, puddled by rains and wash, have become permanent water ponds, valuable for stock purposes, and susceptible of much higher value if stocked with fish, especially the German carp, recently introduced into this country by Prof. Spencer F. Baird, United States Fish Commissioner. This carp, so highly recommended by Prof. Baird for land locked waters, is a rapid grower and ranks high as a food fish; it will survive in stagnant water almost as long as a catfish, and feeds on confervæ and aquatic plants.

To the cultivation of fish for healthful and economical food for home table and for market, the attention of farmers and others is urgently invited. Actual experiment has shown that an acre of water, under control of the owner, is from five to twenty times more profitable in this way than for agriculture.

Elizabeth is situated in the valley of Sand branch of Buck creek, surrounded on either side with gently undulating or level continuation of the prairie like "flat woods." The village contains the usual manufacturing and mechanical establishments necessary for the accommodation of the vicinage.

A band of black, bituminous limestone in the hill south of town is the northern outcrop of the hydraulic beds which obtain remarkable development in the extreme southern part of the county; it will furnish material for good water-lime, but the thinness of the strata (two feet) will forbid economical preparation on a large scale.

Bridgeport, situated at the point where the eastern boundary of the county diverges from Ohio river, is located in the river valley, near high water level. The narrow valley is backed by grand, steep hills of Knob Sandstone, capped with limestone of the Keokuk and St. Louis groups, over five hundred feet high. The sharp conical knobs tower up, seeming to almost touch the clouds, and from their tops an interesting view, filled with picturesque beauty, is spread out, that rivals scenes in other lands, famed in song and story, and includes Louisville and Jeffersonville, eleven miles distant, Bardstown, forty miles away, and twenty-five miles of river valley. Just north is a very high pinnacle, noted as a landmark to pilots on the river. Well up on the steep side of the bluff is the sandrock stratum from which stone was quarried for the locks and canal around the Falls at Louisville. The stone is accessible and in heavy beds. It comes from the quarry soft and hardens on exposure, and is eminently adapted for foundations and underground work, on account of the facility with which it may be worked.

SECTION AT BRIDGEPORT.

St. Louis limestone and fluviatile drift	80 to 110 ft.
Keokuk limestone and shale	66 ft.
Knob shale	20 ft.
Knob sandstone, quarry rock	40 ft.
Knob shale and sandstone	210 ft.
Alluvium to low water in river	67 ft.
	513 ft.

Many interesting Keokuk fossils were observed in descending the creek, which has hewed its way through the heavy limestone on the Lafollet farm, a mile and a half north of the village. Almost a complete suite of the representatives of that group were collected there; also of the Knob shales, which, generally barren, contain at this point some shells with chondrites and annulated vermiform markings.

Glaze's landing, on section 25, township 4, range 5, is noted as the point from which most of the white sand is shipped for the New Albany Plate Glass Works. The road over which the sand is hauled to the river winds along the sides and around the sharp points of the steep bluff, at which point the following section was noted:

SECTION AT GORE'S HILL.	Ft.
Common soil	30
Dark irregular St. Louis limestone	11
Yellow Niagara shale	18
Cherty shale	13
White, fissile, sandy shale	7
Hard siliceous limestone	9
Argillaceous limestone	18
Geodiferous shale	20
Keokuk limestone with argillaceous parting	77
Knob shales and sandstone	180
Alluvium to low water in river	67
	450

The St. Louis shales above are rich in characteristic corals, shells and bryozoans, while the Keokuk rocks exhibit a few well preserved fossils.

Glass sand occurs here as elsewhere in the county, as well as north in Floyd county, and south across the state of Kentucky in separate deposits or basins along the east or west bank of the depression provisionally named the pre-glacial river bed. This depression trends, in this county, by a gentle curvature, and the sand banks are at the most easterly or eddy point of the curve, and just in the eastern edge of the "flat woods" flood plain of the supposed river. Just what connection their existence had with that river is not clearly seen, but their peculiar location in reference to it, and the fact that in the lower beds of sand and kaolin clays beneath it are fossils which had their origin to the north, it seems at least probable, if not reasonably certain, that the current of water, which deposited them, flowed from the north of Washington and Floyd counties with no great current but in great volume. The deposits, commencing two miles south of Bridgeport, are in regular series, though variable in extent, down to near the extreme southern extremity of the county, near the mouth of Mosquito creek, or twelve miles long by a half to one mile wide, and 400 to 450 feet above Ohio river. The geological horizon, of course, is not constant. In this vicinity it lies upon Keokuk rocks, further north on a St. Louis bed, and at one point in Kentucky it caps the Chester hills; in the beds and under them are found pieces of chert and silicified fossils from each one of the groups. At Captain Lawson's mine, owned by Wash. C. DePauw, Esq., proprietor of the New Albany Glass Works, the sand is coarse, in massive strata of rough sandstone, with somewhat regular layers, but generally striated by false bedding; from the bottom of the pits fine specimens of white and yellow kaolin (Indianaite) were obtained.

SECTION AT DEPAUW'S SAND MINE.

Loamy sand and soil	1 to 3 ft.
Indurated sand in strata, one to two feet thick, containing spangles of mica and a few quartz pebbles	18 to 30 ft.
Kaolin and clay, with St. Louis fossils	0 to 4 ft.
	37 ft.

After disturbance by quarrying a slight exposure causes the stone to disintegrate. It is then washed, or, rather, wetted, and thrown on a platform to drain, which removes all the iron coloring matter, and the snow-white product is ready for market. Captain Knight, who has worked these mines for eight years, says that at two of them he found streaks of black magnetic sand carrying fine gold dust in the bottom layers. On account of water I was not able to see this horizon, but such being the case it would at once settle the extreme northern origin of such drift material. The kaolin pockets, he reports, are of frequent occurrence, varying from white to yellow, green and sometimes red; when semi-crystalline it is pale blue or chalk white. Other beds of sand are worked by J. F. Irwin and Fred Shuck.

Glass sand has been opened and a few boat loads shipped from the land of Lydia Peters and R. Krow, section 15, township 5, range 5. Beneath the sand kaolin was here found white as snow. In the flat prairie area to the east, on the road to Stoner's hill, is a large extent of red, yellow and green kaolin in persistent beds two to three feet thick, which would be of immense value if free from coloring matter, and is eminently adapted to the manufacture of ordinary pottery, ornamental terra cotta and tile products.

SECTION AT STONER'S HILL.

(Sec. 11, Town. 5, Range 5.)

	Ft.
Soil	40
Barrens—chert, etc	15
Siliceous shales and bands of amorphous geodes	15
Dark siliceous shale	12
Heavy Keokuk limestone	20
Heavy cherty limestone	45
Geodiferous argillite	11
Black, white and blue flint, in bands of one to two feet, with clay partings	14
Red encrinital limestone	8
Knob shales	60
Knob, yellow sandrock	9
Knob shales, with plates of sandstone, to low water level of Ohio river	110
	359

On the farm of W. S. Eversol, section 13, township 5, range 5, is a boldly escarped bluff, precipitous or overhanging, which presents a wild ragged front to the river, and shows the following section:

SECTION AT EVERSOL'S CLIFF.

	Ft.
Soil	11
Keokuk, crinoidal limestone	39
Keokuk, clay, shale and geodes	7
Keokuk, blue, fossiliferous limestone	3
Keokuk, siliceous argillite, with geodes	14
Keokuk, flint in bands of six to twenty inches, with partings of argillite	12
Knobstone, siliceous shale, small geodes	25
Knobstone, thin bands of red encrinital limestone	15
Knobstone shale, with bands and plates of sandstone and clay iron-stones, partly covered to low water in river	190
	316

The cliff is over three hundred feet high; the blue Ohio quietly rolls at its base, or at flood-tide, sixty-seven feet above low water, surges against its sides. Gay steamers, the finest in the world, sweep like great white swans upon the river, giving scenes like Rhineland, enlivened with practical interests of prosperous thrift. The bottoms bordering the banks of the stream are three to four miles wide, a vast level plain of highly productive garden soil, dotted with farmer's homes and clumps and groves of shade and fruit trees; also, forests of maple, elm, beech, poplar, oak, walnut, etc. On the Kentucky shore the bottoms are traversed by a turnpike and railway; the trains on the latter, when first seen, two miles away, come around a point of the bluff, and although running at express speed, seem to creep over the plain, hiding at intervals behind clumps of trees, until, at eight miles away, they appear not larger than the toy cars of our childhood.

Up the river, sixteen miles distant, are seen the spires of the cities of Louisville and New Albany, hooded with a canopy of black smoke—banner and emblem of industry—telling of the vast iron and glass furnaces, the products of which reach all the markets of the continent. Still beyond, and to the east, the "rock ribbed and eternal" hills of Kentucky, world-famed for its fair women and brave men, meet and melt into the azure-tinted sky. Directly north, the Bridgeport knob is a prominent landmark, overlooking the long stretch of valley and river.

The summit of the cliff is sharp and conical, with steep sides, by which the sudden changes of temperature are so modified that sub-tropical plants formerly flourished, some of which still survive. Chestnut, black, white and chestnut oaks, black and white gums, sugar, ash, beech, cherry and walnut trees compose the forests, the first two named not growing one hundred feet below the hill tops. In Autumn the well-ripened foliage of these clumps of trees presents a brilliant, fluttering, quivering kaleidoscope of colors—brown, russet, purple, crimson, vermillion and orange, shading to delicate tints of pink, yellow and gold, rendered brilliantly conspicuous by a background of the richest emerald green—nature, draped for the harvest, in her regal robes of glory.

The southern cane (*Phragmites communis*) which is generally confined to the bottoms, formerly covered this hill with a rank growth from ten to fifteen feet high, in which the horse thieves of 1810 corraled their stolen property, affording them a hidden and almost inaccessible retreat.

At the time of the New Madrid earthquake, in 1811, a pioneer had built his cabin near the foot of the cliff. The mother, who still survives, often tells of that terrible night of fear and suspense, when massive blocks of limestone, eight to twelve feet square, loosened by the tremor, came thundering and crashing down the steep cliff. Many of the larger blocks, the work of that night's disruption, remain to this day.

A quarter of a mile northwest from the cliff is a natural rock-house, a shed thirty feet long by eighteen feet wide and twelve feet high, formed by the disintegration of a pyritiferous argillite just under the quarry sandrock of the Knobstone group. The latter is the equivalent of the quarry beds worked at Bridgeport for the stone used in the Louisville canal locks. At the point of the hill eighty feet above the rock-house, the flint band at the base of the Keokuk group crops out. Exposure to the weather has riven the band into cubes and oblong prisms, in which a vivid fancy could discern an ancient stone wall, partly overthrown; it is only the natural effect of moisture and freezing on such materials.

The gas flow, a mile below Eversol's, and half a mile above Rosewood postoffice, on Captain Strong's land, northwest corner section 25, township 5, range 5, is peculiar and of importance. All along the Ohio river, for a space of half a mile or more, whenever the water is not more than two to ten feet deep, bubbles may be seen hurrying upward. Near the edge of the river it pushes its way through the muddy deposit with a restless motion; in deeper water the discharge is greater, a continuous flow of small or large bubbles, and at places, in time of low water, Captain E. Knight informs me, in sufficient volume and force to give a rocking motion to a skiff, and in some instances threatening to overturn his row-boat. On the shore line small springs, with gas, break out. Confined in a tube or clay chimney, the gas is often gathered and ignited; these jets burn night and day until extinguished by wind, storm or overflow, like the Ghebers' holy light in the Sun Worshipers' land of fire, exciting the fear of boatmen, who could only wonder at a "hole on fire." It is a very pure carburetted hydrogen, burning with a white flame of high illuminating power and evolving great heat. The flow of gas is on a part of the river about half a mile long and trending from northeast to southwest. It is not confined to the river bed alone. In time of high water the ebullition of gas is noticed in the back water over the low lands, and is traced by the gas well near Buena Vista in a southwesterly direction across the country by Boone's landing, to a similar phenomenon in the bed of the river, and at the Gas-salt works at Brandenburg, Ky.

An imaginary line has been drawn across the county connecting the points inclosing the probable area over which gas may be found by boring from 500 to 800 feet, and accompanying the gas will be a flow of salt water, but it must not be expected that a good supply of either will be found in every bore that may be made in the area.

This vast supply of gas, of inestimable value as a fuel for evaporating salt brine, generating steam and other economic purposes, sufficient to propel the machinery of and illuminate the streets and dwellings of a city, is now suffered to go to waste. Over the whole territory where it occurs it ought to be utilized for the purposes mentioned, as it is at Brandenburg, Ky.

The gas area is noted for the many pre-historic stone implements found, including not only the flints of the savage race, but also the highly wrought and polished gorgets and ornaments of their predecessors—the Mound Builders—who are supposed to have been the American sun and fire worshippers.

Buena Vista precinct of Taylor township is situated in the rather deep valley of Mosquito creek, and is surrounded by a hilly country. The hills are built up of St. Louis limestone, which, by decomposition, produce the yellow and red soils characteristic of this group. Choice oak timber is abundant; good crops of wheat and grass are prodnced, and the farmers, especially on the upland plateau of ancient fluviatile loam, are prosperous and full handed. Many good orchards in full bearing were noticed. In fact, this region of elevated land is peculiarly adapted to the growth of fruit, and will bring satisfactory returns. The St. Louis limestone in the bed of Mosquito creek is fossiliferous, offering several species of *Zaphrentis, Orthis, Rynchonella, Lythostrotion, Palœacis* and *Dichocrinus,* with many crinoid stems. A well bored during the oil excitement a short distance south of the village, yields burning gas, showing that it is near the gas line.

Buena Vista is perhaps most widely known as the locality around which the Harrison county aerolite fell in 1859. About four o'clock in the afternoon on the 28th of March a slight glare was observed by a few of the residents, although such phenomena are usually noticed only from ten to fifteen miles away; this was followed by loud bursting reports, succeeded by continuous reverberations along and across the deep valleys and high ridges, which seemed to some of the hearers to equal the discharge of many batteries of heavy artillery in continued succession. On the spot the terror was intense; the flash of fire and frightful explosion, followed by a rushing, rattling noise in the air, and the crashing and tearing of the fragments against the trees, are to this day vivid in the memory of the older inhabitants. Mrs. Goldsmith saw one of the pieces fall on the road in front of her house and picked it up while still warm. She said that not only the men, women and children were frightened, but dogs ran howling to their masters for protection; birds were first paralyzed and then driven in furious flight; horses snorted in agony of fear, and cattle bellowed in wild confusion. A small piece of this aerolite, belonging to the writer, is all of it that is known to remain in the State. Any one wishing to see the larger pieces can do so, I am informed by Hon. B. E. Rhoades, by calling for the "Indiana Meteorite" at the British Museum in London.

I am indebted to Dr. E. S. Crozier, Surveyor of the Port of Louisville, for the privilege of making the following extract from his account, written on the spot immediately after the fall of the meteorite:

"On the 28th of March, 1859, about 4 o'clock P. M., three loud reports, in rapid succession, resembling the discharge of artillery, were heard in Harrison and adjoining counties. The reports were preceded by a sudden glare of light, peculiar and by no means like a flash of lightning. There was a dark cloud overhead at the time, and the reports were followed by a long rumbling sound, which proceeded in a southwest direction, lasting probably a minute and a half.

"The peculiar reports were matters of conversation with every one, and we were not surprised to hear that a fall of aerolites had occurred in Taylor township, Harrison county. I at once resolved to investigate the matter and secure specimens, if possible; many and marvelous were the stories in circulation in the neighborhood. Such a superstitious dread prevailed among the people that but little effort was made to recover the fragments, most of which had penetrated some little distance into the earth.

"Several pieces fell in the door-yard of John Lamb; a small boy saw one of them fall and dug it out of the ground. It was about three inches long and of an oblong shape. A fragment, picked up by Mrs. Kelly near Buena Vista, was brought to me; it had been broken after the fall, and presented a very peculiar appearance. It was covered externally with a thin crust resembling a coating of bitumen, the inner portion was of a light gray color, and interspersed with bright, metallic specks. It possessed magnetic properties in an eminent degree, the external coating appearing to attract the magnet with greater energy than the internal portion. It weighed 167.5 grains, troy, and had a specific gravity of 3.438.

"Robert Somers procured for me a much larger piece, which weighed one pound and three ounces, avordupois; it was 4.4 inches long and 2.3 inches through its shortest diameter. It also attracted the magnetic needle, which proved the presence of iron. This piece was dug up at Buena Vista by Mr. Goldsmith, and had the same external dark crust and internal gray appearance as the small fragment first described. But four pieces were found, although a great number must have fallen, as over an area of about four miles square, almost every individual testified to having heard the hissing noise made by the falling fragments, it having occurred at a very favorable time in the day for observation—about 4 P. M.

"Three or four loud reports, like the bursting of bombshells, were the first intimation of anything unusual; a number of smaller reports followed. The stones were seen to fall immediately after the first loud explosion. Some who were in the woods distinctly heard the stones striking among the trees. A peculiar hissing noise was heard, during the fall of the stones, for miles around. As a lady described it, 'the air seemed as if it had, at once, become filled with thousands of hissing serpents.' Mr. and Mrs. Josiah Crawford were standing in their door-yard at the time, and hearing a loud hissing sound, looked up and saw an aerolite fall just before them, burying itself four inches in the ground. They immediately dug it up. It did not possess any warmth, but had a sulphurous smell. Another, which they did not find, fell near them.

"Two sons of John Lamb were out near the barn, when their attention was attracted by a loud, hissing noise, and immediately a stone fell near them, penetrating some three or four inches into the hard earth. This was of an oblong shape, about three inches in length, and not more than a half inch thick, and was quite warm when first taken from the ground. The general appearance and composition of this was the same as those above described. Another fell in newly plowed ground near by, but they were unable to find it."

Dr. J. C. Clark, at Buck creek bridge, eight miles north of Buena Vista, and B. P. Douglas, Esq., at Corydon, in describing the meteoric occurrence, say there was a rushing, whistling, windy noise, then a rattling, roaring sound, like the stampede of General Pope's wagon train driving recklessly over a wooden bridge, then the explosion for a minute, like the rapid discharge of a park of artillery, followed by the prolonged, rolling reverberations, passing from the southwest to the northeast.

The following notes and analyses by Dr. J. Lawrence Smith, of Louisville, Ky., a distinguished chemist and naturalist, shows the compositions of this "unbidden messenger from another world:"

ANALYSES OF THE HARRISON COUNTY METEORITES.

"Nos. 1, 2, 3, and a fragment of No. 4, were placed in my hands for examination. Nos. 1, 2 and 4 are cuboidal in shape; No. 3 was considerably elongated. They are all covered by a very black vitrified surface, equally intense on every one, and on every part of each one, and, when broken, show the usual gray color of stony meteorites, interspersed with bright metallic particles.

"The mean specific gravity is 3.465. When broken up and examined under a glass, four substances are distinguishable—metallic particles, dark glossy mineral, dark dull mineral, and white mineral matter.

"Examined as a whole, the following elements were found in it: Iron, nickel, cobalt, copper, phosphorus, sulphur, silicon and oxygen. By the action of the magnet it was separated into:

	Per Cent.
Nickeliferous iron	4.91
Earthy minerals	95.09
	100.00

"The earthy minerals, acted on by warm, dilute, hydrochloric acid, thrown on a filter and thoroughly washed, then treated with dilute, caustic potash, to dissolve any silica of the decomposed portion that was not dissolved by the acid, gave:

	Per Cent.
Soluble portion	62.49
Insoluble portion	37.51

"The metallic portion separated from the earthy portion, gave:

	Per Cent.
Iron	86.781
Nickel	13.241
Cobalt	.342
Copper	.036
Phosphorus	.026
Sulphur	.022

"The earthy portion freed from metal, gave:

	Per Cent.
Silica	47.06
Oxide of iron	26.05
Magnesia	27.61
Alumina	2.35
Lime	.81
Soda	.42
Potash	.68
Protoxide of manganese	trace.

"It is clear, from the analyses made out, that these meteoric stones contain the constituents frequently found in similar bodies, namely, nickeliferous iron, phosphuret of iron and nickel, sulphuret of iron, olivine, pyroxene and albite, and in about the following proportions:

	Per Cent.
Nickeliferous iron	4.989
Schreibersite	.009
Magnetic pyrites	.001
Olivine	61.000
Pyroxene and albite	34.000

"I have no intention to enter into any speculations in relation to these meteoric stones, although I have accumulated some additional matter on the subject since my memoir on Meteorites, published in the *Amer. Jour. Science and Arts*, Vol. xix., pp. 152 and 322, intending to reserve their publication for a future occasion."

The high alluvial table lands extend west to and beyond Laconia, and south to near the bluff adjoining Boston, where the following section was observed:

SECTION AT DUG HILL.

(Sec. 5, Town. 6, Range 5.)

	Ft.
St. Louis limestone and shales, with *Productus*, *Zaphrentis*, *Ptilodyctia*, *Athyris*, etc., mostly in hydraulic bed	120
Keokuk limestone, with crinoids	30
Buff argillite, with geodes	6
Argillaceous shales and plates of sandstone	40
Knob shale and coarse crinoidal limestone, with *Platycrinus halli*, *Spirifer grimesi*, etc	12
Knob shale and sandstone, partly covered	95
	303

At Brown's Landing, near the mouth of Mosquito creek, the Knobstone group, still dipping to southwest at the average rate of thirty-nine feet to the mile, passes from sight beneath the low water mark of the river. The ocean in which it was deposited was subjected to new conditions. The long reign of muddy deposits in a tideless sea was ended. Fresh currents of clear water swept over the soft bottom, and with strong tidal waves sweeping up from the deep central areas to the west moulded the surface into a succession of wave-like undulations which are well preserved in the Keokuk rocks exposed at low water for nearly a mile just below the mouth of Mosquito creek. These alternations or changes of conditions were disastrous to life. The rocks along the beach are profusely filled with long, bending, plumed crinoid stems, and with them are found, more rarely, their medusæ-like heads, with *Archæocidaris* and plates of *Melonites*.

The road cut in the hill leading from the landing affords a good opportunity for seeing the great hydraulic bed lying above the grandest, most compact, homogeneous, gray limestone I have seen. The latter is unique; it deserves the attention of engineers, especially for piers which are intended to resist the destructive action of ice and violent currents of water, and for break-waters in the ocean, such as the jetties at the mouth of Mississippi river.

HYDRAULIC SECTION.

(Shackleford's Land, Sec. 14, Town. 6, Range 4.)

	Ft.
St. Louis beds, loose cherts, etc	55
Heavy blue argillaceous limestone	50
Buff soapstone	10
Hydraulic cement rock	30 to 55
Thick bedded, dark limestone	20
Massive, compact, choice limestone	50
Keokuk blue limestone	70
Covered to low water	35
	345

The river bank on this tract of land is precipitous, and is noted as a "buzzard roost." The birds gather every evening, from eight hundred to twelve hundred in number, from a radius of thirty to forty miles, and hold their daily evening consultation before going to roost, which is mostly on the limbs of the trees, but often on the sheltered benches of the banded limestone. They very successfully and effectually defend themselves against enemies and assailants by vomiting and ejecting the filthy contents of their stomachs. At early dawn they depart in search of food. This tract of timber has been the scene of their nightly gatherings for over thirty years, certainly, and probably for a much longer time.

At Kintner's Landing, a few miles below, was a noted rookery, or roosting place for crows; and below Rockhaven, an eagle roost, at which the eagles gather at nightfall from over an area of about one hundred miles square.

The St. Louis cherts, in the upper part of the Hydraulic section, given above, are the loose residual materials equivalent to the sub-stratum of the "Barrens," and contain *Productus punctatus, P. altonensis, P. semireticulatus, Bellerophon, sublævis, Allorisma sinuata, Dentalium venustum, Orthoceras sp.? Euomphalus spergenensis, E. plano-spira, Orthis dubia, Rhynchonella mutata, R. grosvenori, Hemipronites crenistriatus, Zaphrentis, Fenestella, Retzia verneuilanum, Athyris royissi, A. hirsuta, A. subquadrata, Pentremites conoideus, Palæacis cuneatum, Aulopora gigas*, etc., etc.

In the cement bed were noticed *Lingula, Discina, Fenestella, Ptilodyctia, Spirifera fastigiata* and *Aviculopecten hertzeri.*

The Keokuk rocks below contain a multitude of larger fossils: *Spirifera, Dorycrinus, Synbathocrinus, Platycrinus, Strotocrinus, Archeocidaris, Melonites, Nautilus* and *Zaphrentis,* are common in this group.

A mile below, the Keokuk rocks are exposed on the Kentucky side of the river, and are rich in *Crinoids*, etc., and pass below the water level at the cement warehouse.

Rockhaven, on the Kentucky side of the river, furnishes a first-rate open view of the strata which are partly covered on the Indiana bluffs. A quarter of a mile below the landing is a perpendicular cliff, boldly ribbed with massive belts of limestone more than three hundred feet high. Two hundred feet above low water in the river, an orifice or doorway, ten feet high and four feet wide, opens into a cave, described by Major Wright as more than a mile in length, containing a lake three hundred feet long and thirty feet wide; also a river on which is a fall fourteen feet high, a natural bridge, and rooms ten, twenty and thirty feet high and wide. It is inhabited by sightless fishes, cray fishes, bats, rats, 'coons, striped squirrels, ground hogs and mice; buzzards shelter and nest in the first room, which is difficult of access. In summer a small stream of water trickles from the doorway; after a heavy rain a torrent of water, four feet in diameter, is hurled from the doorway in a single leap of sixty feet to the rocks below, landing in a sheet of foam. In winter the cliff is cased in a shining armor of ice, with pendants and columns of snow-white brightness.

The most important interest is the hydraulic cement, found here in immense beds on the Indiana side of the river. In 1872, Major J. H. Wright, of Louisville, tested a dark, bituminous clay limestone, and found it possessed of high cementing properties. A company, under his direction, organized for work. The bed was found to be thirty-six feet thick, almost uniform in quality, and situated so high up the hill that the stone may be cast from the quarries to the kilns, drawn from the kilns into the mill, and thence, a step down at each manipulation, to the wharf for shipment. Five of Page's perpetual flame kilns are in use, each thirty-six feet high, eighteen feet square on the outside, with a diameter of eight feet inside the cupola; average capacity of each, per day, two hundred barrels, drawing the lime every four hours. Ordinary kilns fail on account of bursting of the stone, which packs the material and smothers the fire. The flame kiln obviates this difficulty, and is in all respects a success.

The stone is highly impregnated with petroleum and bitumen, which assists in calcining. The stone is burned at a bright red heat only; a higher degree renders the lime inert. It does not contract much in burning, and loses but little of its weight. Drawn from the kilns, the stone is reduced by a crusher to fragments about the size of hulled walnuts; it is then ground by three run of burrs, each pair of the extraordinary weight of 60,000 pounds, the whole being driven by a forty-horse power engine. After grinding, the cement is carefully cooled, screened and packed in barrels. The cost of manufacture ought not to exceed fifty cents per barrel, not including packages. Either wood or coal may be used in calcining the stone.

Fixtures, including kilns, mill, engine, tenements, shops, warehouse, tramway, tools, etc., is estimated at $15,000 to $35,000, and has a producing capacity of one hundred thousand barrels of cement per year. The largest day's work done produced five hundred barrels, and the heaviest year's production, in 1875, was thirty-five thousand barrels. The cement meets with ready sale, and the result of four years' test under sharp competition indicates that it is equal, if not superior, to the ordinary commercial article. It sets slowly, and is therefore peculiarly adapted to brick and stone masonry, as in cellars. It sets well under water, and has been used for steps, pavements, roads, vats, cisterns, mill-races, etc. When salt water is used as a solvent it hardens more slowly, but equally well.

In a competitive test in a mill-race at Georgetown, Ky., Major Wright informs me that fifteen barrels were used of each of the following brands: Black Diamond, Louisville, Common Louisville, Rosendale, N. Y., and Rockhaven. The work was under a rapid current of water. The Rockhaven is still good, superior to some of the others and equal to the best. This particular notice seems due from the fact that the very extensive and easily accessible beds on the Indiana side of Ohio river invite the attention of capitalists, and ought to be worked.

Hydraulic limestone occurs in the same vicinity, on the Ellis farm, easily accessible, with a thickness of twenty to forty feet, and on the Craven Lane farm, a mile above the ferry, where it seems saturated with petroleum, and forty to fifty feet thick; on John Briggs' farm, where it is easy of access and twenty-two feet thick, and on the magnificent

"Cedar Grove" farm of Kintner there is twenty-two feet of cement in the bluff.

The vicinity produces excellent fruit in large quantities. Kintner's orchard covers twenty-five to thirty acres, with a thousand apple trees in full bearing, peaches, pears, cherries, berries, etc.

The well stocked nursery of W. H. Lane, at the extreme southern point of the promontory of Harrison county, was in excellent condition and contained a good assortment of acclimated fruit trees.

This vicinity was a favorite home of the Indians; the site of an extensive village, formerly occupied by some fixed people, was noticed half a mile north of the ferry. Stone hammers, arrow points, flint chips, etc., were very abundant; at Cedar Grove a *cache* of leaf-shaped flint spear points was discovered a few years ago, in which more than a hundred specimens were found. From the top of this southern promontory of the State, 410 feet above Ohio river, a fine outlook is enjoyed; the ever beautiful Ohio river circles in a broad sweep, comprising miles of river scenery equalling the historic waters of the Rhine; sometimes a mad, rushing torrent, at others a quiet, sleeping expanse. Beyond, in Kentucky, the Muldraugh range of hills are built up against the sky ten to thirty miles away, while six great, sharp, conical, isolated, monument-like knobs, the result of past erosive energy, seem to pierce the blue heavens, solemn in their silent loneliness, and a measure of the ages necessary to remove, by denudation, a thousand feet of overlying strata.

Tobacco Landing was, in early times, intended by some speculative proprietors as one of the most important trading posts on the river. Warehouses and other appointments were prepared sufficient for the transaction of all the business of the neighboring region; but trade would not come. Its chief notoriety is for having been the boyhood home of the traveler and author, J. Ross Brown. His mind was educated to an appreciation of natural scenes of beauty by the outlook above mentioned, but more by the dreary scenery of the dark chasm of Falling-spring brook. The walls are steep or precipitous, of banded limestone, over three hundred feet high. Remote from the intrusion of domestic animals, the original growth of plants, feathery ferns flourish in profusion on the shaded benches and caves. Each escarped band of rock was festooned with trailing creepers and clinging lichens, while the steep face of Douglass' pinnacle would always excite a boy's dreams of romance. In this solitude was nurtured the longings which were embodied in his first published sketches. The neighbors, in kind remembrance, have named his favorite retreat, "Ross Brown's Gulch."

Laconia is on the dividing plateau between Mosquito and Buck creeks. The surface is level or very gently undulating. The soil is black, rich, and a good example of ancient alluvium, and although over four hundred feet above low water in the Ohio river, is so nearly level that swamps and ponds occur which should be thoroughly drained by open or tiled ditches. With such improvements the results will be equal to any in the southern part of the State. Fair crops of corn, wheat and tobacco are produced. Red-top grows well. J. L. Kintner, after a fair trial, has found that orchard grass is fully twice as profitable as any other, and is one of the surest crops the farmer may cultivate. The orchards were in good condition, the apples were free from imperfections, and a full yield seldom or never fails. It would seem that these conditions would invite the attention of persons who desire to engage in the business of canning, drying and permanently preserving fruit for market. There is a bone mill in the town, and much bone dust is used for fertilizing, with remunerative results.

West and northwest of Laconia, as will be seen by the map, there are four small creeks or brooks, which, after gathering the surface drainage of from two to four miles, suddenly sink in the ground to the cavernous St. Louis limestone. After an underground course of less than two miles they are collected together and burst forth from an opening in the limestone bluff of Buck creek in sufficient volume to turn an old-fashioned overshot wheel and mill. This region is historic ground, on the verge of the battle-land which divided the semi-civilized Indians of the south from the savages of the north, and subject to incursions from these irreconcilable enemies and from predatory parties from other tribes. It was inhabited by wild animals—a land of game—bears, deers, turkeys, etc., were abundant. Notwithstanding the danger of the situation, this hunting-ground soon attracted the attention of the Boones and others of the chivalrous pioneers of Kentucky. Every excursion was a scouting expedition, and every trail a "war path." The foemen neither asked or gave mercy. On one of their hunting expeditions, Squier Boone, brother of the famous Daniel Boone of Kentucky history, in passing along the eastern bluff of Buck creek, noticed a small cave-like opening in the rocks, partially hidden by bushes. It appeared to be a good hiding-place for large, wild game. A few miles further on he was attacked by three Indians; his only chance for life was to fly. The pursuit was immediate and earnest. Although he had then thrown away his arms their nearer approach was constant, and it was evident they would soon overtake him. He remembered the hiding-place discovered a few hours before, and reached it when his pursuers were less than a hundred yards behind him. Throwing himself into the cave, he heard the Indians pass over his head. The little cavern had saved his life. To him it was holy ground; he selected it as his final resting-place—a sepulcher carved out by the hand of nature. He required that, after his death, his body should be entombed in this cave. Going to the spot, a rough, flat stone was shown us —the door to "Boone's Grave Cave." Removing the stone, a small opening is exposed in the side of the hill; a descent of about seven feet led to a room six by eight feet on the floor, and a little less than five feet high. The coffin had been broken away, and the exposed bones showed that this intrepid pioneer had been a man of stalwart frame and great muscular power, at least six feet two inches high. The skull was gone. A decent regard for the family and memory of a man who contributed so much to the pioneer history of the Ohio valley, and gave name to so many counties, towns and villages in the Garden of America, demands that a suitable memorial column or block of stone should be placed over this grave, not only to mark the spot, but to preserve his mortal remains from the vandal hands of relic hunters.

Squier Boone spent his latter days in this vicinity. The great cave spring poured its torrent down the side of the hill, having a fall of eighteen feet. Boone built a mill, preparing the material almost wholly with his own hands. The building was of stone. Many of the blocks were ornamented with figures and emblems, displaying some degree of artistic skill, and all by the hand of the old hunter. A trailing vine in full leaf and laden with fruit was cut upon the lintels, and figures of deer, fishes, a horse, a cow, a lion, a human face, and stars, and many texts from the bible were sketched upon the stone in different parts of the building. Over a door-way was this inscription:

"The . Travelers . Rest . consecrated . By . Squier . Boone . 1809 ."

Over another door is the following:

"I . Set . And . Sing . My . Souls . Salvation .
And . Bless . The . God . OF . My . Creation ."

A broken stone says:

"My . goode . frind."

BOONE'S MILL CAVE.

Dr. Potts and some friends, in 1870, determined, if possible, to explore the cave which gives egress to the stream that drives the Boone mill. Near the mouth of the cave, which is twenty feet wide and ten feet high, the water rushes out with a violent current, and for one hundred and fifty yards was found to be waist deep; thence for half a mile the stream was smaller, a mere tunnel four and a half feet high, where they found interesting waterfalls, one ten and the other twelve or fourteen feet high; passing these, they entered a dry hall-way, for nearly a mile averaging twenty feet wide and sixteen feet high, the sides highly ornamented with snow-white or translucent stalactites, and numerous stalagmites built up from the floor, which, in many cases, nearly approach the pendants from the roof. Dr. P. was delighted with the beauty of the scenes. Sightless fishes and bats were the only observed inhabitants.

Returning to Boone's Landing on Ohio river, the line of "Gas Springs," the ebullition of which has been mentioned in the bed of the river, a short distance above Rosewood postoffice, and which was found in the oil well bore near Buena Vista, is again noticed, entering the river a short distance below Tobacco Landing and trending obliquely to the southwest, until, at Morvin, the phenomena of the bubbling gas was seen from the Indiana shore to the Brandenburg wharf. In time of overflow the ferryman reports that for many years he has noticed the same occurrence at many points on the Indiana bottoms back of Morvin, where the discharge of gas was in great volume, but where it is scarcely to be noticed when not so confined by the water. The immense amount of this gas, and the possibility of its economical use for illuminating, heating, cooking and steam purposes, induced a visit to Brandenburg, on the Kentucky side of the river. Immediately adjoining the town, and thence east to Doe run, eight wells are reported as having been bored to depths varying from 478 to 800 feet, and from seven of them gas and salt water were discharged; in more than half of them the gas was in considerable quantity, and in at least two of them the brine was strong and in reasonable quantity.

The principal well, belonging to Mr. Alonzo Moreman, named the "Glen Font Salt Works," was bored in 1864 for oil. It is 527 feet deep, at which point the auger struck a sloping crevice. On account of the inclination of the sides of the crevice the drill could not be made to bore deeper. Further search for oil was abandoned and attention given to the flow of gas and salt water, containing a small amount of petroleum. The brine measured 31° by the salometer, which is equal to the best Kanawha or Pomeroy wells; ten gallons of the brine yielded one gallon, or seven and a half pounds, of salt. The gas is the only fuel used for evaporating the brine; but about one-third the amount discharged is needed for this purpose and for lighting the dwellings and doing the cooking in the neighborhood. They are now making over twenty 280-pound barrels of salt per day. The gas and water come from the well in strong pulsations about every minute, with many weaker ebullitions between. This carburetted hydrogen gas is gathered in an iron tank ten feet deep by eight feet in diameter (holding 502.6 cubic feet of gas at atmospheric pressure).

Allowing the gas to pass through a two and a half inch discharge pipe, it filled the tank in a little over three minutes, and exerted a lifting force of 4,300 pounds, which would indicate a discharge of nearly two hundred cubic feet of gas per minute. The brine is evaporated in two large pans; each fire-box is supplied with two gas-pipes, one and a quarter inches in diameter, which make a vivid sheet of flame five feet wide and filling the fire space to a depth of eight inches. The supply of gas is believed by the proprietor to be ample to evaporate the amount of salt mentioned, drive a steam-mill, and light, warm and cook for the town of Brandenburg. An experienced glass manufacturer declares the amount ample to carry on extensive glass works.

An analysis by Dr. J. P. Barnum, gives the following as the composition of the salt:

	Per Cent.
Chloride of sodium (table salt)	99.45
Chlorides of calcium and magnesium, sulphate of soda, organic matter and loss	0.55

The cost of manufacturing this salt is forty cents per barrel, and it sells at $1.45.

The following section in bore was given by David Miller:

SECTION AT BRANDENBURG WELLS.

	Ft.
St. Louis and Keokuk limestone	220
Knob-stone shale	200
Knob-stone silicious argillite	50
Knob-stone shale with nodular iron stones	130
Devonian shale	130
	730

Busey's burning well is in the low river bottom, half a mile above town. It discharges brine and carburetted hydrogen gas in large quantities, and also large quantities of sulphuretted hydrogen gas and sulphur water, which injure the quality and lessen the quantity and purity of the salt.

The gas constantly bubbles up from a basin of water, eight feet in diameter, and when ignited covers the basin with a waving mantle of fire. In times of high river the locality is covered with back water to a depth of seven to fifteen feet. The gas, divided into small streams, bubbles through the water over a space ten or fifteen feet in diameter, making a sulphurous, red sheet of flame, writhing and twisting before the wind, and in the still, dark hours of the night the goblin-like flames dance upon the water like lost spirits hovering over the sulphurous pits in Dante's Inferno.

Mauckport is situated on the bank of Ohio river, and is surrounded by extensive, rich, alluvial bottom lands. It is also the entrepot for the products of the fertile uplands on either side of Buck creek, but is especially notable from the fact that extensive beds of Oolitic limestone crop out in thick strata in the hills from two to four miles north of town, the product of which is shipped from this port. Maple Grove, on southwest quarter, section 21, township 5, range 3, the residence of Captain Jacob Stockslager, one of the venerable pioneers of this region, was visited under the guidance of Hon. S. M. Stockslager. Ascending the hill south of the residence, the flint quarry-bed was noticed, with evidences of much work by Indians and earlier prehistoric races. The ground was covered with broken nodules, spawls, chips, splinters and broken or imperfect implements—unsuccessful attempts of the apprentices to ancient arrow-pointers.

Still higher up the hill a massive stratum of Chester lime and sandstones reach well toward the top. From here a grand view is enjoyed, reaching across the Ohio valley to the Knobs of Kentucky—pinnacles of the Muldraugh hills, fifteen to twenty miles away, with Brandenburg, Bardstown and other points of interest—a mere outline-tracing in the dim, blue distance.

To the east the rough valley of Buck creek and its tributaries is leveled by distance, to appear as a valley plain, sloping eastward.

East of the residence is the well-known Stockslager Oolitic quarry. The stone is in a broad band, cropping out on the side of this and several adjoining knobs, varying from six to eight feet thick. It is almost snow-white, homogeneous, composed of small concretions like the eggs of fish, and, from this peculiar structure and its almost perfect purity, is believed to owe its origin to precipitation from solution by some chemical action in the old St. Louis sea.

The quarry has been opened on a face of more than a quarter of a mile, at every opening showing a stone unsurpassed for uniformity of color, texture and quality. The product is fine-grained, compact and strong; saws well, is easily dressed or ground, and on account of fine texture and pure white color, is one of the most attractive limestones known on the globe, unsurpassed if not unequaled.

In the table of crushing resistance, by General Gilmore, in this volume, it shows strength ample to sustain heavy burdens. Specimens seen after fifty years' exposure to the elements show no sign of yielding, the only wear being a slight roughening of the surface. The quarry has been worked only enough to obtain the exposed or surface samples, which come out, from diagonal cleavage, in angular blocks. As the entry is deepened, the superintendent reports that larger masses are obtained, and he confidently expects that, as the work proceeds, the whole thickness of the strata may be made available. Stone from this quarry has been burned, and yields a fine, pure white lime of superior quality for masonry, plastering and whitewashing.

A valley leading from the quarry to Ohio river offers a gently declining grade for rail or tramway.

SECTION AT STOCKSLAGER'S OOLITIC QUARRY.

	Ft.
Loamy clay	70
Massive Chester sandrock (Hay's farm)	6
Siliceous Chester limestone	30
Cherty Chester argillite	10
St. Louis, argillaceous limestone	40
St. Louis, gray, fossiliferous limestone	5
St. Louis, snow-white *oolitic* limestone	8
St. Louis, banded limestone	8
Massive, gray, limestone	10
Cherty argillite, with bands of limestone	80
Flint balls	10
Argillaceous limestone	30
	307

On W. G. Hay's land, adjoining, a quarry has been opened on the same strata. The product is a little coarser, and contains a few fragments of fossils, but is of excellent quality for building purposes and for burning into caustic lime. Jackson's Knob, adjoining, is supposed to be the highest in the vicinity, and, by barometer, its top is five hundred and sixty-nine feet above low water in Ohio river.

Ohio river is subject to great floods as well as very low stages. The river men at Mauckport gave the following figures to show the greatest hights attained by the floods since the historic period:

	Ft.	In.
January, 1832, above low water mark	73	0
January, 1847, above low water mark	72	6
March, 1867, above low water mark	72	0

On all the hillsides, for several miles north and northeast of Mauckport, flint balls and concretions were abundant, and many broken and partially worked specimens were seen. These flint balls vary from two to eighteen inches in diameter.

Huffman's hill, southwest quarter, section 23, township 5, range 3, is a Knob-like elevation, a monument of the solid rocks which once built up, as a level plain, this now broken and hilly region; its companion strata have been eroded and carried away. A solid band of flinty chert, fourteen to sixteen inches thick, was seen near the base and on the sides, the rocks containing many characteristic St. Louis fossils, including a delicate *Lithostrotion*, for which Prof. Herzer has proposed the name *L. mammillare*. The view from the summit will interest the geologist as well as those seeking the beautiful. In addition to the picturesque knobs of Kentucky, gaps in the Muldraugh range may be recognized, through which Salt river flows, and the broad, continued depression of the barrens plain which led the preglacial river by Elizabethtown to Nolin valley. To the north this great valley, for miles in length and breadth, is well exposed to view—better than at any other point except Pilot Knob—with its high, stony Chester bluff to the west, and, dimly in the distance, the Floyd county knobs near New Albany may be seen, composing the eastern bluff of the same valley plain. To any one interested in dynamical geology, a view from this point can not fail to be of great interest.

New Amsterdam is pleasantly located on a dry loam soil, and is a trading point for the farmers who cultivate the rich lands of Ripperden and Grassy valleys, a few miles to the east. The underground drainage of these sunken lands—they have no surface outflow of water—is by the "Blue spring," adjoining the village, where a creek boils up from a hidden channel, clear, pure and cold, and in sufficient volume to turn a mill. To the tourist this region is full of interest, and will well repay a visit, including the beautiful sunken valleys already mentioned.

Blue Island cliff, just below Kendall's Landing, is known to river pilots as "Hole in the Cliff," on account of a heavy bedded rock projecting a few feet, which casts a strong shadow and forms a shed-like recess. The following section was taken up the precipitous face of the hill:

SECTION NEAR KENDALL'S LANDING.

	Ft.
Sandy loam	33
Shale and sandstone	17
Thin bedded sandstone	40
Massive sandrock, gritstone	7
Soft gritstone	5
Calcareous shale and soft sandstone	20
"Keil" (red pudding stone)	5
Massive crystalline limestone	30
Shale	15
Gray and red laminated limestone	11
Fissile argillaceous limestone	25
Massive, gray, St. Louis limestone	25
Flinty, argillaceous limestone	26
White oolitic limestone	4
Argillaceous limestone with plates of chert	40
Cherty limestone, covered with great blocks of sand rock from the top of the cliff	75
	378

The red "Keil" was worked at McCullen's lick, near Ray's Chapel, about the year 1833. It was sawed into pencils and supplied to the limited western market, but the pocket was soon exhausted; careful search will doubtless discover more on the same horizon.

In the valley of Potato creek several outcrops of *oolitic* stone were observed, where extensive lime-kilns were formerly operated. At John Brown's mill, on section 10, township 4, range 2, two miles above the mouth of the creek, the following strata outcrop:

SECTION AT BROWN'S MILL.

	Ft.
Conglomerate and Chester sandrock	100
Kaskaskia beds of Chester group	22
Shaly clay (marl?)	18
Argillaceous limestone	15
Shaly clay	11
Argillaceous limestone	35
Flinty limestone	30
St. Louis gray limestone	40
St. Louis hard limestone	15
St. Louis white oolitic limestone	4
Cherty limestone	12
Oolitic limestone, fractured	6
	308

In passing over the county a barometer was carried and notes made of elevations, corrected, where possible, by repeating the observations, but without the aid of a station instrument or other corrections. Careful leveling may detect errors as great sometimes as fifty feet for stations remote from Ohio river or the line of railway surveys. The datum plane assumed is the elevation above mean tide of the mud-sill of the lower lock in the Louisville canal, which was determined by Stansbury and Williams (U. S. Engineers) in 1832, to be 353 feet above the ocean.

TABLE OF ALTITUDES.

Points of Observation.	Datum Planes.	
	Ocean.	Ohio R
New Albany, low water, canal sill	353	.....
Corydon	593	240
Frenchtown	741	388
Lanesville, east of	743	390
Knob summit, east of county line	960	607
Edwardsville	843	490
Palmyra, loess	711	358
Barrens	690	340
Barrens above Corydon, average, 150 feet	.....	.....
Oakland, Floyd county	983	630
Mouth of Blue river	303	.....
Mouth of Blue river, high water	373	.....
Loess loam, southwest part of county	771	468
Keller's hill, above mouth of Blue river	956	653
Keller's hill, highest summit	963	666
Brackenridge	723	370
L. & St. L. R. R. tunnel, Edwardsville	785	432
Knob at Edwardsville, above tunnel	980	527
Georgetown, on line of railroad survey	684	331
Crandell's branch, on line of railroad survey	625	272
Big Indian creek, on line of railroad survey	571	218
Big Indian creek, proposed railroad bridge	650	297
Salisbury, on line of railroad survey	683	330
Fair Dale, on line of railroad survey	673	320
Arnold's Hill	719	366
Blue river, Milltown	492	139
Milltown, bridge grade	535	182
Middletown	700	347
Elizabeth	683	330
Buena Vista	602	249
Buena Vista summit	722	369
Evans' Landing	330	.....
Mauckport	310	.....
Amsterdam	306	.....

ECONOMIC GEOLOGY.

AGRICULTURE.

In a state of nature Harrison county offered features that fairly invited the early pioneer. To the brave hunter it was a land of wild plenty. Large game was abundant. The flesh and skins fed and clothed, and, as currency, supplied every want. The fertile bottoms, "tickled with a hoe, smiled a harvest." The barrens, almost prairies in contour and freedom from trees, clothed in a luxuriant coat of grass, gave abundant pasture and forage without labor, except the gathering. Wild fruits, as the plums, grapes, haws and persimmons, walnuts, hickorynuts and chestnuts, were everywhere abundant. No wonder it was deemed a second Paradise by the fathers of our State.

Sixty years' cultivation has robbed the soil of its virgin fertility. The river bottoms, consisting of deep alluvial loam, annually recruited by spring overflows, still produce fair crops. An estimate by a well informed agriculturist places the annual return per acre from the better land as follows:

Corn, forty bushels at forty cents per bushel	$16 00
Wheat, twenty-two bushels at one dollar per bushel	22 00
Hay, two tons at fifteen dollars per ton	30 00
Potatoes, one hundred and fifty bushels at seventy-five cents per bushel	112 50
Cabbages, one thousand five hundred heads at five cents per head	75 00

On the uplands the yield is less satisfactory, and by the same authority is estimated as follows:

Corn, twenty bushels at forty cents per bushel	$8 00
Wheat, eight bushels at one dollar per bushel	8 00
Potatoes, one hundred bushels at seventy-five cents per bushel	75 00
Hay, one ton at fifteen dollars per ton	15 00

This statement includes some new, good tracts lately brought under cultivation. There are many farms long and exhaustively cropped, which yield fifty per cent. less than the above. Such minimum returns are not remunerative, and will not support the farmer and his family. For some years the question has been anxiously discussed whether it was not best to abandon "barrens" land. A few experiments with bone dust showed that to be a sure source of relief. After a continued use for several years this fertilizer is found to nearly double the crop of corn, wheat or grass, and leave in the ground the elements, in part, of other crops. Four bone mills are established in the county and doing a good business, and large quantities are also taken into the county from the mills at New Albany and Louisville. Bone dust is applied at the rate of 125 to 250 pounds per acre. A careful estimate of its benefits by a thoughtful farmer gives the following showing: In the fall of 1877 there was bought and applied to the wheat crop an aggregate of 3,330 tons, costing $30 per ton, or nearly $100,000. This was applied to 33,300 acres of wheat; with the low estimate of an increase of four bushels of wheat per acre we find the farmers who applied the bone dust have an aggregate net profit of over $33,000. With such results it is apparent that the use of such fertilizers will pay and should be encouraged. It may not be improper to suggest that the use of commercial manures, when farm products bring no higher prices than they do in this county, should be only a temporary expedient. A farm should be self-sustaining. As soon as the fertility of the soil is partly restored attention should be given to the culture of clover and the grasses, by which, with a fair rotation of crops, the fertility of the soil may be indefinitely sustained. Blue grass and timothy, which succeed so well in the center of the State, fail in parts of this county by reason of the drought and hot sunshine. Experience in Southern Indiana, Kentucky and Tennessee has shown that orchard grass (*Dactylus glomerata*), when closely seeded, will withstand drought in partly shaded ground or open fields far better than any grass above mentioned; that where a drought of four or five weeks would cause the blue grass to wilt and dry crisp, the orchard grass would be comparatively green and luxuriant. The advantage of this over other grasses are: "It can be grazed two weeks earlier in the spring; its fattening qualities are equal or superior; it affords more grazing or hay to the acre; in summer it will grow more in a day than blue grass will in a week, five or six days being generally sufficient for a good bite; it makes a permanent sward for pasturage or hay, and does not run out." A field on Blue river has furnished good pasture for twenty-five years, and in adjoining states fields of orchard grass have been continuously pastured or mowed for forty or fifty years. Not less than two bushels of seed should be sown per acre to prevent it from growing in bunches or stools.

With a mixed husbandry incident to grazing and the rearing of sheep and cattle the future of the farmer will be bright.

FRUIT.

The earliest settlers in Harrison county planted apple trees; many old apple trees were seen from two to two and a half feet in diameter. Their descendants have kept up the practice until nearly every farm has its orchard of well selected varieties. The apples are highly colored, well ripened, and the crop usually exceeds the demand. It is suggested that a canning and drying establishment would be profitable at some river point. On the elevated table lands and "flat woods" district the apple crop is usually very large, and rarely fails. Peaches bear fairly in the sandy regions and on the loamy hill tops. Grapes and the small fruits succeed well.

SUMAC.

This shrub, so extensively used for tanning, and so largely imported from Europe, is indigeneous in this locality. The leaves are gathered by women and children, dried, beaten with flails or tramped to separate the stems, and then sacked and sold at one cent per pound. The crop of 1860 was the largest ever gathered in this county, and brought about one thousand dollars.

ROAD MATERIALS.

No people can expect fair returns from their labor without commerce and means of transportation for exchanging their commodities. Good roads are indispensable for social intercourse and the enjoyment of progressive civilization. The limestones of this county furnish good materials for stone roads; they are abundant and easily accessible at all points, and should be utilized. The partially decomposed ferruginous cherts, forming the under beds of the "barrens," the remains of the eroded limestones, have been used with best success on the splendid Corydon and New Albany turnpike. No better material could be desired. Beds of the same chert transported from this region ages ago by the Ohio are eagerly sought after and utilized at Evansville and Paducah. The streets of these cities are models, and the stone with which they are covered is the common eye-sore of this its native region. It breaks into small, angular fragments, which wedge together, forming, theoretically, an arch which is compact, waterproof and almost frostproof, elastic, and in process of pulverization and disintegration the iron oxide in some degree re-cements the particles. Good roads and their economic value can not be too highly commended and urged.

BUILDING STONE.

When the developments of the future create a demand the great staple of this county will be building stone, which occurs here in every variety, comprising the ornamental as well as those of sterling useful qualities.

The buff calcareo-magnesian beds at New Salisbury were mentioned by Dr. D. D. Owen in the first report on the geology of the State. The quarry has been worked at intervals ever since. The color is a subdued, neutral tint. Directly from the quarry it is soft, and may be hewn with a broad ax or cut with a common saw, but on exposure to the air becomes hard. Samples seen in the old Capitol at Corydon and in use as door-sills and steps to residences show the satisfactory hardness and endurance of this stone after sixty years' exposure and use. The well defined, creamy, buff tint will, by harmony as well as contrast, be found desirable for ornamental work in artistic edifices.

The light gray limestone at King's Cave Quarry, and many other points in the county, is, practically as well as geologically, equivalent to the famous quarries at Salem, Bedford, Bloomington, etc. It is an elastic, compact, homogeneous limestone, capable of sustaining heavy burdens and, from the boldly escarped bluffs and exposure, known to absolutely resist for ages the action of the elements. When facilities for transportation exist this stone, equal to the best heretofore offered in the markets, will meet a good demand.

The snow-white oolitic limestone has been opened at the Stockslager quarry, near Mauckport, although it occurs in thinner ledges in other parts of the county. A chemical precipitate from an aqueous solution, it is of almost perfect purity. In color it is more brightly white than marble. It is susceptible of a high polish, and the egg-like concretions add a signal beauty and variety to the peculiar structure.

In color, beauty and uniformity it is unique, and is believed to be unsurpassed if not unrivaled. Tested by General Q. A. Gilmore, it was found to weigh nearly 150 pounds per cubic foot, and to have a crushing strength per square inch of 10,250 pounds, or more than eighteen times as strong as good bricks. The ratio of absorption is 1 to 27. An analysis made in the laboratory of the State Geologist gave the following result:

ANALYSIS OF STOCKSLAGER'S WHITE OOLITIC LIMESTONE.

	Per Cent.
Water expelled at 212° F	0.50
Insoluble silica	0.31
Ferric oxide	0.18
Alumina	0.14
Lime	54.93
Carbonic acid	43.17
Sulphur	0.25
Chlorides of alkalies	0.40
Combined water and loss	0.12
	100.00

This analysis shows it to contain 98.10 per cent. of carbonate of lime, being remarkably pure, as it contains less than two per cent. of impurities.

Colonel S. M. Stockslager furnishes the following estimate of the product of his quarry in cubic feet of stone for the years named: 1875, 500 feet; 1876, 1,000 feet; 1877, 2,000 feet; 1878, 5,000 feet.

When burned, this stone yields pure white lime, a superior article for plastering, white-washing, etc. It works cool under the trowel, giving ample time for ornamental finish. On account of its purity it is in good demand for defecating sugar and other chemical purposes on the lower Mississippi river.

At ordinary stone quarries, spawls and broken debris are a serious and costly encumbrance; here, every rejected fragment is in demand for calcination and adds to the value of the quarry, and almost insures profitable results to operators.

A dark gray limestone is seen just below the mouth of Musquito creek, near the extreme southern promontory of the county. It is homogeneous, massive, and shows in solid stratum a full thickness of fifty feet. I have never seen a stratum of limestone so much resembling granite in external appearance; from indications on the outcrop, it is almost equal to granite in strength and endurance. This stone deserves the careful attention of engineers having in charge the construction of piers, walls and foundations exposed to ice, floods and surging ocean waves. It is believed that it would fully meet the requirements of the general government improvements at the deltas of the Mississippi river. When burned it makes a strong white lime.

The sandstones of the Chester group cap the hills in the western and southwestern parts of the county. The massive beds which crop out on the bluffs of Blue river and Ohio river in Washington and Scott townships, when undermined, sometimes break off and dash down the steep bluffs, especially in the spring, when the thawing frost renders the underlying rocks weak and yielding. Many of the fallen masses still retain their sharp, well-cut angles, although the surroundings indicate an exposure to storm and ice for centuries. It is a choice stone for exposed foundations, frost and water-proof. A good grit stone, large sized grindstones, four to five feet in diameter, were obtained from Rhodes & Rothrock's quarry on Blue river, and used in manufactories in Louisville, and found to be first-class.

BRICK MATERIAL.

Clay for bricks is abundant throughout the county. At every town and village, and at many farms, kilns have been burned. The product ranges from fair to good, and some samples observed were of superior quality.

LIME.

In addition to the special mention of this important item under the head of "Building Stone," lime has been burned by log-heap and other primitive methods in every part of the county. Formerly, when flat-boats carried the commerce of the West to New Orleans, kilns for calcining the white oolitic stone lined the banks of Ohio and Blue rivers wherever that stone was obtainable along those streams, from which the burned lime was shipped as "Blue River Lime," on "Broad-horns" (flat-boats,) to the southern planter and merchant. The trade, stopped by the "late unpleasantness," has not been revived. The lime is good; none other in the valley of the West surpasses it, and if enterprise and capital could be enlisted in preparing and putting it on the market, it would soon stand at the head of the brands.

For home uses it is necessary to ask the attention of the farmers of Harrison county. Acidulous gases in water decompose limerocks, leaving insoluble siliceous materials as a residuum; of this and a small per cent. of clay the soil is composed. A few years cultivation exhausts the soluble silica of which the "bone" and bark of plants is composed, and a weak, spindling plant and barren harvests result. Sand is made soluble plant-food by the alkalies. Lime is here omnipresent and the cheapest alkali within reach. The farmer may test for himself by pouring vinegar, or any other acid, on a specimen of his farm soil; if lime is present in quantity an effervesence will take place; without lime there will be no ebullition of gases. It will be found that the "barrens'" weak soils are, although in a limestone country, almost entirely without alkaline matter. The first step in restoring the fertility of such soils is to apply lime at the rate of fifty to one hundred bushels to the acre.

CEMENT OR HYDRAULIC LIME.

The immense beds of highly bituminous shaly limestone exposed in the bluffs reaching across the great bend of Ohio river from Brown's Landing to Cedar Grove, have already been mentioned in local details. This stratum is here thirty to forty feet thick, and at localities on the river bank, so situated that cartage and elevators are unnecessary; all the costly and heavy work may be chiefly done by downcasts. For burning this rock wood is plenty and cheap; coal may be had from barges at a low figure. With these advantages, cement, which sells from one to two dollars per barrel, may be prepared for less than fifty cents. It is believed that a fairly organized company with well devised fixtures could successfully meet the river market if not defy competition.

At the same locality materials abound which, if properly manipulated, would produce an artificial cement equal to the celebrated English Portland, thus combining every department of the cement trade.

The following table gives the results of careful analyses by Dr. G. M. Levette, of the Geological Survey:

ANALYSES OF HYDRAUIC CEMENT STONES.

Name of Quarry or Owner.	Insoluble Silica.	Soluble Silica.	Ferric Oxide.	Alumina.	Lime.	Magnesia.	Carbonic Acid.	Sulphuric Acid.	Chloride of Alkalies.	Moisture at 212° F.	Combined Water and Loss.	Ratio of Bases to 100 of Silica.
Briggs	25.40	0.10	2.50	2.80	36.46	tr.	28.64	tr.	......	1.00	3.10	144.
Kintner	26.20	1.00	3.25	5.45	35.14	1.67	28.06	0.80	......	0.80	....	131.
Natural Cement	27.45	1.40	tr.	4.75	23.50	2.98	21.76	......	2.80	0.60	14.76	113.
Shackleford	10.25	1.13	1.95	2.00	46.65	0.50	36.55	0.14	......	0.25	0.58	468.
Rock Haven, top	31.00	0.35	4.20	4.40	28.60	0.43	22.47	1.20	......	1.00	6.30	114.
Rock Haven, bottom	27.10	1.10	6.75	2.40	31.00	0.66	24.35	1.80	......	0.75	4.09	151.

GLASS SAND.

These beds are marked upon the map; they are so extensive as to be practically inexhaustible. Large quantities have been used in the manufacture of plate glass at New Albany and Louisville with satisfactory results. When exposed and slightly washed it is pure and white.

KAOLIN.

In working the sand banks, pockets and beds of white Kaolin were discovered. The sand miners were not searching for porcelain clay, and disregarded the "white putty," as they termed it, from its plastic nature. At the time of my visit the deeper excavations, near the reputed horizon of the Kaolin pockets, were filled with water and inaccessible. Small fragments were seen at the banks east of Elizabeth, and at the Peters farm near Eversole Cliff. These were pure white, and almost entirely free from iron. Just east of the last point an immense stratum of Kaolin was noticed, more than fifty acres in extent; the bed is nearly continuous, and from three to five feet thick. At the exposed points it varies in color from ash gray to pale green, pink, red and dark brown, the first colors predominating. A sample of the green variety, analyzed by Dr. Levette, gave the following result, and, for comparison, the analysis of a remarkable pure specimen from Lawrence county is also given:

ANALYSES OF KAOLIN.

	Harrison Co.	Lawrence Co.
Water	9.00	14.00
Silica	58.70	46.00
Alumina	26.00	36.00
Ferric oxide	5.50	3.00
Magnesia	0.80 }	1.00
Lime	None }	

This extensive bed will, it is believed, prove of value for making yellow ware, tiles, water-tubes, fire-bricks, ornamental terra cotta ware, and, perhaps of more importance, as an addition in manipulating artificial cements.

The beds of glass-sand and kaolin are found along the margin and deeply sunk in the "flood plain" or "flat woods" border of the pre-glacial river valley. The rule is so persistent that the inference seems irresistible that their origin is due to the circumstances which gave rise to that valley. This rule prevails southward in Kentucky as well as here, indicating a great breadth of energy, somewhat analogous to the very ancient river channels filled with gold-bearing gravel in California, which, with many windings, run in general direction north and south, and at right angles to the present rivers, but whose waterless beds are now elevated on the sides and crests of the mountains high above the actual water courses.

GAS SPRINGS AND SALT BRINE.

Gas springs are noted as being found in the bed of Ohio river at two points, having a well defined line or trend from northeast to southwest; the scanty information available fosters the inference that this line is continuous between these points. A line of dots is marked on the map of Harrison county approximating the trend of gas springs. It is probable that bores to a depth of 600 to 800 feet along this line will, in many cases, discharge salt water, together with more than enough gas to evaporate the brine. In every case thus far tested the supply of gas is largely in excess of the quantity needed for that purpose, and may be utilized for generating steam, light, heat, burning lime and cement, baking pottery, etc. It is a grand and inexhaustible fund of power and wealth, and should be utilized. Special points on this matter are given on a preceding page under local details.

WHITE SULPHUR WATER.

The white sulphur well at Corydon merits, and has for many years maintained a high reputation. Hundreds of visitors bear unqualified testimony to its remedial powers. It is believed to be a specific in cases of dyspepsia, rheumatism, chronic neuralgia and other diseases which owe their origin to malaria. Certificates from persons of repute show that it is remarkably efficacious in scrofula, sore eyes, affections of the skin, liver and kidneys; ladies, after years of suffering, are happy in advising the use of this water.

A qualitative analysis by T. E. Jenkins, M. D., shows the following constituents:

ANALYSIS OF CORYDON SALINE SULPHUR WATER.

Specific gravity, 1.0077; salts in one wine gallon, 450.88 grains.

Gasses in solution: Carbonic acid and sulphuretted hydrogen.

Salts in solution: Bicarbonate of soda, bicarbonate of magnesia, sulphate of soda, sulphate of magnesia, sulphate of lime, chloride of sodium, chloride of magnesium, chloride of calcium and silica.

Springs of a similar water are found in the bed of Buck creek, three miles southwest from Middletown, and may be reached by bores at many points in Taylor and Boone townships.

CAVERNS, ETC.

The caverns of this county, although not extensive, are full of interest and beauty, and will fully repay the tourist or pleasure seeker for a trip during vacation. In fact, residents of cities could enjoy, without much expense, a week of rambling among the health giving hills and valleys, surrounded by ever changing scenes of interest and beauty, in this county in a much more profitable manner than in long, expensive wanderings in more distant regions.

On the excellent turnpike from New Albany to Corydon the naturalist will be interested in the fossil beds at Edwardsville, Lanesville, Myers' Hill, near Breckenridge, as well as Yocum's and King's caves. At Corydon, Pilot Knob and Martin's hill afford extensive outlooks; Keller's Hill is a first-class illustration of coal measure life. Rhodes' and Borden's caves, and the Harrison and the Blue spouting springs, on the road to Wyandotte Cave, are attractions which no Indianian can afford to ignore.

ARCHÆOLOGY.

No earthworks characteristic of a pre-historic race were seen in this county. The only evidence of their presence, and that not conclusive, was the finding of a single beaten copper implement, with a few totums, ornamental gorgets and pendants wrought from the chloritic slate or "striped stone" of the northwest, so much affected by that race, and a few arrow points which, from their aged appearance and form, are peculiarly "Mound Builder."

To the second or intermediate race between our savage, nomadic Indians and the Mound Builders is attributed the bone or shell banks below New Amsterdam, the stone graves at Kendall's Landing, the village site long occupied as a permanent residence by an agricultural people, and the peculiar flint implements attributed to the race of "bow-legged fishermen."

One mile below the village of New Amsterdam, and immediately below the mouth of Indian creek, is a mound containing human bones, flint chips, broken pottery and burned stones. Half a mile down the river is one of the large shell mounds, a mass of river and land shells, with a few nearly decayed bones of buffalo and other wild animals common to this country at that date. It is one hundred and seventy yards long, ten yards wide at one end and eighty-five yards wide at the other end, which was least disturbed by undermining currents of the river, and two to six feet deep. At places the bank is nearly a clean mass of shells, but the bed is generally throughout profusely sprinkled with flint chips, spawls, cores, broken knives and various implements, with many rounded mallets and pounders of granitic stone, and occasionally a pick-hammer of hard, specular iron ore for splintering flints. Many of the pounders and other stones had been reddened by fire, and at several points the shells showed that fire had been built upon them. The whole mass plainly indicated the hand of man; many of the mussel shells showed an old fracture at the edge, made in opening. Mr. George Wolf, of New Amsterdam, has known this locality for half a century, and says that from fifty to one hundred and twenty feet of the river side of the heap has been undermined and removed by high water in Ohio river. Back of the mound is a perfectly level area of two and a half acres, over which were seen many flint and stone implements, defaced or broken, as if relics of tools in daily use.

The large amount of shells, bones, etc., but particularly of broken flints, seem to indicate the permanent village of a resident people; the locality accommodated them with cold spring water, good fishing, rich, alluvial loam for cultivation, with forests of game immediately adjoining in the high hills along Indian creek.

The last race of savages were skilled artizans in working flint; on every hillside and plain their implements of war and the chase are found, the latter especially adapted to killing the kind of game sought or expected. To their implements, judging from the known and probable effects of exposure and time, we may estimate an age varying from two hundred to eight hundred years.

FLINT QUARRIES.

The question has been well asked, "Where did the Indians get the material for their flint implements?" Evidences seen in this county offer direct and conclusive answers. Alleged silver and lead mines, garnished with all the unreliable embellishments of the red man's traditions, were confidently believed in. The fact that, after their migration to the west, delegations had been known to return light and go back loaded, seemed proof of hidden wealth. Their habits were secretive. Secrecy is mystery, and mystery more alluring and seductive than unveiled fact.

Visiting the reported "diggings" on the farm of Ph. Blume, northwest quarter, section 19, township 4, range 3, on the west side of Indian creek, Scott township, a line of pits, one to three feet deep, nearly connected, and four to ten feet long, were discovered. The sides of these pits having crumbled and fallen in under the action of frost and rain, they were no doubt at one time, much deeper and wider than at present. The horizon is in the upper half of the St. Louis limestone and twenty feet below the oolitic bed, and at outcrops shows a band of clay crowded with slightly flattened balls of dark flint. A careful examination showed this to be the article sought. Around the pits and in the debris were found great quantities of flint balls with pale brown or bluish-gray interiors. Taken fresh from the quarry and tested with a smart blow from a hammer, it was found to break away in level cleavage, first from top and bottom, then, with some practice, this flattened section of a sphere could be cleaved in straight lines perpendicular to the plane of deposition. The miners had been governed by these facts. A blow on the upper or lower surface would disclose any existing imperfections, and if any were found, as a white or crystalline core, it was thrown aside. Such rejected specimens, showing imperfections, were numerous. Geodes and hard pieces of granitic or porphyritic stone were used as hammers. Thin plates and spawls of limestone, found in the pits, were evidently used as hoes or picks in the excavation. At a little distance flint chips and splinters were so abundant as nearly to cover the ground. Some cores were seen showing the cleavage of from five to seven splinters for their angular sides, and indicating the mode of preparing the strips from which knives, awls and points were made by the skilled flint-worker. Many of the spawls and imperfect implements exhibited chafed or serrated edges, showing use as scrapers by the workers in wood. The overshadowing forest was principally of oak, from 100 to 400 years old, without scar or mutilation, indicating a new growth since mining was carried on. Blocks of limestone adjacent, judging from the amount of spawls surrounding them, had been used as anvils. Select materials were carried to their village homes in the shape of sectional blocks and cores, to be wrought into spears, knives, daggers, drills, rimmers, hoes, arrow-points, etc., etc., by masters in the art. At the village site, around a spring in Blume's bottom field, the fine chips and splinters cover the ground and may be measured by the wagon-load. This material can be worked successfully only when fresh from the quarry, while it still retains an excess of water, which is soon dissipated on exposure to the air. On losing its moisture the flint becomes obdurate and difficult to work. To prevent the escape of moisture the blocks and cores, when carried away, were buried in damp earth until the workmen were ready to chip them into desired shapes.

The quarry pits cover a space three rods wide, and extend half a mile around on the foot of the hill. Another row of pits of equal extent occurs on the neighboring Kintner farm. From the evidences seen one might infer that flints enough to satisfy the wants of the savage hunters and warriors of the interior of the continent for a century had been mined here. Similar quarries were noticed near Mauckport.

THANKS.

Acknowledgements are due to many citizens of the county who assisted with facts and information. Thanks are here tendered for hospitality and special aid to Dr. J. C. Clark, Dr. H. H. Wolf, Colonel B. Q. A. Gresham, Major Thomas McGrain, Colonel S. M. Stockslager, Cortes M. Miller, S. D. Blackburn, B. P. Douglas, Eli Crabill, William Hancock, Hon. George W. Denbo, Noah Rhodes and brother, James P. Kintner, William Kintner, W. S. Eversole, Captain E. Knight, S. J. Wright, John Brown, George K. Green, Judge Slaughter and a number of others whose names have escaped memory.

CRAWFORD COUNTY.

Crawford county is bounded north by Orange and Washington counties, east by Harrison county and Ohio river, south by Ohio river and Perry county, and west by Perry and Dubois counties. It was organized in 1818, and contains 320 square miles, or 204,800 acres.

Leavenworth, the seat of justice, is situated on the alluvial bottom of Ohio river, just within the high water line, and is 126 miles south from Indianapolis. The great curve of Ohio river, on which Leavenworth is situated, is known to steamboat men as "Horse Shoe Bend."

The surface is very uneven and broken. The bluffs of Ohio river are generally steep or precipitous, rising 300 to 500 feet above the bottom lands, which are very narrow. Great Blue river washes the eastern border, and furnishes valuable mill sites and water power. Little Blue river and its many irregularly diverging tributaries drain the central areas from north to south. Patoka river and Anderson creek have their rise in the high north-south ridge of conglomerate table lands, with drainage to the west, and empty their waters into Wabash and Ohio rivers. Each of these streams have their beds in narrow, canon-like valleys, with steep or precipitous bluffs from 100 to 400 feet high.

The principal villages are Magnolia, Milltown, Springtown, Brownstown, Hartford, Grantsburg, Marietta, Alton and Fredonia. The narrow bottoms which border the streams are extremely fertile, producing good crops of corn, wheat, grass, potatoes and cabbages. The Loess plateau, which stretches out an almost level, unbroken area of table land from below Fredonia to Springtown on the north, and from near Grantsburg to the bluffs of Blue river on the east, has a peculiar soil; with careful husbandry, attention to drainage and rotation of crops, good returns of hay, corn and wheat reward the farmer. In the sandstone hills the soil is thin, and the best crops are none too good. Over all the uplands fruit trees are healthy, bear well, with rarely a failure.

GENERAL GEOLOGY.

The rocky exposures in this county belong to the carboniferous age, and comprise the lower or conglomerate member of the coal measures and the Chester and St. Louis groups of the sub-carboniferous period. Bores and deep wells cut through the Keokuk and Knobstone groups, and have pierced the black slate or upper member of the Devonian formation. The different beds and outcrops, brought together in connected section from widely separated stations and from bores, give the following stratigraphic exhibit:

CONNECTED SECTION OF CRAWFORD COUNTY.

QUATERNARY AGE.

Alluvium	70 to 150 ft.
Fluviatile drift and terraces	30 to 400 ft.
Lacustral beds—Loess	10 to 40 ft.
Glacial drift	0 to trace.

CABONIFEROUS AGE—CARBONIFEROUS PERIOD.

COAL MEASURES.

Conglomerate sandrock	10 to 120 ft.
Ferriferous, pebbly sandstone	0 to 5 ft.
Shale with plant remains	0 to 1 ft.
Coal A	1 to 4 ft.
Stigmarial fire-clay	3 ft.
Bituminous, pyritous shale	25 ft.

SUB-CARBONIFEROUS PERIOD.

CHESTER GROUP.

Kaskaskia limestone, upper bed	2 to 10 ft.
Black pyritous shale (marl?)	1 to 25 ft.
Kaskaskia limestone, lower bed	5 to 20 ft.
Massive sandrock, passing to shales and flagstones	20 to 98 ft.
Argillaceous limestone in bands, with pockets and partings of gray and blue flint	10 to 26 ft.
Coal-bone	trace to 1 ft.
Siliceous limestone and argillite	2 ft.

ST. LOUIS GROUP.

Brown pyritous limestone	2 ft.
Argillaceous limestone, with flint	11 ft.
Gray limestone and silicious argillite	8 ft.
Buff magnesian limestone	3 to 8 ft.
Buff and gray limestone in thin beds	39 ft.
Hard brown limestone in massive layers	38 ft.
White *oolitic* limestone	3 to 15 ft.
Gray and brown limestone	35 ft.
Argillaceous limestone	40 ft.
Limestone in bores	150 ft.

KEOKUK GROUP.

Keokuk limestone in bores	80 ft.

KNOBSTONE GROUP.

Knob shales and sandstone in bores	450 ft.

DEVONIAN AGE.

HAMILTON GROUP.

Black slate in Ott's bore	110 ft.
Total	1,916 ft.

RECENT GEOLOGY.

The recent geology shows the energetic erosive and denuding agencies at work since the surface was elevated, as a great, nearly level plain, above the surface of the Paleozoic sea. It exhibits many valleys cut out of solid rock 200 to 500 feet deep, with side deposits, and although they may not be of pronounced type, yet they give an interesting chronological abstract of the history of this part of the earth during vicissitudes incident to periods of extreme arctic cold, great precipitation of moisture, alternating with temperate and tropic warmth.

ALLUVIUM.

The river and creek bottoms which border all the water-courses are due to causes now in action. They are composed of materials more or less comminuted, derived by disintegration and pulverization of the older rocks, mostly from the strata in the immediate neighborhood, but still largely imported from the head-waters of rivers and smaller streams. Soil composed wholly of materials from a single rock formation is, as a rule, not remarkable for fertility, while a soil made up from many different formations is, as a rule, fertile; hence the remarkable productiveness of bottom lands. Each overflow builds up the flood plain and adds to the deposit.

While ancient flood plains of dead rivers and creeks are found on high levels, as in Harrison county, adjoining on the east, it was found in boring the artesian well at Louisville, that at one period the channel of Ohio river was where the city now stands, south of and around the present falls. This channel, now filled up with alluvial sands, gravel and earth, was over 100 feet deep. From a number of test bores, it is known that Ohio river, from near the mouth of Salt creek to its upper tributaries, runs in a valley which has been cut more than 150 feet below the present river bed.

FLUVIATILE DRIFT AND TERRACES.

These deposits form benches on the bluffs of creeks and rivers, and mark the standpoints where for a considerable period such streams flowed at a single level. They range from near the present water level, decreasing in magnitude, to the tops of the highest plateaus, where such streams began their existence in poorly defined channels. Although these terraces are but slightly developed here, on the upper river and in regions covered with heavy deposits, they form remarkable landmarks, and have been noticed as parallel roads on opposite sides of valleys, or as ancient earthworks.

LACUSTRAL BEDS OR LOESS.

The Glacial Period was followed by an oscillation in the earth's crust, depressing areas to the north or elevating those to the south, forming a series of great lakes.

The great southern lake covered considerable sections in Southern Indiana and larger districts to the southwest. A shallow arm reached over part of Crawford county. The peculiar deposit called *Loess* was formed in the waters of this lake or along its shores, and on the banks of quiet, almost currentless rivers which flowed into the lake. This Loess bed consists of impalpable siliceous material and sand, containing a very small amount of clay, ferric oxide, etc. It is an ash gray color when dry, and forms a compact, retentive soil, well adapted to the growth of grasses; when drained good crops of corn, wheat, oats, etc., are produced. It is especially suited to fruit. Persimmon trees flourish on this soil. Animal and vegetable remains found in this deposit indicate a tropical warmth similar to the present climate of Cuba and Central Mexico.

GLACIAL DRIFT.

Preceding the Lacustral period occurred the Glacial or "Great Ice Age." Intense cold prevailed, accompanied with heavy precipitation of moisture. Existing facts show that the northern and central parts of the State were covered with a great sheet of ice, hundreds of miles in width, more than a thousand miles long, and from one hundred to four hundred feet thick. Alternations of temperature, slight warmth and intense cold, gave this glacier a motion from the center of extreme cold toward the south. Having its initial impetus among the granitic rocks of northern British America, it carried, clasped firmly to its icy bosom, immense rocks or boulders, gravel, sand and clay. These, thrown off or dropped at the southern, melting foot of the glacier, formed beds ranging in thickness from a few feet to two hundred and fifty feet. This deposit is termed the Boulder Drift. In this county but few indirect evidences exist of the ice age; they consist of minute, well worn pebbles found in the bed or on the banks of Blue river, rolled by the running water along the bottom of that stream, and the dark, hard granitic stones and pebbles found near Ohio river. Still back of the Glacial Age was a long period which, from evidence elsewhere reported, was of temperate if not tropical warmth. The data for the geological history of that period are not well ascertained or studied. A few facts and deductions may be seen in the Geological Report on Harrison county in this volume.

PALEOZOIC GEOLOGY.

CARBONIFEROUS AGE AND PERIOD.

COAL MEASURES.

The paleozoic rocks have been deposited in an ocean varying from the shore line to miles in depth. The animal remains are almost exclusively marine. The coal measures existing in this county comprise only the Conglomerate Sandrock or lowest bed of that formation. They are the surface rocks in the western part of the county, extending eastward across the center to and into Harrison county. They fill a paleozoic sub-aqueous valley or gulf terminating in a point at the east, but broadly widening and becoming deeper in its western extension.

The Conglomerate (equivalent of the Millstone grit) of English geologists is here a massive or laminated sandstone containing few or none of the pebbles usually characteristic. The material is coarse-grained, requiring a current of some velocity to transport the particles; it generally exhibits much false bedding, indicating a stormy sea with strong waves breaking over the shallows of the shore line. The conditions were unfavorable for the perfect preservation of animal and vegetable remains. Several trunks of *Sigillaria, Lepidodendron, Stigmaria* and *Calamites* were observed in imperfect condition. Fern fronds and the broad striated leaves of *Cordaites* in fragments were noted, with an excellent specimen of *Trigono-carpum,* by some recognized as the frint of Sigillaria.

Coal A is found near the base of the Conglomerate; it varies from a mere trace to a little over one foot in thickness; is of medium quality, burning with a yellow flame and sulphurous odor to a red ash, containing much cinder. At other localities it is so impure and pyritous as to be utterly worthless. The outcrops are thin, and can be worked only by stripping. There is no probability of the seam being found of workable thickness in areas of any extent. The supply can only meet a small local demand. At a few points a limestone, carrying fossils, overlies this coal, and generally the superimposed bituminous slate is filled with nodules which contain a few fossils of the Coal Age, as *Productus longispinus, P. semireticulatus, P. cora, Spirifer cameratus, S. lineatus, Athyris subtilita,* with a few gasteropods, etc. In Dubois county, adjoining on the west, a fragment of a giant fish was found at this horizon, and is mentioned by Dr. Newberry in his description of fishes on page 347 of this volume, and known as *Edestes vorax.*

The fire clay, underlying coal A and the occasional seam B, will furnish good material for bricks, tiles and terra cotta work. The scenery is wild, and the surface is a succession of high, steep hills and deep valleys, clothed with a medium sized growth of oak timber.

CHESTER GROUP.

This group is well exhibited. It lies beneath the Coal Measure series with a wide margin extending beyond and bordering them. The rocks vary much at different stations. Two sections nearly alike could not be taken at any stations a few miles apart. The connected section gives the average strata at the southern line of the county and along the northern line of the deep sea valley mentioned heretofore in the extreme northeastern part of this county and in the southern part of Orange. A little north of the center, and especially in the vicinity and east of Mt. Prospect, and thence in the direction of Pilot knob, the Kaskaskia is the only limestone present; the other limerocks and the massive ledges of sandstone are replaced with soft mud shales. This circumstance shows that limestone forming animals prevailed only along the shore lines in water of a suitable depth, as is the law in the present seas, while the deep central areas were built up more slowly by sedimentary deposits. It will be seen in comparing the thickness of strata here with those of Harrison county that the rocks of each group are here thicker than in that couuty; or, as we pass from the original shore line near Cincinnati, each succeeding stratum thickens up as it dips to the central ocean depths in south Central Illinois.

The Kaskaskia limestone is everywhere persistent, and is usually rich in characteristic fossils. *Productus*, *Spirifera* *Athyris* and *Pentremites* are abundant, as *P. godoni*, *P. pyriformis*, *P. obesus*, *P. sulcatus* and *P. symmetricus*. *Zaphrentis spinulosus* and the central axes of *Archimedes* are common, with a few Crinoid heads and stems, including specimens of *Poteriocrinus* and *Dichocrinus*. For a more complete statement reference is made to the full list given in report on Harrison county, page 313 of this volume, which includes vegetal as well as animal remains.

Immediately above and below the Kaskaskia rocks are beds of black pyritous shale, which readily and quickly disintegrate on exposure. The destruction or pulverization of these beds forms a dark, tenaceous material, pulverulent when dry, so fully charged with copperas (ferrous sulphate) and other salts that the deposits are quite barren of vegetal growth. These barren spots are locally named "glades." The black, decomposed shale was supposed by some persons to contain a large amount of potash (eighteen per cent.,) and hence would be valuable as a fertilizer for thin soils. Analysis discovers no appreciable amount of alkali in this shale, and on trial it was found to benefit sandy soils just as any clay would, and no more.

The sandstone division is well developed in the outcrop on the river bluff west of Leavenworth, at Indian Hollow. Many of the strata are heavy-bedded or massive. It is an excellent building stone; fresh from the quarry it works soft and hardens on exposure, and may, by skillful workmen, be broken or split in cubes or blocks of any shape and of any desired size. It is a superior grit-stone, and should be utilized.

The limestones at the base of the Chester are argillaceous, contain but few fossils, and are of no great economic value. A coal-bone at this horizon is of great persistence, showing itself in Orange, Lawrence, Owen and other counties. It has attracted the attention of many persons who wished to find coal, and much money has been wasted in shafting and drifting on this stratum. It is of no economic value, and is only useful in pointing out, pretty nearly, the dividing line between the Chester and St. Louis rocks.

ST. LOUIS GROUP.

The heavy-bedded limestones with intercalated beds of clay, belonging to this group, form the lower part of the bluffs of Great Blue river and its tributaries, exposing a considerable thickness at Milltown; thence southwest the exposure is gradually thinned as the strata dips toward the centre of the synclinal axis of the trough in which is deposited the Conglomerate Sandrock, between Wyandotte Cave and Cole's Bridge on Blue river, from whence, rising with the reversed dip, the thickness exposed to view is increased to Ohio river. Passing down the river, around the great Horse Shoe Bend, the St. Louis rocks descend below the level of the water, by reason of the river having its course turned back, or southeastwardly, against the dip of the rocks. It reappears above and below Sheckel's bar, finally disappearing at low water mark at Alton. The strata vary greatly in thickness and character. A section taken at one point can not be duplicated at any other. At many stations the rocks are so exactly similar to the overlying Chester or the underlying Keokuk limestones, that, from their structure, it will be almost impossible to determine to which group they belong. They are distinguished and determined alone by their fossils. But few of the Coal Measure fossils reach down into the Chester. But few of the Chester animals survived until the coal age, nor are they found in the lower beds. A majority of the St. Louis fossils are peculiar to the conditions which prevailed during that period, and are not found, in any case whatever, in more recent or older rocks—in higher or lower strata.

The buff magnesian limestone which is found twenty to forty feet below the top of the St. Louis is equivalent to the New Salisbury quarry in Harrison county, mentioned by Dr. David Dale Owen, on account of the facility with which it may be cut or sawed when fresh from the quarry. Specimens seen in use at Corydon Court House indicate that it hardens on exposure and wears well. It has been suggested that it would, with proper manipulation, make a natural cement without burning; for chemical composition see "Natural Cement," in "Table of Analyses," page 83 of this volume.

The white oolitic limestone has long been well known for the superior pure white lime it yields when burned. Chemical analysis shows this to be an almost absolutely pure carbonate of lime. Its most valuable quality is for building purposes. It is homogeneous, elastic, capable of bearing heavy burdens, and the delicate creamy white color will effectively contrast with other available material.

In years gone by, when flat boats were the principal means of transportation, large quantities of this stone were calcined and shipped to New Orleans for clarifying sugar and other purposes on the southern plantations. At present this highly remunerative business is entirely neglected.

The fossils of this group are not abundant as they were found in Harrison county, in the report of which a full list is given.

Aulopora, Syringopora, Zaphrentis and *Lithostrotion proliferum* were common, while *L. canadense* was but rarely seen; many *Bryozoans* and *Favestella* were observed, all in fragmentary condition; crinoid heads were not abundant, but included the following genera: *Dichocrinus, Batocrinus, Zeacrinus* and *Poteriocrinus missouriensis, Pentremites conoideus* and *P. koninckianus,* which are peculiar to this group, were found in almost every outcrop. *Streptorhynchus, Orthis, Productus cora, P. punctatus, P. altonensis, Spirifer keokuk, S. pseudo-lineatus, S. suborbicularis, Athyris hirsuta, A. royissii, Retzia, Rhynchonella,* and *Terebratula; Lamellibranchs* were uncommon; *Allorisma* were found only in a broken condition; and, in fact, all frail shells, especially *Gasteropods,* were seen only in minute pieces.

A single well preserved specimen of a tribolite (*Phillipsia*) was exhibited by Dr. Hawn from the St. Louis division of the Leavenworth bluff. The paucity of fossils, compared with Harrison county, may possibly be attributed to the fact that these rocks were deposited farther from the shore line to the east, of the St. Louis ocean, in a sea rapidly deepening toward the central areas, and that here the depths were too great for the survival of many animals which flourished in a zone or level nearer the surface.

The rocks of the Keokuk and Knobstone groups and the Hamilton beds of Devonian age are not exposed, but occur in regular descending sequence, as noted in the Connected section, and as found in the different deep wells bored at many different stations throughout the county.

The following table of altitudes is based on the levels of Ellett's survey of Ohio river and other western streams. The altitudes given are calculated from a single set of uncompensated barometric observations and are, therefore, liable to error. Those on the line of the proposed Air Line Railroad are exceptions, and were copied from the field-notes of the engineers of the railway:

TABLE OF ALTITUDES.

Points of Observation.	Low Water.	Ocean
Leavenworth, low water in Ohio river	......	303
Leavenworth, high water	70	373
Leavenworth, Kelso Knob	425	728
Milltown, Blue river	89	392
Milltown, west bank	120	323
Milltown, railroad grade	132	485
Whisky run, second crossing	170	473
Thirty-mile summit	168	471
Hartford	92	395
Little Blue river valley	75	378
County line, west side, railroad crossing	397	700
County line, west side, on hill top	415	718
Knight's hill	525	828
Ott's well	197	500
Pilot Knob	587	890
Tar Spring	303	606
Fessler Knob	497	800
Chestnut oak ridge	570	873
T. Robinson's, Loess	420	723
Eaton sulphur well	80	383
W. P. Everden's residence	453	756
Lacustral loess	......	735
Lacustral loess	......	725
Lacustral loess	......	750
Lacustral loess	......	710
Wyandotte Cave House	270	573
Loess ridge north of cave	440	743

LOCAL DETAILS.

Leavenworth, the seat of justice and commercial centre of the county, is situated on the north bank of Ohio river, and is a landing point for the mail and packet steamers. Wharf-boats and warehouses are arranged for receiving and shipping merchandise and farm products. The principal articles of export are staves, oak lumber, corn, wheat, hay, onions, potatoes and nuts.

A bold, precipitous bluff presents a mural background, and from a little distance seems to overhang the town. The river approaches with a northwesterly course and, striking against a sandrock wall at Indian Hollow and Fredonia, sharply turns about to southeast, so that the signals of ascending steamers may be heard for hours before they are in sight. The bluffs on each side are equally marked and precipitous, and so closely approach as to show that Ohio river is here presented flowing in a canon-like valley, so narrow that in time of high water the confined river rises to an extreme hight. Nathan M. Morgan, Esq., who has resided here since 1824 and observed the periodic overflows, reports that the flood of 1832 was the highest known, and that it reached a point sixty-nine feet eight inches above low water of September, 1833. The high water of 1828 was eight feet lower, that of 1851–2 seven feet six inches, and that of 1847 ten inches lower than that of 1832. The low water point during the drought of 1848 was ten inches above the extreme low water of 1833. At a medium stage, ten feet above low water, the width of the river at Leavenworth is 1920 feet, and of the valley, from bluff to bluff, 3,960 feet.

During the oil excitement a bore was put down in the eastern part of the town to a depth of 235 feet, which discharges a small amount of sulphuretted, chalybeate water; if the bore had been continued to a greater depth it is probable that it would have reached the level of the white sulphur water, so delightful and healthful for drinking and bathing. In the western part of the town, in a secluded cove, a blue spring boils up from its cavernous home in the underlying rocks, forming a well over three feet in diameter, and flows away with a rapid current. After a heavy rain the spring is changed to a violent spouting torrent. The banks of the Cave spring and adjoining alluvial lands are shaded with black walnut and honey locust trees, which are covered with the parasitic mistletoe in sufficient abundance for all lovers' escapades.

The outcrop on the hill above the Blue spring, taken at the best exposed points, gives the following:

SECTION AT LEAVENWORTH.

COAL MEASURES.

		Ft.
1.	Sandy soil	6
2.	Conglomerate shaly sandstone	43
3.	Conglomerate, massive, ferruginous sandstone	9

CHESTER GROUP.

4.	Kaskaskia limestone, with fossils	17
5.	Covered clay shale	11
6.	Clinky red limestone	9
7.	Pyritous shale	19
8.	Sandstone, with much false bedding	8
9.	Blue argillaceous limestone, with fossils	21
10.	Shales and thin sandstone	18
11.	Coarse and fossiliferous limestone	9
12.	Siliceous and clay shale	18
13.	Sandstone, good grits	6
14.	Siliceous and clay shale, with fossils	19
15.	Brown argillaceous limestone, with Chester fossils	11
16.	Siliceous shale, with plates of sandstone	5
17.	Soft, coarse, yellow sandstone	6
18.	Argillaceous limestone, with bands and pockets of chert and fossils	25
19.	Coal bone ... 2 inches	
20.	Siliceous limestone and argillite	2

ST. LOUIS GROUP.

21.	Brown pyritiferous limestone	1
22.	Gray limestone, with pockets of flint	14
23.	Buff magnesian limestone	3
24.	Gray limerock	3
25.	Brown limerock, with plates of flint	23
26.	Buff argillite	4
27.	Siliceous argillite	5
28.	Gray lithographic stone	21
29.	Buff magnesian limestone	4
30.	Hard brown limerock	48
31.	White *oolitic* limestone	3
32.	Covered to low water in river	45
	Total	436

No. 4 of the above section contains *Pentremites sulcatus*, *P. pyriformis*, *P. Globosus*, *Productus cora*, *Zaphrentis spinulosus* and *Archimedes.*

No. 9 contains *Pentremites pyriformis*, *P. sulcatus*, *P. godoni*, *Zaphrentis spinulosa*, *Chonetes*, *Spirifer keokuk*, *S. kentuckensis*, *S. lineatus*, *Productus punctatus*, *P. cora*, *P. semireticulatus*, *Athyris subquadrata*, *Terebratula bovidens*, *Archimedes* and *Bryozoans.*

No. 18 contains *Athyris*, *Spirifera*, *Terebratula*, *Producta* and *Streptorhynchus.*

A good bed of Chester fossils are exposed at the top of Cole's hill, west of the cemetery, and near the graded school. The following named St. Louis fossils were observed in the white oolitic bed and adjoining strata: *Streptorhynchus crenistriatus*, *Orthis dubia*, *Productus cora*, *P. punctatus*, *Spirifer keokuk*, *S. pseudo-lineatus*, *Athyris hirsuta*, *A. royissi*, *Terebratula formosa*, *Euomphalus spergenensis*, *Cyclonema leavenworthana*, *Phillipsia*, *Cythene*, *Pentremites conoideus* and *P. koninckiana.*

The summit of Leavenworth hill is known as Kelso's Knob. The soil is warm and sandy and well adapted to the growth of tender fruits and flowers. The view comprises the great ox-bow bend, where the river seems mapped on the deep valley, over 400 feet below, and the isolated knobs, ten miles distant, are so relieved by contrast with the sky as to appear close at hand.

East of the town, 215 feet above low water in the river, the parting of "coal bone," which occurs so persistently near the junction of the Chester and St. Louis groups, is exposed. About the year 1851 the citizens made up a subscription and employed a practical miner to drivė an entry two hundred feet back on the seam, hoping, without reason, that it would thicken up under the hill, but, to their disappointment, it nowhere reached a greater thickness than two inches. There is no workable coal at this horizon.

On the land of O. S. Leavenworth, on the high bluff at the mouth of Blue river, the massive sandstone of the Chester group furnished choice blocks of stone for the piers of a bridge over Dry run. The following section was taken at this point:

SECTION AT O. S. LEAVENWORTH'S.

	Ft.
Slope	30
Hard limestone	11
Shale	10
Red limestone	3
Blue and red shale	18
Chester limestone	12
Clay and shale	3
Quarry sandrock with Stigmaria	8
Limestone and shale	12
Coal bone	trace ...
St. Louis limestone and clays	226
	333

At Indian Hollow, over a mile below town, the Chester sandstone, which at Leavenworth is only a few feet thick or scattered in thin strata of siliceous shales, are here brought together and form a cliff of valuable sandrock, which opens to deep, navigable water of Ohio river. The dip of the rocks from Leavenworth to this point is at the rate of sixty feet to the mile, so that the equivalent strata are here more than eighty feet nearer the water level. The following strata were seen:

SECTION AT INDIAN HOLLOW.

	Ft.
Sandy loam	15
Conglomerate sandstone and shales	50
Kaskaskia limestone and shales	65
Laminated sandstone in quarry beds	30
Chester limestone and shale	46
Massive, quarry sandrock—gritstone	40
Shaly sandstone	12
Chester limestone	77
St. Louis, covered	25
Total	360

This bed of sandrock is of excellent quality for foundations, piers, breakwaters, and makes good grindstones. It may be readily broken or split to any desired shape. Exposed surfaces of this rock, 100 to 150 feet above the present level of the streams were heavily cut and moulded ages ago. The faithfulness with which they are preserved show the enduring qualities of this stone under a diversity of circumstances and ages of time; not less significant is the fact that perpendicular faces are covered with mosses and clinging lichens, not seen on perishable rocks.

The Hollow was a favorite resort of the Indians, and at the top of the hill treasure hunters have opened many stone graves. Broken flint implements are strewn over the ground.

Needham's quarry, on section 1, township 4, range 1 east, just below, presents nearly the same outcrops. It opens its massive bed of sandrock, forty feet thick, immediately upon the navigable waters of Ohio river. It is excellent stone, and may be sawed, split or broken into blocks from one to twenty or more feet square. It was formerly worked by chisel, saw and lathe, by a Louisville firm, and has been used for grindstones on farms and in machine shops, in sizes from one to ten feet in diameter, and gave good satisfaction. The lower bed is slightly ferruginous, and, although soft in the quarry bed, soon hardens on exposure. Its fire and waterproof qualities make it of great value as a building material. The precipitous bank retains corrugations made by Ohio river at points 160 to 190 feet above its present level, which are unimpeachable witnesses of the enduring nature of the stone.

Fredonia was formerly the county seat. It is surrounded by a fertile *Loess* plain, level as a prairie, and extends with scarcely a break to Grantsburg, Springtown, Milltown and Wyandotte. A high bluff separates the village from the river, in which many well preserved fossils occur. Near the top of the hill the Conglomerate Sandrock exhibits much false bedding with water-faces to the southwest, indicating that the deep center of the sea in which it was deposited to have been in that direction. The Chester sandstone near the base of the bluff has long been worked by Mr. Chandler, who manufactures grindstones of excellent quality.

SECTION AT FREDONIA.

	Ft.
Soil	12
Soft, flaggy, Conglomerate sandstone	33
Kaskaskia limestone	20
Sandstone	16
Shaly sandstone	25
Shale	5
Argillaceous limestone	13
Siliceous shale	25
Hard, blue limestone	7
Shale and sandstone	28
Fossiliferous shale	7
"Nigger-head" limestone	14
Coal bone	trace
Black slate	1
Siliceous shale	3
St. Louis limestone to low water	90
	299

From the bluff near Schooner point three notches or low places were observed cut across the narrow promontory which here juts out into Ohio river; on examination these were found to be water worn, and were probably once the beds, respectively, of Blue river, Indian and Potato creeks, when all these streams flowed at a much higher level than now. From stratigraphic reasons it was believed that from fifteen to twenty feet of St. Louis limestone was exposed at this place above the medium stage of the river, but not one fossil was seen to determine the question.

Alton, at the mouth of Little Blue river, is the trading point for a large region north and west. The St. Louis beds were observed at extreme low water line, passing below the water surface. The following section occurs a little over half a mile below the village on the river bluff:

SECTION AT ALTON.

	Ft.
Conglomerate sandrock and soil	50
Kaskaskia limestone, with *Pentremites* and *Dichocrinus*	39
Black shale (marl?)	45
Yellow argillaceous limestone	13
Siliceous shale and flagstones	40
Flaggy limestone	21
Massive red sandrock	32
Gray limestone, with *Athyris, Producta, Spirifera, Terebratula* and *Rhynchonella*	22
Shaly slope	20
Brown limerock	28
Heavy sandstone	27
Blue shale	9
Heavy gray limerock	18
Shale, with fossils	3
Sandrock, with *Stigmaria*	3
Coarse red limestone	8
Coal bone	4 inches
Siliceous limestone to low water in Ohio river	6
	384

The upland soil in this vicinity, as well as much of that on the rolling land in the west part of the county, being composed wholly of siliceous material derived from decomposition of the local sandstones, contains little else than sand more or less pulverized. It is therefore deficient in soluble silica, and can be made available as plant food only by preparation of organic matter or by the addition of alkalies. Limestone is present in all deep vallies, with plenty of wood for burning. It offers a cheap fertilizer. Mr. H. B. Maylin, of Alton, applied forty bushels of lime per acre on a valley field which had produced eight to ten bushels of wheat to the acre. Although no marked increase was apparent the first year, the second crop after liming was more than double, or twenty-five bushels, with a similar improvement in the corn crop. Repeated trials show that such increased productiveness is reliable. The lime is equally remunerative when applied to grass or clover.

At the point where the road leading west from Leavenworth crosses Little Blue river the following section was seen:

SECTION ON LITTLE BLUE RIVER.

	Ft.
Conglomerate sandrock	40
Kaskaskia limestone	12
Chester sandstone and shale	80
	132

Eaton's white sulphur well, on section 35, township 3, range 1 west, was bored in the years 1862–3. It is four inches in diameter and 284 feet.

SECTION IN EATON'S SULPHUR WELL.

	Ft.
Soil, level of Kaskaskia limestone	21
Chester sandstone and shale	175
Chester and St. Louis limestone, with many clay partings	88
	284

The water from this well bursts up with violence; when tubed it raised to the top of the derrick, thirty-five feet, and could not be forced through a two inch pipe. It is highly charged with sulphuretted hydrogen and deposits a white sulphurous sediment. Temperature, 59° F. For medicinal purposes it is best fresh from the well, when charged with accompanying gases. The curative qualities of the water have been thoroughly tested for more than ten years. A resident physician declares it to be a specific for dyspepsia, rheumatism, incipient scrofula, constipation and skin, kidney and womb diseases. The flow of water is sufficient for bottling and other uses for five thousand persons. The present accommodations have a capacity to accommodate only from fifty to sixty persons. The well is eight miles west of Leavenworth and nine miles northwest of Alton. Half a mile west from the hotel is a good exposure of strata above the top of the bore.

BLUFF SECTION AT EATON'S WELL.	Ft.
Conglomerate	40
Shale	8
Kaskaskia limestone, with fossils	4
Chester sandstone and shale	20
	72

Mr. J. J. Clark gives the following statement of strata passed through in Clark's well on section 28, township 3, range 1 west, near Marietta:

SECTION IN CLARK'S WELLS.	Ft.
Kaskaskia limestone	6
"Red keil"—decomposed shale	7
Blue Chester limestone	20
Gray shale	8
White flint	3
Limestone, with clay partings	6
Coal bone and bituminous slate	1
Soft clay shale	7
Limestone, with siliceous and argillaceous shale	350
Burning gas	.....
Knob shale and sandstone	240
Salt water and small quantity of petroleum	.....
	648

The ascent from Sulphur Well post office to Fessler's Knob and Chestnut Oak ridge is steep; the scenery mountainous, with a wide view south and east. The elevation of 570 feet above Ohio river mitigates changes of temperature so as to insure tender fruits against sudden cold snaps. On all knobs and elevations having a hight of 400 to 500 feet above the river the trees were loaded with fruit. Few or no peaches were seen lower than 300 to 350 feet above the river.

SECTION AT CHESTNUT OAK RIDGE.

	Ft.
Conglomerate sandrock	110
Kaskaskia limestone	12
Chester sandstone and shale	90
	212

The "Tar Springs," on land of L. D. Parker, southeast quarter of section 15, township 3, range 1 west, is one of the noted localities of Indiana. During the oil excitement of 1862–66 it was the Mecca of petroleum seekers. Two weak springs have outlets from beneath the Kaskaskia limestone, just below a bed of Conglomerate, in a deep, wild valley. The west spring discharges with its waters coal tar and carburetted hydrogen; the outlet is in a basin trough, built up on the rocks, of earth cemented with the deposited asphaltum. The east spring, thirteen feet distant from the last, discharges water and petroleum, with a small quantity of carburetted hydrogen gas. Both are strong flowing fountains during rainy weather, but are weak during dry seasons.

Some instinct of nature, or reason attracts all domestic animals to these springs; in malarial seasons hogs and cattle will break from enclosures and go miles to obtain the water, while pure spring and brook water is plentiful nearer by. There is no saline taste perceptible, but we may infer that there is some remedial effect experienced by the animals after drinking it. I am informed by Mr. T. Roberson that domestic animals not only drink the water greedily, but when foot and mouth diseases are prevalent they manifest a desire to bathe the diseased parts in the oily fluid. It is probable that this spring and other "oil seeps" induced the boring of the six wells which were put down during the "oil fever."

Near Union precinct the hills are Conglomerate, the Kaskaskia division of the Chester generally showing in the valleys with characteristic fossils. The table lands are of brown Loess soil, and the fine farms of Warren Roberson and E. Finch showed good cultivation and fair crops; their orchards were in good condition and loaded with fruit. Evergreen laurel (?) was seen growing luxuriantly on the steep, conglomerate hills.

Orchard grass flourishes well on this soil. Thomas Roberson, Esq., settled here in 1836, and in 1857 seeded eight acres with this grass; it produces good hay, gives extra early, continued pasture, and withstands drought; this plat of grass has been closely cut for twenty-one years, and indicates a permanent sward, which no other grass can form here. He finds it necessary to sow at least two bushels of seed per acre.

Johnson and Patoka townships occupy the extreme western part of the county. The surface rocks are Conglomerate sandstone. Nearly all the creeks and brooks of any size cut their deep valleys through the surface rock down to and sometimes through the Kaskaskia division of the Chester group and at several stations, as on section 15, north of Down Hill, and on section 31, northwest of Brownstown, characteristic fossils are abundant, such as axes of *Archimedes*, *Athyris subquadrata*, *Zaphrentis spinulosa*, crinoid stems and plates, *Dichocrinus sexlobatus*, *Pentremites obesus*, *P. pyriformis*, *P. godoni*, *P. sulcatus*, *P. cervinus*, *P. symmetricus*, etc. The fossils are often in an excellent state of preservation, and of unusual size and beauty.

The Conglomerate contains, as a rule, only the trunks of *Lepidodendron*, *Sigillaria* and *Stigmaria*, presenting casts of the curious external markings with perfect fidelity. A single specimen of *Trigonocarpum olivæformis*, from the vicinity of Down Hill, exhibited by Dr. Hawn, showed the tri-lobed husk and stem attachment of this fruit of the Carboniferous age. Thin outcrops of coal A, the lowest seam in the Indiana series, have been opened in the district south of Wickliffe, but at no point did they find an area of workable thickness. This seam is not reliable; if thick at one point it soon thins out, and does not average anywhere in the Indiana coal field a thickness of more than six inches. Labor or money expended in pursuit of this coal will bring little or no return. At the openings examined the seam was from six to twelve inches thick. Coal A has been worked for local use at the following places in this county:

	Ft.	In.
Knight's, on S. 25, T. 2, R. 2 W., thickness	0	6
Knight's, on S. 25, T. 2, R. 2 W., thickness	1	0
Mullen, on S. 26, T. 2, R. 2 W., thickness	0	8
Speedy, on S. 3, T. 2, R. 2 W., thickness	1	0
Denbo, on S. 12, T. 2, R. 2 W., thickness	0	6
Average thickness, nearly		8½

The following section was taken on southwest quarter, section 25, township 2 south, range 2 west:

SECTION AT KNIGHT'S.

	Ft.
Slope and Conglomerate sandrock	120
Pebbly flagstones	5
Shale and plant remains	5
Coal A, glossy, caking, with cubical fracture	1
Fire clay, or potters clay, with Stigmaria	3
Bituminous and pyritous shale	35
Place of Kaskaskia limestone	9
Chester shale and sandstone to creek	100
	278

Ott's well, at Mifflin, was bored for oil in the years 1864-5, to a depth of 1,165 feet, where a strong brine was found, which flows out, carrying with it a small quantity of petroleum. In settled weather the stream of water will pass through a one-inch orifice, but at low barometer, just before a storm or change in the weather, the gas rushes up, and with a loud, blowing noise, throws out several spurting spouts of water a few feet upward. The petroleum is used locally as a specific for cutaneous diseases on man or beast, as itch, grubs, scratches and sore eyes. Twelve gallons of the salt water made nine pounds of salt, and when pumped the amount of water was 22,400 gallons per day, which, if evaporated, ought to have yielded 16,800 pounds of salt. The actual result was only ten barrels of salt a day, with well arranged evaporating pans and fixtures.

Malachi Ott, Esq., furnished the following statement of the bore:

SECTION AT OTT'S WELL.

	Ft.
Chester limestone and sandstone	120
Petroleum and coal bone ......4 inches	
Chester limestone	70
St. Louis limestone	250
St. Louis black cement	30
St. Louis gray limestone	30
Keokuk and Burlington (?) rocks	80
Knob shale and sandstone, with ironstones	490
Black Devonian slate, with gas and petroleum	110
	1,180

A short distance north of the village is a boldly escarped outcrop of Conglomerate sandstone, projecting far enough to form a wide rock-house cave, which, from the ashes, flint and stone implements found within, has been used as a shelter by the Indians. Evergreen laurels along the pathway concealed the approach as well as the occupants.

ROCK HOUSE SECTION.

	Ft.
Slope and sandstone	80
Massive Conglomerate	50
Place of coal A	...
Pyritous shale	25
Kaskaskia limestone	22
Chester shale and limestone	40
	216

The Rock House was found to be three hundred feet long and averaged fifteen feet deep. The Indian use of this house is indicated by the great number of flint chips, broken knives, scrapers, etc. Along the front edge were many large blocks of sandrock, fallen from the roof, in which were pit holes, called "Indian mortars," drilled by grains of sand and dripping water; they were from two to seven inches deep. One drilled through the stone eight inches deep showed a side discharge or waste for the cutting water; another, fourteen deep and seven inches in diameter at the top, tapered to less than two inches at the bottom.

Benham's salt well, a short distance away, was bored about the same time as Ott's, and for the same purpose. The brine showed a fair strength, and a full plant for evaporation was put up, but after a thorough test it was found that the returns would not pay expenses, and the project was abandoned.

SECTION AT BENHAM'S WELL.

	Ft.
Soil	12
Chester and St. Louis sandstone	488
Knob shale and sandstone	350
	850

The first symptoms of gas and petroleum were met at a depth of 135 feet, and salt brine at about 690 feet.

The artesian flow of water is continuous, accompanied with fine bubbles of gas and oil in small quantities. Continued pumping did not increase the flow of brine or oil. From the many carefully conducted tests made in this county we may infer that the quantity of petroleum is limited, and that further search for it will be attended with loss of time and money. Analyses of these mineral waters will be given in the economical geology of this county.

Grantsburg is a thrifty village on the high eastern bluff of Little Blue river. The valley hills are built up of Chester shales and limestone. The Kaskaskia limestone, with *Archimedes, Zaphrentis, Athyris* and *Pentremites,* is seen near the surface. Sipes' Knob, adjoining on the east, is capped with Conglomerate sandrock carrying coal A in isolated pockets. From this knob a good view is had of the Loess plain to the east, north and southeast, and of distant landmarks.

Hartford is pleasantly situated in the deep valley where two streams unite to form Little Blue river. The town is surrounded by a rich agricultural region. The narrow valleys of the streams, walled with precipitous or overhanging bluffs, gives many wild scenes full of romantic beauty. The forests contain a good proportion of beech, sugar maple and oak trees, indicating an excellent soil, while, towering above all, giant poplars add beauty and value.

The sulphur well, adjoining the town, is worthy of the high character it has justly earned. Almost every citizen and neighbor will bear witness to its efficacy in chronic diseases. For an analysis of this water see analyses of Crawford county mineral waters in this volume.

The table-land and elevated plateaus are capped with Conglomerate sandrock. The surface limestones are of the upper division of the Chester group, with *Archimedes, Zaph-*

rentis, Athyris, Productus, Terebratula, Bellerophon, Pentremites godoni, P. pyriformis, and sharks' teeth.

SECTION AT HARTFORD.

(Sec. 24, Town. 2 south, Range 1 west.)

	Ft.
Slope	20
Soft Conglomerate sandstone	40
Dark shales, place of coal A	20
Kaskaskia limestone, with fossils	10
Red and black shales (*marl?*)	20
Brown limestone	4
Chester sandstone and limestone to creek	30
	144

The Kaskaskia limestone of the above section contains *Zaphrentis spinulosus, Pentremites pyriformis, P. globosus, Spirifer striatus, S. lineatus* and *Dichocrinus corniger.*

Brownstown (Mt. Prospect post office) is at the bottom of a deep cross valley eroded in the shaly strata of the Chester group, which here replaces the massive bands of sandstone seen elsewhere. This change is remarkable, and seems to indicate that near the central depths of the Chester sea only mud deposits were made, and that limestone was found only in moderate depths along the shore or shallow water line at the north and south sides of this Carboniferous gulf, which crosses this county from west to east, and extending a short distance into Harrison county.

Three miles west of the village, on A. L. Whitcomb's land, on section 1, township 2, range 2 west, is a bed of fine whetstone grit, similar and equal to the Hindostan stone of world-wide reputation.

SECTION AT KING'S WHETSTONE QUARRY.

	Ft.
Conglomerate sandrock	80
Grindstone bands	10
Blue calcareous oil stone (iron ore)	2
Fine whetstone bed in thin laminæ	6
Shale	12
Coal A	2 inches
	110

The whetstone deposits, by lamination, separate naturally into divisions most suitable for use and reduces the labor of manufacture to the lowest cost. The whetstone grits were noticed extending along an east-southeast line for over two miles.

A bed of yellow, white and red sand was seen in the southwest quarter of section 34, east of town, which shows a thickness of ten feet. It is formed from soft, coarse, Conglomerate sandrock in a state of disintegration; it is used for plastering, and with transportation could be utilized for glass making. Several beds of white, plastic, potter's clay, free from grit, also occur in this vicinity.

Lambden's peak is a high, sharp, conical hill, a witness of former denuding forces, which removed the great mass of companion rocks, leaving this isolated monument. The outlook from the peak is grand, embracing part of the Loess plain and distant valleys of this and Orange county. It is capped with Conglomerate sandrock, supported by Chester shales and soft sandstone. The strata, beginning at Brownstown and continuing to the summit, is given:

LAMBDEN'S PEAK—BROWNSTOWN SECTION.

(Sec. 31, 32, 35, 36, Town. 15, Range 1 east and 1 west.)

	Ft.
Sandy slope	10
Soft Conglomerate	20
Pyritous black shale	12
Kaskaskia limestone, with *Pentremites obesus*	15
Pyritous black shale	18
Chester shale and thin plates of sandstone	140
Massive Chester sandrock	35
Chester and St. Louis limestone	70
	220

This peak gave name to the post office—Mt. Prospect—on account of the extensive and picturesque view afforded from the top.

Springtown—Marengo postoffice—is a thriving village on Whisky run. Stores, mills, mechanical and manufacturing establishments are well represented. A well-conducted academy for students of both sexes receives, as it deserves, good attendance. The village takes its name from the grand springs which flow out from cavernous openings on the north side of Main street, the central feature of the community. The principle cave has an entrance six and a half feet high and thirty feet wide, and has been explored by a good passage-way in dry weather, a distance of half a mile. The are several large pillared stalactites, with many smaller ones. The lower cave gives discharge to a large stream of water, in which many goggle-eye fishes stay during winter. The temperature is pretty uniform at 52° F.; on this account, and because of the antiseptic quality of the dry atmosphere, the cave is the village storehouse for fruits, potatoes, meats, etc. The surface rocks of the vicinity are Chester shales and sandstone, with St. Louis limestone in deep valleys and in the bed of Whisky run. The coal noticed on Parker's land is an outlier of no economic value. Pankey's cave contains interesting forms of subterranean life worthy the attention of visitors.

Milltown owes its importance to the well equipped mill which is driven by the full power of Blue river. The Chester sandstone caps the tops of the surrounding hills, 300 feet above the river, and is of good quality for piers and heavy masonry. Some of the strata afford excellent gritstones. The St. Louis limestone forms the bed-rock of the river; the exposed rocks below the mill contain pockets and bands of chert and flint, and were in places crowded with *Lithostrotion canadense* and *L. proliferum*, the latter with solitary or clustered calyces. Fine specimens of fluor spar and calcareous spar were seen, and on many of the flints the green stain of copper.

SECTION AT MILLTOWN.

	Ft.
Chester limestone and sandstone	25
Brecciated limestone	5
Brecciated limestone, St. Louis fossils, including *Bellerophon*, *Athyris*, *Zaphrentis* and *Pentremites conoideus*	6
Gray clay shale	9
Brittle columnar limestone	7
Buff, clay shale	8
Lithographic flagstone	7
Massive, gray, argillaceous limestone	14
Massive, buff, or argillaceous limestone	6
Gray oolitic limestone	5
Hard vermicular limestone	6
Argillaceous limestone	5
Clay shale, covered	15
Blue cherty limestone	18
	136

The blue cherty limestone in the bottom of the above section contains *Producta*, *Spirifera*, *Retzia*, *Athyris*, *Myalina*, *Streptorhynchus*, *Pentremites conoideus*, *Zeacrinus armiger* and *Lithostrotion*.

On land of George D. Gibbs, section 32, township 2 south, range 2 east, Chester sandrock caps the hills, and St. Louis limestone forms the slopes and bedrocks of the valleys. At the road-side there is a magnificent bed of oolitic limestone, apparently twelve to fifteen feet thick; and at several neighboring points similar beds, ten to twelve feet thick, were reported. This stone is of excellent quality, and were transportation at hand it would command a large market and good prices.

Pilot Knob was an island in the ancient lake, in the bed or on the sides of which the Loess was deposited. From evidences found in counties to the north, this grand sheet of still water, covering southwestern Indiana and more extensive regions to the west and southwest, was later than the great Ice Age, for its deposits superimpose the true Boulder

Drift. The animal and vegetal remains indicate a tropical temperature. The knob overlooks much of the Loess plateau and affords, from its isolated and monumental position, a highly interesting view from its summit. The Muldraügh (Ky.) knobs are seen like cones piercing the sky twenty-eight miles distant. Seven huge peaks guard the west line of the county, twelve to fifteen miles to the southwest; and on a clear day another range, twelve to twenty miles away, rises up in Perry county; and other peaks, north of Grantsburg, are recognized, although nine miles distant. It is a favorite resort for picnic parties.

SECTION AT PILOT KNOB.

(Sec. 36, Town. 2 south, Range 1 east.)

	Ft.
Soft, disintegrating, Conglomerate sandrock	60
Bituminous shale, with clay iron stones	18
Place of coal A	
Fire clay and shale	12
Kaskaskia limestone	8
	98

The Conglomerate is so nearly resolved to coarse grains of sand that on exposure it is at once reduced and affords superior, sharp, clean sand, and is largely used for masonry and plastering.

From Pilot Knob to Leavenworth the road passes by White Oak Hill, section 1, township 3 south, range 1 east, which is nearly as high as the Pilot, over the fine lacustral lands, so marked a feature in this elevated table land. The farm of W. P. Everden is a choice specimen of this soil, under intelligent and vigorous management. Good crops of hay, wheat and grass are annually secured; he has an orchard of thirty-one acres, including the best varieties of budded apples and peaches; his 1,500 bearing trees yield a handsome income.

The oolitic limestone crops out on Dry run, and on Mrs. Humphrey's land, adjoining, is an excellent bed of paving stones, two to four inches thick; they contain enough siliceous material to prove very enduring; many of the flags are curiously mottled with ripple marks.

At Magnolia several outcrops of coal A occur at the base of the overhanging Conglomerate sandrock. The seam is here from four to ten inches thick. There is no seam of coal below this, and no probability of finding this one of workable thickness, even in small pockets.

SECTION AT MAGNOLIA.

	Ft.
Stratified sandstone	70
Massive Conglomerate	30
Coal A	1
Chester and Kaskaskia limestones	11
	112

WYANDOTTE CAVE.

The history of caves verges on the realm of mystery. The unknown is always full of wonder; solemn silence, utter darkness and a chilly atmosphere have weird attractions. In song, tradition, story and religious teachings every age has borrowed illustrations and incidents from such dim, uncertain homes of darkness, peopling them with all that a wild imagination can create or desire.

The Ecclesiastical Encyclopedia says "the geological formation of Syria is highly favorable to the production of caves. It consists of limestones of different degrees of density, and abounds with subterranean rivulets. The subordinate strata, sandstone, chalk, basalt, natron, etc., favor the formation of caves, consequently the whole region abounds in subterranean hollows of different dimensions. Strabo speaks of a cavern near Damascus capable of holding four thousand men; it is seen at this day. Modern travels abound in descriptions of the Syrian caves, and the Crusaders relate the marvels of the land of caves. One, near Aleppo, it is said, would hold three thousand horse. Another, near Sidon, is described as containing two hundred smaller caverns and dens. Holes and caves were numerous in the sea coast mountains, extending through a long range on each side of Joppa.

The first mention of a cave, in Scripture, relates to that into which Lot and his family retired from Zoar after the destruction of Sodom and Gomorra. The next is the cave of Macpela, which Abraham purchased to sepulture his dead, in which his ashes rest with that of Rebecca, Leah and Jacob."

The caves of every quarter of the globe have been used as habitations, places of retreat, temples for religious worship, or sepulchres for the dead.

The poetry of ancient Greece and Rome placed some of their holiest shrines and oracles in the shadowy realms whose "conditions" were darkness and obscurity.

The oracles of the Sibyl's cave will live as long as classic story, and Virgil's glimpses of the land of shadows are among the brightest pictures of Augustan story. Some of the most interesting events in the history of Asia, America and Europe are connected with caves—deeds of heart-rending disaster and violence or acts of high faith and devotion.

The St. Louis is called the cavernous limestone on account of the numerous caves which occur in it, and similar calcareous deposits at various places, among which are not only the caverns of Indiana, but also Mammoth Cave in Kentucky, Weyer's Cave in Virginia, Howe's Cave in Scoharie county, New York, Kirkdale in Great Britain, the Grotto of Antiparos in Greece, and the noted caves of Franconia.

Owing to the great thickness of the strata of this group of rocks in America, the caverns are here on a grand scale. This limestone forms the surface rocks in the county of Harrison, adjoining Crawford on the east; dipping at the rate of from ten to forty feet to the mile to the west, it runs below the surface, and is seen only in the hill sides along Big Blue river and the deep valleys of its tributaries. Throughout this region nature has excavated a multitude of underground avenues and canals of all forms and dimensions, branching in endless variety. They did not always exist. The rock is of marine origin and was deposited in the bottom of the Sub-carboniferous ocean, having a probable depth of 1,000 to 2,500 feet. Under the pressure of such a depth of water the material, consisting of comminuted shells of animals and debris, was perfectly compressed before hardening. In the process of upheaval through a space of 2,000 to 3,000 feet, which was over large if not continental areas, checks, cracks and cleavage of the rocks was established. The surface water first found open drains, as rivers, creeks, etc., which cut their channels deeply in the rocks, at many points one hundred to two hundred and fifty feet below the level of the present streams. Then the excavation of the underground seeps and rivulets was begun. A drop of water charged with carbonic acid and other gases from the atmosphere, creeping through the slightest fissure, enlarged it by removing a film of carbonate of lime by forming a soluble bicarbonate. This process, in constant action through ages, enlarged the crevices until drops were followed by seeps, these by imperceptible growth became rivulets, which in the ceaseless round of untiring time expanded to the volume of creeks, and when eons of cycles had grown dim upon the recorded page, that which started as a drop upon the surface, had become a mighty subterranean river.

When such passages become enlarged so that water did not entirely fill the cavernous space, the funnel shaped "sink holes," which dot the whole surface, collected heavy air charged with carbonic acid gas and continued the process already begun. At remote parts of a cave this gas is sometimes found pervading the atmosphere to an almost dangerous extent, hence the "air action" within the cave is more powerful than at the mouth, where pure air has access. Running water, carrying mud or clay, has, at some period in the life of these caves, given its mechanical aid in wearing away the insoluble detritus.

The standpoint of the different stages of these streams may often be seen recorded as niches and mouldings on the walls; round pebbles are also often found on the floorways.

At many localities these pebbles and their matrix of clay indicate the direction which the water flowed and the rate of motion; well rounded pebbles and stones indicate a rapid current; where sand is found the current did not exceed four to five miles an hour, and a bed of clay tells of a slower current or still water. Much of the loose, rocky debris, fallen from the roof or sides, is covered with a coating of carbonate or sulphate of lime.

"When water holding bicarbonate of lime in solution drops slowly from the ceiling, by which it is exposed to the air sufficiently long to allow the escape of one equivalent of carbonic acid gas, the lime is deposited in the form of monocarbonate. If the deposit occurs in such a manner that the accumulation takes place from above, downward, in the form of an icicle, it constitutes what is termed a *stalactite;* but if it forms on the floor of a cave and accumulates from below, upward, it is known as a *stalagmite.* Stalactites and stalagmites frequently meet and connect the roof with the floor, and form a pillar or column of support.

"If the solution which forms the stalactite is free from oxide of iron or mud, it will be translucent, or milk white; the presence of any of the salts of iron gives a dirty yellow, red or dark brown color."

By the decomposition of pyrites (sulphide of iron), gypsum (sulphate of lime) is formed. Gypsum, when calcined and ground, forms the plaster-of-paris of commerce. When it occurs in crystals it is known among mineralogists as *selenite,* and when it occurs in translucent or finely tinted masses it is known as *alabaster,* and is quarried and wrought into vases and other parlor ornaments for the art-loving denizens of the larger cities of this and the old world.

"The decomposition and recombination exerts a marked influence on the appearance of a cave. The chambers or avenues in which gypsum occurs are dry. When rosettes of alabaster are formed in rooms containing stalagmites, the water, which furnished the solid material for the latter, has for ages ceased to flow, as rosettes can not form in a damp atmosphere. The force exerted by gypsum in the act of crystallization is thought to be about equal to that of water when freezing. The formation of saltpetre (nitrate of potash) is by absorption of nitrogen by the dry, porous earth from the atmosphere, assisted by the decomposing remains of bats and other animals. It is in the form of nitrate of lime, which, when reacted upon by the carbonate of potash, forms nitrate of potash or saltpetre."*

Many caves give discharge at their entrances to a strong current of air, in winter warm and in summer cold; that is, at a temperature varying but little from the permanent temperature of the rocks. Such caves are fed with air through open sink-holes, and the heavier cold air sinks to the floor and passes away at the outlet.

*Wright's Guide Manual.

Large caves, which do not have openings by sink-holes, inhale cold air during winter, and on the slight rarifaction of summer heat an outward current is noticed. At the equinoxes there is no current because the internal and external temperature is about the same degree.

The process of enlargement of the caves, already mentioned, by atmospheric action, although slow, is constant. In the course of ages, when the caves became so extended as to be beyond the supporting capacity of the roof, it breaks, and with slow, gentle motion the roof settles down, making a depression on the surface. To such a cause the curious, isolated depressions in Harrison county, named Ripperden, Harrison and Grassy valleys may be referred.

Wyandotte cave is five miles northeast of Leavenworth, the county seat of Crawford county, which is fifty miles below Louisville, Ky., and 126 miles south of Indianapolis, the State capital. For the benefit of persons desiring to visit the cave, it may be well to state that a daily coach starts from New Albany, opposite Louisville, for Corydon, the old State capital. The twenty-mile route is through a country abounding in wild and interesting scenery, including several small caves on the way. From Corydon hacks can be had at all times for the remaining ten miles of the route, so the cave may be reached before night. The Louisville and Evansville line of river packets pass up and down Ohio river daily, with regular landing at Leavenworth, from whence carriages are always ready to carry visitors to the cave. Visitors should be prepared with stout shoes or boots and thick clothes, of sufficient strength and warmth to endure rough treatment and resist the chilling air of the cave, which varies from 55° to 58° F. Ladies would feel more comfortable in a semi-bloomer outfit, as some such protection is necessary when climbing the steep cliffs or crawling through the low avenues.

The road from Leavenworth to the cave winds along the foot of the precipitous, wall-like bluff of Ohio river, which towers up 425 feet above low water, the sides corrugated or banded with massive beds of St. Louis limestone and intercalated partings of clay shale and shaly sandstone, which, by decomposition, give prominence and relief to the mighty cornices and mouldings.

The summit of this bluff, capped with fifty to two hundred feet of sand and limerock, belongs to the Chester group. On the opposite—Kentucky—shore of Ohio river, similar precipices wall the whole valley, which from the hill-tops looks like a narrow canon, but which really comprises the fine farms and beautiful homes of the Leavenworth family, who were early New England pioneers in this region.

At the mouth of Big Blue river are two islands, on one of which occurred the Hines defeat during the late civil war.

To this beautiful silver-rippling stream a former tribe of Indians gave their own poetic name, WYANDOTTE; and although the name will live with American history, the last vestige of that once powerful tribe long since embarked for the "happy hunting ground."

The stream was subsequently called "Blue river," because of the singular purity of the water, which gives, at great depths, that peculiar azure tint which the immense depths of air give to the sky. The water owes its purity to the fact that much of it is from cave springs which are fed by subterranean streams, flowing across pools and basins in the caverns, and comes out free from sediment, sparkling and bright. Every pebble and shell may be seen in the deepest water, and the fish seem to glisten and flash like silvered life in a stream of air.

At the barn of Mr. O. L. Leavenworth was a watering pool filling an ancient sink hole, which for years had been a constant convenience; suddenly, after a thunder storm, it was found empty, and although the line of overflow was to the south toward the adjoining valley bottoms, it was discovered that, following the dip, the water had found a long obstructed channel to the north beneath the cliff-like promontory, more than four hundred feet high, and was discharged into Dry run.

About one hundred yards south of the west end of Cole's bridge, on a level bench, twenty-five impressions were observed in the solid rock made when in a plastic condition, apparently of the feet of a herd of horses, mules, colts, deer or sheep. The resemblance is very perfect, and calculated to excite wonder. They are the remains of a peculiar *fucoid* or sea-weed, seen in the Chester and St. Louis rocks of Indiana, Kentucky and Arkansas.

Three and a half miles from Leavenworth the road passes along the base of the lower massive sandrock of the Chester beds. On the west side of the road is one of the wonders of the vicinity, known as "Giant Castle ruins," a depression, such as might be proper for the basement or cellar of an extensive edifice, is filled with a confused mass of clean cut cubes and rhombs of hard, ferruginous, sandstone, of great size; square and columnar masses lie scattered about the rim of the depression, or stand upright as monolithic sentinels. Many a curious spectator has wondered at this phenomenon, and speculated as to the agency, whether human, volcanic or otherwise. It is a sink funnel, beginning at the level of the Chester sandstone, which, from the silicio-ferruginous nature of its material, adopts under earthquake motion such rhombic cubes as its lines of cleavage; these, undermined by a cavernous sink, which washed away the underlying clay and detritus, left the rocks clean cut and bare, as if done by the hand of man. Similar masses of well-shaped rocks, from one to fifty feet square, are seen perched along the steep bluffs of Oil Creek, Penn., especially near Petroleum Centre.

At a "sink hole" on the bluffs of Blue river, one mile south of the cave, was seen a tree splintered to ribbons by lightning. The surrounding hills tower from one hundred to one hundred and fifty feet higher; under the "sink" was damp earth, if not a stream of water, through which the charge of electricity passed—a good conductor, and a more direct route than through the dry, cavern-drained hills. The tree was minutely shivered near the ground, which seemed to indicate an upward burst of electricity.

At the first arrival of the Rothrock family in Crawford county, Wyandotte Cave was known as the old "Indiana Saltpetre Cave." Dr. Adams had pre-empted the land, and during the war with England, or from 1812 to 1818, he manufactured saltpetre, after which he relinquished his claim. Many remains of leaching hoppers, troughs, etc., show the extensive character of his works. One of the old saltpetre kettles is still used on the farm, a curious relic of the metallurgic art of a hundred years ago.

Soon after Dr. Adams retired Mr. H. P. Rothrock, father and grandfather of the Rothrocks now living in the vicinity, entered the land, or bought of the government a tract of four thousand acres, which he supposed included the cave and all of its subterranean ramifications. The cave was open to every one who wished to enter, and was somewhat mutilated by vandal visitors; in fact, it was considered rather a nuisance, as the Indiana Legislature enacted a law compelling the owner to fence up the entrance and prevent cattle from licking the epsom salts.* This, with the west branch, is known as the old cave.

*Statutes 1843, Chapter 53, Section 67.

In 1850 Messrs. Cummins, Collingwood and O'Bannon observed a flat stone, which seemed out of place, at the side and bottom of the pit at the end of "Bandits' Hall," where the old cave turns abruptly to the left. A small opening, when enlarged, led the way by "Fat Man's Misery" to the extensive "new cave." Later in the same year Mr. Rothrock noticed, near "Sulphur spring," a very small, descending, pit-like opening, ten by five inches, which examination showed had once been larger, but was now nearly closed by ages of stalagmitic deposits. This opening, enlarged to eighteen by twenty-four inches, forms the "Augur Hole," through which visitors enter to the northern extension of the "new cave."

Since that time Wyandotte has been open to visitors, with skillful guides and proper equipments. It was visited in early times by President Harrison and the officers of his gallant army, and since by many noted travelers and scientists, editors, professors, professional gentlemen, priests and statesmen, with a goodly host of the fairer sex, all expressing themselves delighted with the grandeur and magnificence of this truly wonderful cavern, to go away fully compensated for their toil and trouble by the curious and entrancing scenery which meets the eye at every turn.

The door of "Fat Man's Misery" is in a dark pit; the opening, hid by a flat stone, as it was when discovered, might have been passed a thousand times unobserved. Up to 1850 this was the extent of white men's explorations. On entering the explorers were surprised to find that this hidden part of the cave had formerly been occupied, including the spacious areas of "Bat's Hall," "Sandy Plain" and "Rothrock Cathedral." Hundreds of poles, six to twelve feet long, and from one to two and a half inches in diameter, were found scattered in all parts, probably used for carrying burdens of food or skins, or for aggressive or defensive purposes. Significant, too, of the Stone Age, the poles were of such soft, brittle wood as sassafras, poplar, pawpaw, etc., as might be readily obtained by breaking; many having been twisted off at the ground, others torn from the earth with part of the roots attached, while a few had been cut with some dull implement, indicating the use of stone axes and flint knives. It was not a house of darkness; the charred remains of torches, made of shell-bark hickory, tell of the mode of illumination. The ceilings of several of the rooms are still sooty from the smoke of flambeaus and fires for cooking.

Sulphur spring was apparently the farthest limit of the explorations of the more recent Indians; but still beyond, on breaking away the slowly growing stalagmite which had so nearly closed the "Augur Hole," it was found that a party—one large man, two smaller men or women and three children—had been there, leaving the prints of their moccasined feet in the plastic clay on the floor. These tracks or, "Indian foot prints," were there in good condition, and if they had not been obliterated by white men tramping over them they would have remained for ages. In "Sheep Cave" are tracks made by a lost sheep, thirty-five years ago, as distinct as if made but yesterday.

The wandering or lost band, above referred to, were brave or earnest explorers; they examined carefully every nook, cranny or crevice of the long north cave on one side, and returned with the same close examination on the opposite side. The lapse of time since these tracks were made, may be approximately inferred from the fact that there being no other known entrance, they must have gone in by the "Augur Hole," which, to have admitted a full-grown person of average dimensions, must have had an area of twelve by eighteen inches; white men found this closed to a space of ten by five inches; now the deposit made by water holding lime in solution, on the same spot, since the opening in 1850, a period of twenty-eight years, is a mere film, not one-hundredth of an inch in thickness, so that, inferentially, more than one thousand years must have elapsed since those tracks were made. The more rapidly dropping water at the "Pillar of the Constitution" has deposited a film of less than one-fiftieth of an inch during five years, or at the rate of one inch in two hundred and fifty years, and as the water drops at the "Pillar of the Constitution" ten times as rapidly as it does at the "Augur Hole," and provided the supply of water at the latter place has not from any cause decreased, it is fair to infer, from these imperfect data, that the tracks were impressed in the soft clay eighteen hundred or two thousand years ago. The tracks were seen by many visitors, including Dr. Hawn, Prof. Hovey, Prof. Richard Owen, Josephus Collett, and others, up to the year 1855.

The cave is situated south of the southern limit of the Drift. Three smooth glacial boulders were discovered by the writer and Washington Rothrock in 1877, at the "Senate Chamber," which, from indications, such as wear and bruises, had been used as hammers or grinding pestles, and proved conclusively that that part of the "old cave" had been visited, if not occupied, by men of the Stone Age.

The Cave House is situated on a commanding eminence, 573 feet above tide water, 270 above low water in Ohio river, and 220 above Blue river. The air is free from malarial impurities and the pests incident to overflowed lands. Blue river, sparkling with crystal brightness, flows in a narrow valley, across which Greenbrier mountain, with sharp conical peak and steep faces belted with massive rings of rock, variegated with evergreen cedars, affords a scene of quiet, stately beauty. The mountain is capped with Chester rocks, and in the background knobs are seen reaching from two hundred to two hundred and fifty feet higher than the hotel. Roaming through the forests in search of game, or climbing the steep hills gathering plants, fossils, shells or insects, is invigorating exercise, while the romantic scenery and charming views fully repay this healthful toil. Blue river affords good bathing and infinite sport for the disciples of Isaac Walton.

On the occasion of the sudden, intense cold of December 2d and 3d, 1876, which closed navigation on the river, and for several consecutive days, a thermometer at the Rothrock residence in the valley, marked 10° lower than at the hotel; or during sudden "cold snaps" elevation, or the proximity of deep valleys, to which heavy cold air is withdrawn, modifies the temperature on the hills at the rate of one degree for every twenty-two feet of hight. The same fact has been observed in other parts of this and the adjoining county of Clark. The hotel is situated, geologically, near the base of the Chester group, or at the top of the St. Louis, so that the hills which ascend to the northward to the great Lacustral plain, which stretches across the county from north to south, are of partly covered Chester sandstone and limestone.

SECTION AT WYANDOTTE CAVE.

	Ft.
Slope and Loess	20
Buff sandstone with fossil plants	75
Gray limestone, with *Archimedes*, etc	6
Brown limestone and shale	40
Gray limestone and shale	50
Lithographic bands	34
White oolitic St. Louis limestone	4
Gray, cherty, encrinital limestone	220
Blue river	
	449

The "outer door" of the cave, thirty feet lower than the hotel, admits to the subterranean world by an entrance twenty feet wide and five feet high. A sharp, short descent conducts visitors by the "Arched entrance" to "Faneuil Hall," a spacious corridor forty feet wide and eighteen to twenty feet high; here daylight ends and darkness begins. Here, too, we see the first of cave life; clusters of bats, which hibernate in myriads, were seen attached to the sides and roof by their hind feet, with heads down. The surface of the stone being slightly porous affords good attachment for their tiny claws. During the winter they remain in a semi-torpid condition, and on the return of spring scatter over the surrounding country.

The London *Naturalist* gives the following on

"BATS AND THEIR WAYS."

"Bats live their active lives in the night; when sunlight comes they fly away to their holes, there to sleep until twilight comes again, when they resume their occupation of insect killing. The female bat has a hard time of it; she is the nest, and has to procure the food for her young until they are themselves able to fly. Often I have seen a female bat with her young clinging to her breast, flying about in search of food, and the little ones were not so small either. How else could they get along? The old ones make no nest; if they wanted to ever so much they could not, and the chances are that from their wandering habits they spend the day in one place and the next in another two or three miles distant, just as that happens to be when day overtakes them, and if they left their young behind them the exact locality might be forgotten. When the young ones are to shift for themselves their mother's life is easier, and until winter comes to kill insect food she lives luxuriously. Then, when all nature is preparing to put on the livery of winter, instead of leaving the scenes where they have passed the summer, repair to their haunts in the caves and walls, and hanging by their hind feet in little groups, pass the dreary season in sleep."

Next we enter the "Normal School," twenty feet wide and fifteen high, and through the "Columbian Arch," an almost perfect semi-cylindrical tunnel, we enter "Washington Avenue," 450 feet long, thirty to forty wide and twenty to seventy high, with a slightly descending floor. "Bandits' Hall," 210 feet long, with a roof ninety feet high, encrusted with a starry fresco of gypsum, away up in the black darkness, contains blocks and masses of stone for hiding places, and is guarded by the "Falling Rock," which seems so loosely poised as to be ready to leap from its bed, and by its threatening position tells the story of the cave's formation. The "rock," a cube of solid limestone, twenty feet square, torn by the hand of time from the roof of the cave, stands like a monolithic altar of giant worshippers; just above is dimly seen the recumbent form of the princely "Chief of the Wyandottes," still guarding the fireless altar of his extinct race and forgotton Manitou.

The "Old Cave" from "Bandits' Hall," 130 feet below the hotel, leads almost abruptly to the left; from this depression an abrupt ascent is made by "Jacob's Ladder," a fixture of three steps placed there in 1812, and doubtfully supposed to be emblematic of "Friendship, Love and Truth." The succeeding passway leads over nitrous earth by "Pigmy Dome," "Coral Gallery" and "Debris Dome" to the "Canopy," a room describing almost a circle, ten feet high and twenty-five feet in diameter, with a flat, clean cut ceiling.

The "Continued Arch" is a glorious tunnel, 600 feet long, with an arched roof symmetrically covering the roomy passage. "Lucifer's Gorge" is a dark chasm, forty feet deep, with precipitous or overhanging sides from eight to twenty-five feet apart; the bottom of this chasm is on a level with that of "Bandits' Hall." After a sharp ascent the visitor reaches the "Natural Bridge," which gives a climbing or stooping passage to the "Grecian Bend," a low room, through which one is compelled to crawl upon the knees.

Climbing the "Angel Hill," twenty feet of sharp ascent, the "Temple of Honor" is reached, through which we pass to "Odd Fellows' Hall;" this is one of the royal subterranean rooms of the world, 210 feet long, 100 across and eighty feet high; the walls are built up of massive ledges of limestone, thinning toward the top, and thus, by perspective, exaggerating the dim hight. The elliptical crown of the dome is smooth as if purposely made ready for the fresco artist, and is bordered with heavy mouldings ten feet deep; the whole, illuminated by magnesium light, is imposing, massive, grand and coldly beautiful. On the side near the greatest depths of "Atræus" is the white "Phantom Ship, Millie," with sails spread and rudder set for the unknown realms of darkness.

Near the entrance to the hall, in a narrow crevice, is "Rothrock's Straits," through which we pass by a low, tortuous course to "Monument Mountain," in the new cave. The explanation of these great domes and halls is that smaller caves or crevices, as "Rothrock Straits," crossed under the main old river, undermining its bed, widening its sides and receiving and hiding in the lower channel the fallen rocks and debris from above.

Soon, by "Pharaoh's Stairs," we pass over "Pyramid Hill," then descend to the dark "Valley of the Shades," and quickly ascend the "Hill of Humility," where walking on the knees again becomes necessary. The succeeding incline leads to "Conrad's Hall," 200 feet long, 25 wide and 20 feet high, where the ceiling is exceptionally dark, and seems, from its peculiar color, to be lifted up and exaggerated in hight. After a short ascent a mighty crevice is seen, ragged with angular sides and walls; the entrance is by "Jolter's Hole," where a plethoric attorney was once arrested and held in durance vile until discharged. At the bottom is a prism-shaped, columnar mass of stone, twelve by five feet, leaning against the wall, called the "Leaning Tower." Crossing over another good hill, we pass into the "Abyss" by a decent of sixty feet; the north wall is slightly overhanging and, although now dry, was once wet with flowing water, which, by evaporation, has whitened "The Cliff" with stalactite incrustations and fringed projecting ledges with clusters of delicate, white pendants; this marble cascade is called the "Falls of Minnehaha." Below the abyss, a crevice called "Talbot's Pit," proves the existence of a lower unexplored cave, for stones cast down may be heard to leap and roll full fifty feet in the black depths. "Uncle Sam's Stairway" is an Alpine ascent of about fifty feet, from which the path leads under the "Dead-fall," where a huge slab, held by a point, is suspended over the way, and seems to threaten those who dare to enter the "Cyclopean Chasm." In the sides of the chasm is the quarry fossil bed of St. Louis limestone four feet thick, with crinoid and pentremite stems and plates in abundance, and also *Zaphrentis spinulosa*, beautifully weathered. "Fossil Avenue," six hundred feet long, roomy, but mountainous, has several beds of fossils, indicating the line separating the St. Louis and Chester groups. The top of the highest rock in this "avenue" is ten feet below the house; the temperature 66° F.

The farther end, estimated as over two miles from the outer door, is the crowning glory of the old and new caves; passing the "Archimidean Screw Hole," a narrow, difficult, bewildering, twisted way, a sharp, rough descent leads to the "Senate Chamber," a vast elliptical amphitheatre, estimated at six hundred feet long and one hundred and fifty feet wide. The sides are built up with massive ledges of limestone, thinning and converging upward into a monster dome, with a flat elliptical crown, fifty by twenty feet in diameter. The centre of this vast room is piled up with a great mass of rocky debris fallen from the immense cavity above. Ascending to the top of this hill it is found to be composed of one immense stalagmite or incrustation of white, lustrous spar, from one to six feet thick, and is called "Stalasso Mountain." From the breast of this mountain hundreds of lesser stalagmites have grown up, varying from a few inches in diameter and hight to three feet high and a foot in diameter; one of the latter is named "Ben Butler," and another "Stalasso Monument."

From the top of the "Mountain" springs the pre-eminent glory of cave formation, the "Pillar of the Constitution," a monster fluted stalactite, twenty-five feet in diameter and about thirty-five feet high, pendant from near the center of the dome, composed of bundles of smaller stalactites, sheaved together like the Roman *fasces*, with regularly butressed pediments; it is extended downward until the base rests in "Union" on the crystal mountain below, and becomes "E pluribus unum," or one united whole. On one side a stalactitic fringe-work is thrown around as if an attempt at a composite capital, and close by hangs the "Bell of Independence," which, with gentle stroke, proclaims liberty, as of old, in clear, musical notes. The "Chair of State" is canopied with snowy curtains in marble folds. The cornice behind the Pillar is garlanded with sprigs, leaves, twining tendrils and mosses, all wrought most exquisitely by the hand of nature, in calcite and alabaster; some parts are hoar and russet with age, while others are of bright, pearly crystal, in the lamplight flecked with the iridescent nacre of a sea shell. Drops of water from the roof preserve the perennial freshness and lustre to this cluster of jewels.

A little basin, cut in the top of a stalagmite, receives the drops which are unceasingly emitted from a stalactitic tube, pendant from the ceiling, and furnishes cool water to the thirsty visitor, so thoroughly charged with carbonate of lime that it soon forms a filmy coating over a glass or other article left on the surface. An estimate, based on quasi observations, places the rate of this stalagmitic growth at one inch in one hundred to one hundred and fifty years. Still beyond, over two miles from the entrance, "Pluto," in a dark, gloomy ravine, holds court at the finale of this shadowy subterranean world.

To explore the third* or southern route, the entrance is as before. In the year 1850 a small circular hole was noticed at the north end of "Bandit's Hall; on being opened, to admit a passage by crawling, the "New Cave" was discovered.

The entrance called "Fat Man's Misery" is a steeply inclined, narrow, slickened slide, best accomplished feet foremost, with closed eyes, let all holts go, and a most unclassic translation is experienced of "*facilis est descensus Averni.*" The descent seems long, but is only about eight feet to the second story of the cavern. A wooden door is placed here to prevent a draught of air at the semi-annual expirations or inhalations (breathing) of the cave at the change of external temperature which follows the vernal and autumnal equinoxes.

"Bats' Lodge" is a spacious room in which the bats delight to assemble for sleep as well as council; the ceiling was largely covered with clusters of the animals, closely

*To make the narrative conform to an easy comprehension of the map, the description of the third route precedes that of the second.

crowded together; the room was filled with their slight whining, whispering voices and the odor of their bodies. Beyond this the roof so closely approaches the floor that "Counterfeiters' Trench" was dug through the earthy deposit which had silted up the way; advancing by wide, roomy passages, with nearly level floors and the ceilings neatly whitened with shining crystals of lime and soda, the steep ascent of "Rugged Mountain" is found filling a fine, dome-shaped cavity called the "Rotunda," built up with circular layers of living stone in massive strata. At the top of this mountain were seen banks of white, needle-shaped or hairy crystals of epsom salts; handfuls were gathered two inches long, and if not removed for twelve months they continue to exude from the porous matrix until they attain a length of three to five inches; the pure, nitrous air at this point is said to give instant relief to gasping sufferers from asthma.

The "Rotunda" and "Coons' Council Chamber" are in keeping with the grand character of the cave. "Delta Island" is a pillar fifty feet long, twenty feet wide at one end and tapering to a point, in the bed of the ancient subterranean river; here the routes again divide. Proceeding on the southern route, you turn first to the right and then to the left, and enter the broad way which leads around the "Australian Continent." "Creeping Avenue" has a wide, smooth, clean floor for sixty or seventy yards, but the roof is scarcely two and a half feet high, and hands and knees are useful or necessary. The visitor is at once rewarded by enjoying one of the most brilliant and interesting of cave scenes. The "Pillared Pallace" is entered by a broad doorway, flanked by stalacto-stalagmites, while within, ceiling, cornices and shelves are fringed with stalagmites and frosted with a never ending medley of strange, crooked, writhing, twisting, unsymmetrical sprigs of white limestone, pushed out of the solid rock, and still growing by propulsion from the bottom; one cluster is a realization in stone of the horrible, snaky tresses of Medusa. Stalactites, large and small, are suspended centrally along the whole length of the room, and the plain-like floor is occasionally relieved with round, conical stalagmites, resembling cypress knees of southern swamps; the weird and interesting scenery is continued through the "Palace of the Genii," the roof of which is spangled with glittering crystals and a pendant stalactite resembling a "hornet's nest" may be so illuminated as to disclose the translucent material. "Caliope Bower" is broad, and the ubiquitous resonance with which every movement fills the cave seems to authorize the common belief of a hollow floor; the noise is due to repeating echoes developed and magnified by the great width of the adjoining room.

The chambers just mentioned, which by far exceed in beauty anything and everything that I have seen in exploring more than fifteen miles of the best reputed cave formations in Kentucky and Iowa, nature guards well by the difficult access of "Creeping Avenue," and just beyond by another creep, between a smooth floor and level roof, of seventy or eighty yards. This creep is somewhat tiresome, and readily suggests its name, "Purgatory." The "Mound" is next, with a block of stone on top, both typical rather of our pre-historic races and their ever-blazing altars than the "Hippopotamus," as it is named; an oblong piece of stone prone upon the floor, to an eye searching in the dim light for monsters, is an "Alligator."

To the left you approach the "Audience Chamber," and ascending a steep rocky incline "The Throne" is seen, unique, beautiful and petite, as if for the queen of fairy land; heavy fringed draperies of stone hang in graceful folds about the seat, supported on either side by an undulating cornice. Royalty *offers at its* banquets here only sparkling, pure water in a drop-fed basin. Beyond is a long stretch of partly explored avenues, branches, etc., with many ramifications, but being damp and in many places muddy, it is not often visited.

Returning on the west side of the "Continent," the "Alligator" sleeps with open eyes, watching for the "Nest Egg," an extraordinary concretion nearly three feet long, lying loose in its bed. Here, as elsewhere in much of the cave, the sides are belted with massive strata of limestone and alternating beds of shale, in which are bands and balls of black flint in clusters. The flints show the sharp, clean cleavage at right angles to the line of deposition, so useful to the Indian race in the manufacture of flint knives, awls, gouges, arrow-points, spears, hoes, spades, etc.

The "Hall of Representatives," about one hundred and eighty-five feet below the hotel, is a grand rotunda, well arched up, surmounted by a striking dome.

The "Wyandotte Council Chamber" is an enlargement of "Starry Hall;" in the dome of the latter a number of dark concretions are fixed, which, contrasted with the matrix, give a fine illusion of a starry canopy. A flat stone is the "Card Table" upon which visitors usually leave their cards, and among the hundreds accumulated since the custom was established, nearly every visitor will recognise some well-known name or familiar friend.

The second route is from the outer door by "Delta Island," already mentioned, northward. Passing the "Island" you traverse "Sandy Plain," nine hundred feet long, forty feet wide and ten feet high, over a good, smooth floor. Sand bars were deposited here by the ancient cave river, and are first observed on the right, and then on the left. The barometer indicates this point to be one hundred and eighty feet below the hotel, and the air has a temperature of 64° F.;* toward the further end the ceiling approaches to within five feet of the floor, but in it are reversed pot-holes and trenches in which a tall man may straighten up and rest.

From the "Plain," passing on the left the narrow entrance to "Rothrock Straits" on the lowest of the three floors of the cave, you ascend the "Hill of Difficulty;" massive cubes and blocks of stone, fallen from the hollow dome, obstruct the way; the hill is fifty feet high, and gives access, by a difficult incline, to "Monument Mountain," over which expands "Wallace's Grand Dome," fifty feet above the top of the mountain, and one hundred and eighty-five feet above the foot of the hill; the mountain path requires alpenstock and cane; the outlook from the top is a narrow opening between craggy masses of stone, fallen from above, which seem loosely wedged together in a confused heap, startling the timid with a sense of danger so they naturally seek the hand of guide or protector.

The laborious ascent is repaid by the glorious view at once realized, embracing the mountain and dome, which, together, form a grand chasm, named in honor of the discoverer and worthy citizen, "Rothrock Cathedral," two hundred feet in diameter; the mighty dome springs from the very floor, like the auditorium of the proposed Mormon temple, and ascends with arched sides, heavily corrugated with massive bands of limestone, to a flat elliptical crown, so garnished with fugitive lines of pearly crystals that it seems frescoed with fickle scrolls of silver mirage. The sharp conical sides of the upper dome are of thin-bedded limestone in regular well-defined courses or bands, which by perspective exaggerate the hight; those just below the capstones are ornamented with heavy fringes of robust stalac-

*September, 1877.

tites closely clustered, with an outer belt of delicate, slender, ice-like tubes in relief, each point bright with drops of water, which, in the brilliant illumination usual at this point, flash and sparkle like diamonds.

The interior of this grand dome is pretty well occupied with "Monument Mountain;" from the ceiling drops of water, charged with lime and continuously falling, on evaporation deposit a pure white film which forms a stalagmitic incrustation all over the top. The sharply conical pinnacle is crowned with a monumental obelisk, five feet high and eighteen inches in diameter, surrounded by white and dusky pillars known as "Lot's Wife and Daughters," ranging from two to six feet in hight, and from one and a half to two feet in diameter.

The "Sulphur Spring," in a reniform basin at the foot of the mountain, furnishes good cold water, and is the usual dining spot.

At the side of the spring is a small hole in the floor, which would be observed only on close inspection; the guide calls all to prepare for a new mode of locomotion, and making profound obeisance to visitors, with face to the floor, first feet, then legs, disappear, and soon a voice from the lower regions invites all to follow. This is the "Augur Hole," in which an edition of the Indianapolis *Herald* tightly fixed the ponderous body of Dr. Hawn, and kept him there, holding the world in anxious suspense until the next issue of the paper, when, according to the editor, the Doctor's rotundity had collapsed as fully as did the circumstantial picture which had been telegraphed and reprinted in the public journals of America and Europe.

The "Augur Hole" is one and a half by two feet in cross section, and seven feet deep. "Liliputian Hall" is one hundred yards in length, and low enough for Gulliver's spunky little friends. "Spades' Grotto" is one hundred feet long, fifty feet wide and twelve feet high, with flat roof seamed by earthquarke partings, through which lime water seeps, forming nests and fringes of stalactites—some straight, others strangely twisted, strangulated or rounded, all tipped with bright drops of water, which lengthen the stalactites and repair broken ones. This hall formerly extended to the northwest, but is now banked up with mud deposited when the old, dead, cave river passed this way.

The "Hall of Ruins," two hundred and twenty-five feet long, forty wide and twenty high, contains many angular and cubical blocks of stone; the temperature was 71° F. for some unknown reason, the warmest spot in the cave, and, in fact, so exceptional, as to be contrary to every other observation.

The "White Cloud Room," three hundred feet long, thirty wide and twenty high, is one of the largest and most beautiful areas in the cave. The roof is symmetrically arched and fretted with incrustations of lime, rounded by depositions into billowy masses of fleecy clouds. Parts of the walls were coated with snow-white gypsum, and several exquisite rosettes were observed still growing by out-thrust from minute crevices or pores in the rock, as plastic ice oozes from the ground on sharp frosty nights. The two most prominent political newspapers in the State, supposed to be typified in some obscure way by angular blocks and fragments of stone in a badly confused condition, if not "pied," flank the "Bishop's Rostrum," which is a level platform, eight by ten feet square and twenty feet above the floor, ornamented with white incrustations pendant from the platform and altar. Sophomoric declamations have often vexed the echoes of the "Bishop's" quiet little amphitheatre.

The visitor passes to the right of "Calypso Island," returning on the opposite side. "Calypso Avenue," three hundred feet long, fifty wide and forty feet high, has a whitened ceiling and perpendicular sides, ornamented with boquets of rosettes and spherical bosses. The "Aerolite," a triangular block of stone, lies near the centre of the avenue; in the ceiling the cavity is plainly visible from which the ponderous mass fell. "Cerulean Vault" gives entrance to "Rugged Pass," consisting of four hundred yards of rough ascent and descent. "Milroy's Temple" was discovered in April, 1878, by students from Wabash College. In it are found some interesting novelties: a "frozen cataract, creamy curtains and musical stalactites." The "Chapel" is crowned with a dome of rare perfection and beauty, fretted with heavy circular cornices; the "altar" is built up by visitors, each casting a stone of remembrance.

"Josephine Arcade" is a rough and toilsome path, but to the left her bower, a garden of rosettes and leaf-like sprigs of gypsum, rewards the visitor with a feast of beauty. The "Lone Chamber," or "Ball room," is one hundred and fifty feet long, forty wide and twenty high; merry dancers, with gay music, have often filled this room with festive joy. The ceiling is of white, rounded, cloud-like masses, and near the end is the "Arm Chair," which, though small, is unique; it was supposed to be the "Chair of State," now vacant, but once occupied by the "Queen of the Fairies" at their midnight festivals; since, it has seated many a queen fairer to western hearts than brightest dreams of elfin lore. At the "Dry Branch" were seen fragments of sandrock, indicating beds of the overlying Chester group.

The "Islands of Confusion" are large and small pillars in the bed of the dead river; on each side are large, roomy halls, ten to thirty feet high, with whitened walls and ceilings; horizontal recesses along the floor and sides are filled with gypsum in powder and hairy crystals. Still beyond are long stretches of cave, not fully examined, leading to "Crayfish Spring," and by "Wabash Avenue" to "Butler Point," one and a half miles farther. In this distant part evidences of former occupation are most common; Indian footprints were preserved by stone walls as late as 1855; still yet may be seen, burden poles and charred fragments of hickory bark; these pieces of wood were not rotten, for timber never decays in this dry, antiseptic air, but was simply worn to attenuation by the silent breath of the cave during ages of time. Beyond "Crayfish Spring" and "Butler Point" the large, dry halls give place to low, muddy passages.

Circumnavigating the "Islands," the left hand strait has white walls, and from the ceiling hangs curious, pendant forms; one resembles a plow-share; another thin plate, hanging obliquely from above, is named the "Silver Bell," which at gentlest touch gives out soft, musical notes, quivering like the vesper anthems of happy spirits in the still, pure air. The roof is low, but being slightly inclined allows the visitor to walk erect. The white, smooth-walled entrance is used as the "Cave Register," and here are found many familiar as well as strange names.

The passage leading southwest from the "Arm Chair" gives entrance to "Ewing Hall" and "Frost King's Palace," a grand assembly room, six hundred feet long, ten to forty wide and twenty feet high; the roof and sides are covered with white incrustations spangled with sparkling facets. From the center a "Carpet Bag" of unique pattern is suspended; the whole is beautiful, and readily suggests a palace cased in crystal by the ice king's wondrous art. The "Ice House" is a rough room where water dripping from the roof covers the surfaces of the rocks on the floor with a white, translucent film resembling ice. A sharp descent leads to the "Snowy Cliffs," four hundred feet long, thirty wide and fifteen high; the walls are massive ledges of lime-rock, covered with gypsum, resembling drifted snow and frost; in the ceiling you notice "flint balls" or boulders from one to fourteen inches in diameter, which are partly exposed, as if ornaments of jet were set in a living matrix.

"Morton's Marble Hall" is a continuation of the last, and is six hundred feet long, twenty-five to forty wide, and fifteen to twenty high; the sides and roof are completely dressed in snowy whiteness, equalling the brightest marble halls of dreamland, song or story. United, these two halls make a grand thoroughfare over one thousand feet long, and more like a railway tunnel than an ordinary cavern. Allowing eighteen inches square for the standing-room of each, 20,000 men might be massed in these halls. All minor details are lost sight of in the wonder and interest aroused by a comprehension of the grand extent and massive stability of this hall, the largest recorded cave room in the world. Just beyond is "Beauty's Bower," a prolongation of the grand avenue. But what a change! Near the floor rocky shelves project; the "Queen's Garden," the lower sides of which are covered with boquets, clusters and beds of rosettes,* leaves, lilies and sprigs of white or translucent gypsum. From the garden a low way guards the entrance to the "Fairy Palace." Here the fairies were communists, occupying together a long, low, unsightly room; but smaller bevies had made their homes along the low sides or under the projecting ledges, always covering the under side of the shelves, their elfin roof trees, with budding roses and lilies in crystal; the full-blown or opening flowers were poised in pearl, with every weird variation that the wildest imagination could compass, yet perfect in their strange, grotesque attractiveness. The exquisite beauty of these translucent

* *Oulopholites.*

or opalescent gems must be seen to be appreciated, as no description can give an adequate conception of the "Fairy Palace Home."

"Queen Mab,"* herself, would delight to hold court and revel here.

The great amount of gypsum in this part of the cave shows that it is old, and long protected from access of water or air laden with moisture; sulphate of lime being soluble, these tiny forms would be dissolved and removed were the contrary the case. This tunnel suddenly terminates, but the excavation required the existence of one large or many small streams of water. The presence of sand and rounded pebbles, known as "Wyandotte Potatoes," proves that the stream acted with violent current; that river has long been lifeless or found lower routes, while the eddies or still current once existing at this spot has silted up the continuation to the north; future exploration may find new routes by excavating such obstructed avenues.

Returning from the "Ice House" a passage leads southward to "Queen Mab's Retreat," which for a time was supposed to be the end of this branch; a narrow outlet was discovered, which added many miles to the cave, over a long lower story or floor; this has been but imperfectly examined, and many of the passage-ways leading from it have never been visited. The floor is covered with gypsum, obstructing the passage, and presenting the appearance of drifted snow.

The "Round Room" reminds one of a railway roundhouse for locomotives; going northwest from this the "Dead Sea" is a pool of bright, clear water, and "Heman's Bower" is a large room brightly decorated with gypsum rosettes and flowers.

*Shelley's poems.

Here the cave divides. The northern route has not been fully explored. The southern way leads by "Hines Cliff" and "Lonigan Pass," to "Diamond Labarynth," immediately under the old cave heretofore visited.

"Rode-rock" No. 1, is a back bone or prism shaped rock filling the bottom of the narrow passage; you must mount, best astride, and by alternate leap and spring the "rode rock" is ridden. Next is a wide, low, mud-floored room named "Wild Cat Avenue." At the northeast and southwest corners the roof approaches the floor, indicating a silted up tunnel of great extent. Passing beneath "Calypso Island" of the new cave, "Maggie's Grotto," "Lama Bower," "Marble Rivulet," "Marble Hall," "Miller's Reach," "Andrew's Retreat," "Rode-rock No. 2," still longer than No. 1, a sharp turn at "Devil's Elbow" and "Wash. Rothrock's Island" succeed, and the wide unknown beyond for limited time did not admit the name of exploration. It is almost certain that further examination, assisted by excavation of the banked up termini at a dozen points, will develop routes and distances which will show that the present explorations are only a beginning. So that future maps will exhibit many avenues and rooms in addition to the estimated extent of twenty-three miles.*

The following analyses and observations are quoted from the report of Prof. E. T. Cox, on pages 162–4 of this volume; they solve many important questions on the chemistry of the subjects under discussion.

Analysis of red plastic clay, unctious to the touch, and without grit, cuts very smooth:

* The accompanying map of Wyandotte Cave was prepared from the best attainable data, and has been revised and corrected by the proprietor and guides. The dotted lines indicate the lower story or floor. The dimensions are generally estimated.

	Per Cent.
Loss at red heat	11.70
Silicic acid	48.50
Ferric oxide	12.30
Manganic oxide	1.05
Alumina	19.50
Lime	1.79
Magnesia	0.52
Carbonic anhydride	1.97
Sulphuric anhydride	1.11
Phosphoric acid	0.44
Chloride of alkalies and loss	1.12
	100.00

"Magnesian earth" is more properly a combination of gypsum and ferruginous clay. Analysis:

	Per Cent.
Loss at red heat	24.10
Silica	31.60
Ferric oxide	10.70
Manganic oxide	trace
Alumina	3.90
Lime	8.28
Magnesia	1.54
Carbonic anhydride	8.22
Sulphuric anhydride	11.00
Phosphoric acid	0.41
Chloride of alkalies and loss	0.25
	100.00

"Nitre earth." This is a red clay similar to that used for the manufacture of saltpetre during the war of 1812. A large amount of this earth was lixiviated during that period, and owing to the high price of nitre the manufacture was conducted with profit. It contains in 100 parts:

	Per Cent.
Loss at red heat	16.50
Silica	20.60
Ferric oxide	6.03
Manganic oxide	0.75
Alumina	20.40
Lime	8.06
Magnesia	4.58
Carbonic acid	10.38
Sulphuric acid	6.55
Phosphoric acid	2.43
Nitric acid	3.50
Chloride of alkalies and loss	0.32
	100.00

The 3.5 per cent. of nitric acid would unite with 3.05 per cent. of potash to form 6.55 per cent. of nitre, or 100 pounds of the earth would yield 6.55 pounds of nitre. The large amount of phosphoric acid present is probably due to the clay containing some decomposed animal bones.

"Bat guano." In portions of both the old and new caves there are deposits of bat guano, but it is possible that the expense of bringing it out through some very narrow and rugged passages will be too great to render it available for fertilizing purposes. Composition:

	Per Cent.
Loss at red heat	44.10
Organic matter	4.90
Ammonia	4.25
Silica	6.13
Alumina	14.30
Ferric oxide	1.20
Lime	7.95
Magnesia	1.11
Sulphuric acid	5.21
Carbonic acid	3.77
Phosphoric acid	1.21
Chloride of alkalies and loss	5.87
	100.00

"Analysis of water from the "Sulphur spring" in Wyandotte Cave. An imperial gallon contains 55.3 grains of solid matter, composed of:

	Per Cent.
Insoluble silicates	0.200
Ferrous oxide	0.144
Calcium oxide	4.170
Magnesium oxide	9.830
Sulphuric anhydride	25.180
Carbonic anhydride	8.160
Sodium oxide	1.127
Potassium oxide	5.560
Chlorine	0.350
Loss and undetermined	5.679
Total solid matter	55.300

This is a sulphate of magnesia water, and might be more properly called an epsom spring.

The above substances are probably combined to form the following salts:

	Per Cent.
Carbon dioxide, free	5.6946
Silicic acid	0.2000
Ferrous carbonate	0.2319
Calcium carbonate	3.8899
Calcium sulphate	6.4537
Magnesium sulphate (epsom salts)	29.4929
Potassium sulphate	1.0366
Sodium sulphate (glauber salts)	2.2088
Sodium chloride (common salt)	0.5757
Loss and undetermined	5.5149
Total solid matter	55.3000

Medical properties, diuretic and tonic.

Of seeing animals, the raccoon, fox and opossum are known to visit and roam through the cave in winter. Bears formerly retired to the cave, and their wallows and beds are still pointed out. Bats are always present, but more numerous in winter than in summer. Cave rats are abundant; they are of a light gray color, with long, slim, weasel-like bodies; the sensitive whiskers or feelers about the mouth are nearly twice as long, the ears longer and larger, and the eyes much larger than in the common rat. The flesh of dead animals dries up and does not decay in the cave. The body of an opossum, found twenty-five years ago in "Counterfeiter's Trench," still testifies to the antiseptic character of the dry cave air.

The following observations on the fauna of Wyandotte Cave and its companion, the Little Wyandotte, were prepared by Prof. E. D. Cope, for the Rep. Ind. Geo. Survey, 1872, and have been carefully revised and corrected by the author of this Report:

OBSERVATIONS ON WYANDOTTE CAVE AND ITS FAUNA.

BY PROF. E. D. COPE.

The Wyandotte Cave traverses the St. Louis limestone of the carboniferous formation in Crawford county, in southwestern Indiana. I do not know whether its length has ever been determined, but the proprietors say that they have explored its galleries for twenty-three miles, and it is probable that its extent is equal to that of the Mammoth Cave in Kentucky. Numerous galleries which diverge from its known courses in all directions have been left unexplored.

The Wyandotte Cave is as well worthy of popular favor as the Mammoth. It lacks the large bodies of water which diversify the scene in the latter, but is fully equal to it in the beauty of its stalactites and other ornaments of calcite and gypsum. The stalactites and stalagmites are more numerous than in the Mammoth, and the former frequently have a worm or maccaroni-like form, which is very peculiar. They twist and wind in masses like the locks of Medusa, and often extend in slender runners to a remarkable length. The gypsum rosettes occur in the remote regions of the cave, and are very beautiful. There are also masses of amorphous gypsum of much purity. The floor in many places is covered with curved branches, and what is more beautiful, of perfectly transparent acicular crystals, sometimes mingled with imperfect twin-crystals. The loose crystals in one place are in such quantity as to give the name of "Snow Banks" to it. In other places it takes the form of japanning on the roof and wall rock.

In one respect the cave is superior to the Mammoth—in its vast rooms, with step-like domes, and often huge stalagmites on central hills. In these localities the rock has been originally more fractured or fragile than elsewhere, and has given away at times of disturbance, piling masses on the floor. The destruction having reached the thin-bedded strata above, the breaking down has proceeded with greater rapidity, each bed breaking away over a narrower area than that below it. When heavily-bedded rock has been again reached, the breakage has ceased, and the stratum remains as a heavy coping stone to the hollow dome. Of course the process piles a hill beneath, and the access of water being rendered more easy by the approach to the surface, great stalactites and stalagmites are the result. In one place this product forms a mass extending from floor to ceiling, a distance of thirty or forty feet, with a diameter of twenty-five feet, and a beautifully fluted circumference. The walls of the room are encrusted with cataract-like masses, and stalagmites are numerous. The largest room is stated to be 245 feet high and 350 feet long, and to contain a hill of 175 feet in hight. On the summit are three large stalagmites, one of them pure white. When this scene is lit up, it is peculiarly grand to the view of the observer at the foot of the long hill, while it is not less beautiful to those on the summit. There is no room in the Mammoth Cave equal to these two.

An examination into the life of the cave shows it to have much resemblance to that of the Mammoth. The following is a list of sixteen species of animals which I obtained, and by its side is placed a corresponding list of the species obtained by Mr. Cooke and others at the Mammoth Cave. These number seventeen species. As the Mammoth has been more frequently explored, while two days only were devoted to the Wyandotte, the large number of species obtained in the latter suggests that it is the richer in life. This, I suspect, will prove to be the case, as it is situated in a fertile region. Some of the animals were also procured from caves immediately adjoining, which are no doubt connected with the principal one.

Of the out-door fauna which find shelter in the cave, bats are of course most numerous. They are probably followed into their retreat by owls. The floors of some of the chambers were covered to a considerable depth by the castings of these birds, which consisted of bats' fur and bones. It would be worth while to determine whether any of the owls winter there.

I believe that wild animals betake themselves to caves to die, and that this habit accounts in large part for the great collections of skeletons found in the cave deposits of the world. After much experience in wood craft, I may say that I never found the bones of a wild animal which had not died by the hand of man, lying exposed in the forest. I once thought I had found the place where a turkey vulture (*Cathartes aura*) had closed its career, on the edge of a wood, and it seemed that no accident could have killed it, the bones were so entire as I gathered them up one by one. At last I raised the slender radius; it was broken, and the only injured bone. I tilted each half of the shaft, and from one rolled a single shot! The hand of man had been there. One occasionally finds a mole (*Scalops* or *Condylura*) overcome by the sun on some naked spot, on his midday exploration, but if we seek for animals generally, we must go to the caves. In Virginia I found remains of very many species in a recent state; in a cave adjoining the Wyandotte I found the skeleton of a gray fox (*Vulpes Virginianus.*) In a cavern in Lancaster county, Pennsylvania, in an agricultural region, I noticed bones of five or six box turtles (*Cistudines,*) as many rabbits, and a few other wild species, with dog, horse, cattle, sheep, etc., some of which had fallen in.

LIST OF LIVING SPECIES IN THE TWO CAVES.

WYANDOTTE.	MAMMOTH.
Vertebrata.	
Amblyopsis spelæus, DeKay.	Amblyopsis spelæus, DeKay.
	Typhlichthys subterraneus, Girard.
Arachnida.	
Erebomaster flavescens, Cope.*	Acanthocheir aramanta, Telk.
	Phrixis longipes, Cope.†
Anthrobia.	Anthrobia monmouthia, Telk.
Crustacea.	
Orconectes pellucidus, Tellk.	Orconectes pellucidus, Tellk.
Cæcidotea microcephala, Cope.‡	Cæcidotea stygia, Pack.
Cauloxenus stygius, Cope.‖	Stygobromus vitreus, Cope.§

*Ann. Report Geol. Survey Indiana, 1872, p. 176.
†L. c., p. 180.
‡L. c., p. 174.
‖L. c., p 175.
§L. c., p. 181.

Insecta.

Anophthalmus tenuis, Horn.**	Anophthalmus Menetriesii, Motsch.
Anophthalmus eremita, Horn.††	Anophthalmus Tellkampfii, Erichs.
Quedius spelæus, Horn.	Adelops hirtus, Tellk.
Lesteva sp. nov. Horn.	
Raphidophora.	Raphidophora subterranea, Scudd.
Phora.	Phora.
Anthomyia.	Anthomyia.
Machilis.	Machilis.
Campodea sp.	Campodea Cookei, Pack.
Tipulid.	

Myriopoda.

Spirostrephon cavernarum, Cope.	Scoterpes Copei (Pack.) Cope.

The blind fish of the Wyandotte Cave is the same as that of the Mammoth, the *Amblyopsis spelœus*, DeKay. It must have considerable subterranean distribution, as it has undoubtedly been drawn up from four wells in the neighborhood of the cave. Indeed, it was from one of these, which derives its water from the cave, that we procured our specimens, and I am much indebted to my friend N. Bart. Walker, of Boston, for his aid in enabling me to obtain them. We descended a well to the water, some twenty feet below the surface, and found it to communicate by a side opening with a long low channel, through which flowed a lively stream of very cool water. Wading up the current in a stooping posture, we soon reached a shallow expansion or pool. Here a blind crawfish was detected crawling round the margin, and was promptly consigned to the alcohol bottle. A little further beyond, deeper water was reached, and an erect position became possible. We drew the seine in a narrow channel, and after an exploration under the bordering rocks secured two fishes. A second haul secured another. Another was seen, but we failed to catch it, and on emerging

** L. c., p. 177.
†† L. c., p. 178.

from the cave I had a fifth securely in my hand, as I thought, but found my fingers too numb to prevent its freeing itself by its active struggles.

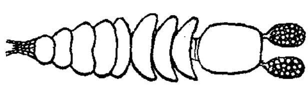
If these Amblyopses be not alarmed, they come to the surface to feed, and swim in full sight like white aquatic ghosts. They are then easily taken by the hand or net, if perfect silence is preserved, for they are unconscious of the presence of an enemy except through the medium of hearing. This sense is, however, evidently very acute, for at any noise they turn suddenly downward and hide beneath stones, etc., on the bottom. They must take much of their food near the surface, as the life of the depths is apparently very sparse. This habit is rendered easy by the structure of the fish, for the mouth is directed partly upwards, and the head is very flat above, thus allowing the mouth to be at the surface. It thus takes food with less difficulty than other surface feeders, as the perch, etc., where the mouth is terminal or even inferior; for these require a definite effort to elevate the mouth to the object floating on the surface. This could rarely be done with accuracy by a fish with defective or atrophied visual organs. It is therefore probable that fishes of the type of the *Cyprinodontidæ*, the nearest allies of the *Hypsæidæ* and such *Hypsæidæ* as the eyed *Chologaster*, would possess in the position of the mouth a slight advantage in the struggle for existence.

The blind crawfish above mentioned is specifically the same as that of the Mammoth Cave, though presenting slight differences from it. Its spines are everywhere less developed, and the abdominal margins and cheles have slightly different forms. I call it *Orconectes pellucidus*, separating it generically from *Cambarus*, or the true crawfishes, on account of the absence of visual organs. The genus *Orconectes*, then, is established to include the blind crawfishes of the Mammoth and Wyandotte Caves. Dr. Hagen, in his monograph of the American Astacidæ, suspects that some will be disposed to separate the *Cambarus pellucidus* as the type of special genus, but thinks such a course would be the result of erroneous reasoning. Dr. Hagen's view may be the result of the objection which formerly prevailed against distinguishing either species or genera whose characters might be suspected of having been derived from others by modification, or assumed in descent.

The prevailing views in favor of evolution will remove this objection; and for myself I have attempted to show* that it is precisely the structural characters which are most obviously, and therefore most lately, assumed on which we have been in the habit of depending for discrimination of genera. The present is a case in point. So far also as the practice of naturalists goes this course is admissible, for the presence or absence as well as the arrangement of the eyes have long been regarded as generic indications among the Myriopoda and Arachnida. Without such recognition of a truly structural modification our system becomes unintelligible.

Dr. Packard described in his article already quoted an interesting genus of Isopoda allied to the marine form *Idotœa,* which Mr. Cooke discovered in a pool in the Mammoth Cave. He called it *Cæcidotea.* I obtained a second species in a cave adjoining the Wyandotte, which differs in several important respects. The head is smaller and more acuminate, and the bases of the antennæ are more closely placed than in *C. stygia* Pack. I call it *Cæcidotea microcephala.* Both species are blind. The new species is pure white. It was quite active, and the females carried a pair

Fig. 100.



Cæcidotea microcephala Cope, magnified 6.5 times.

*Origin of Genera, p. 41.

of egg pouches full of eggs. The situation in which we found it was pecular. It was only seen in and near an empty log trough used to collect water from a spring dripping from the roof of one of the chambers.

The Lernæan *Cauloxenus stygius* Cope is a remarkable creature. It is a parasite on the blind fish, precisely as numerous species near of kin, attach themselves to various species of marine fishes. The Wyandotte species is not so very unlike some of these. It is attached by a pair of altered fore-limbs, which are plunged into the skin of the host and held securely in that position by the barbed or recurved claws. The position selected by the blind fish *Lernæan* was the inner edge of the upper lip, where she hung in a position provocative of attempts at mastication on the part of the fish, and reminding one of the picture of the man on the ass' back, holding a fork of fodder before the animal's nose, in illustration of the motto that "persuasion is better than force." The little creature had an egg pouch suspended on each side, and was no doubt often brought in contact with the air by her host.

Fig. 110.

Cæcidotea microcephala Cope. The mandible and palpi of right side more enlarged. The outer palpus lies above the lateral plate, and its origin was not seen.

This position would not appear to be a favorable one for long life, as the body of the *Cauloxenus* would be at once caught between the teeth of the fish, should its direction be reversed or thrown backwards. The powerful jaw-arms, however, maintained like a steel spring a direction at a strong angle with the axis of the body, which was thrown upward over the upper lip, the apex of the cephalo thorax being between the lips of the fish. This position being retained, it becomes a favorable one for the sustenance of the parasite, which is not a sucker or devourer of its

Fig. 111.

Cauloxenus stygius in position on the lip of *Amblyopsis spelæus*, enlarged.

host, but must feed on the substrances which are caught by the blind fish and crushed between its teeth. The fragments and juices expressed into the water must suffice for the small wants of this crustacean.

But if the supply of food be precarious, how much more so must be the opportunities for the increase of the family. No parasitic male was observed in the neighborhood of the female, and it is probable that as in the other *Lernœopodidœ*, he is a free swimmer, and extremely small. The difficulty of finding his mate on an active host-fish must be augmented by the total darkness of his abode, and many must be isolated owing to the infrequent and irregular occurrence of the fish, to say nothing of the scarceness of its own species.

Fig. 113.

Cauloxenus stygius. Antennal processes and muzzle more enlarged.

The allied genera, *Achtheres* and *Lernœopoda,* present very distinct distributions, the former being fresh water and the latter marine. *Lernœopoda* is found in the most varied types of fishes and in several seas; *Achtheres* has been observed on perch from Asia and Europe, and in a South American *Pimelodus.* It is to the latter that *Cauloxenus* is most nearly allied, and from such a form we may perhaps trace its descent; modification being consequent on its wandering into subterranean streams. The character which distinguishes it from its allies, is one which especially adapts it for maintaining a firm hold on its host, *i. e.*, the fusion of its jaw arms into a single stem.

Fig. 112.

Cauloxenus stygius. The animal viewed from below, with an infero-lateral view of the cephalothorax.

Whether the present species shared with the *Amblyopsis* its history and changes, or whether it seized upon the fish as a host at some subsequent period, is a curious speculation.

Its location at the mouth of the fish could scarcely be maintained on a species having sight, for if the host did not remove it, other individuals would be apt to.

I may here allude to another blind Crustacean which I took in the Mammoth Cave, and which has been already mentioned in the Annals and Magazine of Natural History as a Gammaroid. Mr. Cooke and myself descended a hole, and found a short distance along a gallery, a clear spring covering, perhaps, an area ten feet across. Here Mr. Cooke was so fortunate as to procure the *Cæcidotea stygia*, while I took the species just mentioned, and which I name *Stygobromus vitreus*. The genus is new, and represents in a measure the *Niphargus* of Schiodte found in the caves of Southern Europe. It resembles, however, the true *Gammarus* more closely, by characters pointed out at the close of this article. This genus has several species in fresh waters, which are of small size, and swim actively, turning on one side or the other.

Of insects I took four species of beetles, all new to science, two of them of the blind carniverous genus *Anopthalmus*, and two *Staphylinidæ*, known by their very short wing-cases and long, flexible abdomen. Dr. George H. Horn has kindly determined them for me. One of them, the *Quedius spelæus* Horn, is a half inch in length, and has rather small eyes.* It was found not far from the mouth of the cave. Dr. Horn furnishes me with the following list of Coleoptera from the two caves in question:

Anopthalmus Tellkampfi, Erichs.	Mammoth Cave.	
Anopthalmus Menetriesi, Motsch, *anagulatus* Lec.	Mammoth Cave.	
Anopthalmus erimita, Horn.	Wyandotte Cave.	
Anopthalmus tenuis, Horn.	Wyandotte Cave.	
Anopthalmus striatus, Motsch.	Mammoth Cave.	Unknown to me.
Anopthalmus ventricosus, Motsch.	Mammoth Cave.	Unknown to me.
Adelops hirta, Tellk.	Mammoth Cave.	

*See Proceed. Amer. Entom. Soc., 1871, p. 332.

These are the only true cave insects at present known in these fauna. Other species were collected within the mouths of the caves, but which can not be classed with the preceding, as cave insects proper.

Catops n. sp.?	Wyandotte Cave.
Quedius spelæus, Horn.	Wyandotte Cave.
Lesteva n. sp.	Wyandotte Cave.

And another, Alæocharide Staphylinide, allied to Tachyusa, also from Wyandotte Cave. No names have as yet been given to any of these excepting the second. A monograph of Catops has already appeared containing many species from our fauna, and as the work is inaccessible at present, I have hesitated to do more than indicate the presence of the above species.

Two other species of true cave insects are known in our fauna; *Anophthalmus pusio* Horn, (Virginia) Erhart's Cave, *Anophthalmus pubescens* Horn, (Illinois) Cave City Cave.

The cricket of the Wyandotte Cave is stouter than that of the Mammoth, and thus more like the *Raphidophora lapidicola* of the forest. There were three species of flies, one or more species of *Poduridæ* and a *Campodea* not determined.

Centipedes are much more abundant in the Wyandotte than in the Mammoth Cave. They especially abounded on the high stalagmites which crown the hill beneath the Mammoth dome, which is three miles from the mouth of the cave. The species is quite distinct from that of the Mammoth Cave, and is the one I described some years ago from caves in Viginia and Tennessee. I call it *Spirostrephon cavernarum*, agreeing with Dr. Packard that the genus* to

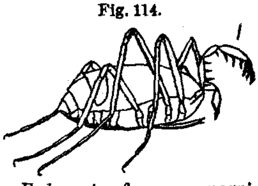
* *Pseudotremia.*

which it was originally referred is of doubtful validity. The species is furnished with a small triangular patch of eyes, and is without hairs, but the antennæ are quite elongate. Its rings are quite handsomely keeled. The allied form found by Caleb Cooke in the Mammoth Cave has been described by Dr. Packard as *Spirostrephon Copei.* It is eyeless, and is, on this account alone, worthy of being distinguished generically from *Spirostrephon,* though the absence of pores asserted by Dr. Packard, would also constitute another character. *Spirostrephon* possesses a series of lateral pores as I have pointed out in accordance with Wood's view.† This genus may be then named *Scoterpes.* I look for the discovery of *S. cavernarum* in the Mammoth Cave.

Two species of Arachnidans were observed, one a true spider, the other related to the "long-legs" of the woods. A species, similar to the former, is found in the Mammoth Cave, and others in other caves, but in every instance where I have obtained them, they have been lost by the dissolution of their delicate tissues in the impure alcohol. The other forms are more completely chitinized and are easily preserved. They are related to the genus *Gonyleptes* found under stones in various portions of the country. Dr. Wood describes a species from Texas, and I have taken them in Tennessee and Kansas. In the Wyandotte Cave I found a number of individuals of a new species at a place called the Screw Hole. This is a narrow passage between masses of rock, which rise from the end of a gallery to the floor of a large room called the Senate Chamber. Though living at a distance of four or five miles from the mouth of the cave, this species is furnished with eyes. Its limbs are not very long, but its palpi are largely developed, and armed with a

† Proceed. Amer. Entom. Soc., 1870.

Fig. 114.

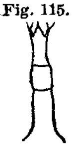


Erebomaster flavescens, magnified 7.6 times.*

double row of long spines pinnately arranged, like its relative of the Mammoth Cave, the *Acanthocheir*. This species is described at the end of the article as *Erebomaster flavescens* Cope. In its relationships it may be said to stand between *Acanthocheir* and *Gonyleptes*.

Besides *Acanthocheir*, another blind Gonyleptid exists in the Mammoth Cave, which I found several miles from the mouth. It is blind like the former, but differs in having many more joints to the tarsi, approaching thus the true *Phalangia*, or long-legs. There are six joints and terminal claws, while *Acanthocheir* is said to have two and *Erebomaster* three joints. It is larger than *A. armata*, and has much longer legs. Its palpi are also longer and their spines terminate in long hairs. I have named it *Phrixis longipes*.

Fig. 115.



Erebomaster flavescens. Male organ from below.

Dr. Packard and Mr. Putnam have already discussed the question of the probability of the origin of these blind cave animals by descent from outdoor species having eyes. I have already expressed myself in favor of such view, and deem that in order to prove it we need only establish two or three propositions. First, that there are eyed genera corresponding closely in other general characters with the blind ones; second, that the condition of the visual organs is in some cave type variable; third, if the abortion of the visual organs can be shown to take place coincidentally with general growth to maturity, an important point is gained in explanation of the *modus operandi* of the process.

First, as to corresponding forms; the *Typhlichthys* of the

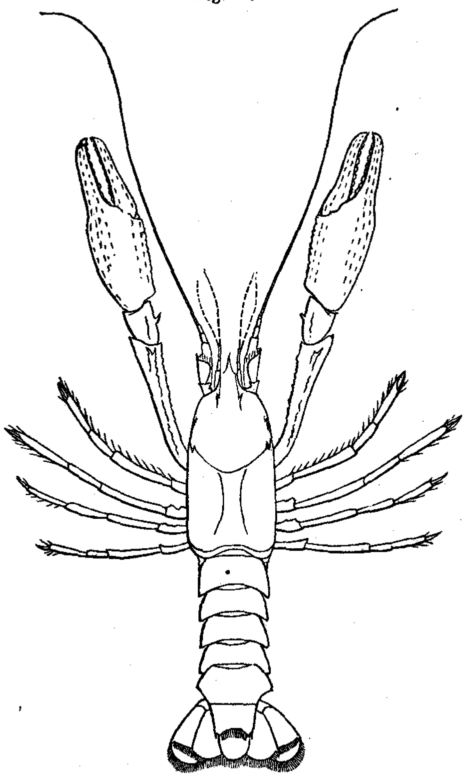
*Our engraver has not correctly represented the posterior lateral border of the large dorsal scutum. The mandible should also have been represented as terminating in a pair of nippers.—Eds.

Mammoth is identical* with *Chologaster*, except in its lack of eyes. *Orconectes* bears the same relation to *Cambarus*; *Stygobromus* bears nearly the same to *Gammarus*, and *Scoterpes* is *Spirostrephon* without eyes, and no pores.

Secondly, as to variability. I have already shown that in *Gronias nigrilabris*, the blind Silurid from the Conestoga in Pennsylvania, that while all of several specimens observed were blind, the degree of atrophy of the visual organs varies materially, not only in different fishes, but on different sides of the same fish. In some the corium is imperforate, in others perforate on one side, in others on both sides, a rudimental cornea being thus present. In some the ball of the eye is oval and in others collapsed. This fish is related specifically to the *Amiurus nebulosus* of the same waters, more nearly than the latter is to certain other Amiuri of the Susquehanna river basin, to which the Conestoga belongs, as for instance the *A. albidus*; it may be supposed to have been enclosed in a subterranean lake for a shorter time than the blind fishes of the Western caves, not only on account of the less degree of loss of visual organs, but also in view of its very dark colors. A feature on which I partly relied in distinguishing the species has, perhaps, a different meaning. The tentacles or beards were described as considerably shorter than those of allied species. On subsequently examining a number of individuals I was struck with the irregularity of their lengths, and further inspection showed that the extremities were in each case enlarged, as though by a cicatrix. I have imagined that the abbreviation of the tentacles is then due to the attacks

*Mr. Putnam shows that the known species of *Chologaster* differ from those of *Typhlichthys* in the lack of the papillary ridges, which is probably another generic character similar to the loss of eyes. The absence in *Chologaster* of minute palatine teeth, and the presence of an additional pair of pyloric cæca, which he mentions, will be apt to prove only specific of carnivorous fishes which inhabit the subærial waters into which the *Gronias* strays, from whom its blindness renders it unable to protect itself.

Fig. 116.



Orconectes pellucidus var., nat. size.

Thirdly, it is asserted that the young *Orconectes* possess eyes, and that perhaps those of the *Typhlichthys* do also. If these statements be accurate, we have here an example of what is known to occur elsewhere; for instance, in the whalebone whales. In a fœtal stage these animals possess rudimental teeth like other Cetacea, which are subsequently absorbed. This disappearance of the eyes is regarded with reason by Professor Wyman as evidence of the descent of the blind forms from those with visual organs. I would suggest that the process of reduction illustrates the law of "retardation," accompanied by another phenomena. Where characters which appear latest in embryonic history are lost we have simple retardation; that is, the animal in successive generations fails to grow up to the highest point, falling farther and farther back, thus presenting an increasingly slower growth in this special respect. Where, as in the presence of eyes, we have a character early assumed in embryonic life, the retardation presents a somewhat different phase. Each successive generation, it is true, fails to come up to the completeness of its predecessor at maturity, and thus exhibits "retardation;" but this process of reduction of the rate of growth is followed by its termination in the part long before growth has ceased in other organs. This is an exaggeration of retardation. Thus the eyes in the *Orconectes* probably once exhibited at maturity the incomplete characters now found in the young, for a long time a retarded growth continuing to adult age before its termination was gradually withdrawn to earlier stages. Growth ceasing entirely, the phase of atrophy succeeded, the organ becomes stationary at an early period of general growth, being removed, and its contents transferred to the use of other parts by the activity of "growth force." Thus for the loss of late assumed organs we have "retardation," but for that of early assumed ones, "retardation and atrophy."

In comparing the list of animals from the Wyandotte with that of the Mammoth Cave, it will be observed that the representatives in the former of two of the blind genera of the latter, are furnished with eyes. These are the *Erebomaster* and *Spirostrephon*, which correspond with the *Acan-*

thocheir and *Scoterpes* respectively. In the outer part of a branch of tbe Wyandotte I took two eyed beetles, the *Quedius spelœus* and a *Platynus.*

The outdoor relatives of the blind forms are various. Those having congeners outside are the *Spirostrephon, Campodea, Machilis Phora, Raphidophora.* Those with near but few allies, the *Scoterpes, Amblyopsis* and the three *Gonyleptidœ.* Species of the latter are much more rare in this country than those of *Phalangiidœ,* which are not known from the caves. The *Orconectes* is mostly fresh water in kindred, while Packard shows that those of the *Cœcidotea* are marine. Those of the *Cauloxenus* are partly marine, and those of the *Stygobromus* fresh water and marine.

The mutual relations of this cave life form an interesting subject. In the first place, two of the beetles, the crickets, the centipede, the small crustaceans (food of the blind fish) are more or less herbivorous. They furnish food for the crawfish, *Anopthalmus,* and the fish. The vegetable food supporting them is in the first place fungi, which in various small forms, grow in damp places in the cave, and they can always be found attached to excrementitious matter dropped by the bats, rats and other animals which extend their range to the outer air. Fungi also grow on the dead bodies of the animals which die in the caves, and are found abundantly on fragments of wood and boards brought in by human agency. The rats also have brought into fissures and cavities communicating with the cave, seeds, nuts, and other vegetable matters, from time immemorial, which have furnished food for insects. Thus rats and bats have, no doubt, had much to do with the continuance of land life in the cave, and the mammals of the post-pliocene or earlier period, which first wandered and dwelt in its shades were introducers of a permanent land life.

As to the small crustaceans, little food is necessary to support their small economy, but even that little might be thought to be wanting, as we observe the clearness and limpidity of the water in which they dwell. Nevertheless the fact that some cave waters communicate with outside streams is a sufficient indication of the presence of vegetable life and vegetable debris in variable quantities at different times. Minute fresh water algæ no doubt occur there, the spores being brought in by external communication, while remains of larger forms, as confervæ, etc., would occur plentifully after floods. In the Wyandotte cave no such connection is known to exist. Access by water is against the current of small streams which discharge from it. On this basis rests an animal life which is limited in extent and must be subject to many vicissitudes. Yet a fuller examination will probably add to the number of parasites on those already known. The discovery of the little Lernæan shows that this strange form of life has resisted all the vicissitudes to which its host has been subjected. That it has outlived all the physiological struggles which a change of light and temperature must have produced, and that it still preys on the food of its host as its ancestors did, there is no doubt. The blindness of the fish has favored it in the "struggle for existence," and enabled it to maintain a position nearer the commissariat, with less danger to itself than did its forefathers.

SALTPETRE CAVE.

Half a mile northwest from the Wyandotte House, and about one hundred feet lower down, in a ravine, a doorway, five or six feet high and thirty feet wide, spanned by heavy ledges of limestone, gives entrance to a room two hundred and twenty-five feet long, seventy-five feet wide and fifteen to thirty high, with flat, clean ceiling. The contents and nitrous earth of the floor was removed for the manufacture of saltpetre during the war of 1812; fragments of the lixiviating hoppers, vats, troughs and furnaces still remain after a lapse of more than sixty years, showing the extent and importance of the work carried on by Dr. Adams.

Near the door, on the right, are two columnar stalactites, ten feet long and fifteen to twenty inches in diameter, which have become united from the center downwards—they are known as the "Siamese Twins;" heavy fringes of stubby stalactites ornament a few of the rocky ledges. In the right hand corner two enormous inverted funnel-shaped chimneys loom up out of sight and light, through the rock, about fifteen feet in diameter—a "Cyclopean furnace." Many pebbles and rounded stones of various sizes, show the volume and velocity of the current of water which once flowed here and excavated this cavern.

LITTLE WYANDOTTE CAVE.

This is close to the hotel, and from parallelism of direction, it is probable that it was once connected in some way with the main cavern, and that passages which once existed are now banked up with silt or fallen rocks; the separation is not great, for on one occasion, when a military band was playing in the latter, the music was distinctly heard in the inner chamber of Little Wyandotte. The whole length is about two thousand feet; it is entered by descending a ladder in a well-shaped opening about three feet in diameter, situated on the side of a sink funnel. After recovering from the sudden darkness, on entering, the vestibule is found to be twenty by forty feet, and ranging from two to fifteen feet high, with a few round or flat stalactites pendant from the roof. Proceeding north the narrow passage is almost obstructed by a huge columnar stalagmite, five feet high and two and a half in diameter, wonderfully symmetrical in form, called "Pompey's Pillar," which guards the entrance to the house of the "Star Eyed Egyptian"—"Cleopatra's Palace"—which is a gem of beauty; hundreds of stalactites, from snowy white to brown, hang from the roof, isolated or clustered in sheaves and fringes. The recesses are draped in wave-folded stone, hanging at places as heavy as damask and at others light as silk. Many of the stalactites are short resonant tubes, while others reach from roof to floor, with little or no variation in size; the floor is encumbered with stalagmites from a few inches to two feet high, and from one to three feet in diameter, finely illustrating Southey's picture of "stone drops from the cavern's fretted hight." On the right stalagmites reach up and blend with stalactites and form a pillared recess, draped about the top with clusters of needle-shaped pendants in sheaves. Close by a broken column, the work of some vandal Anthony, lies prone, and is called "Cleopatra's Couch" and "Bower." The Egyptian department is thirty feet long, twenty feet wide, and from five to twenty high. A pit succeeds, in which flows the "River Styx" at flood time; the violence of this winter torrent is indicated by the extent of the chasm, which is dark as Phlegethon and reported as sixty feet deep; but, happily for moderns, is bridged with a slippery, rough stone beam; crossing this "Natural Bridge," a massive, fluted, monolitic column blocks the way; crawling around and under the inclined side, it is found to be a great stalactite, thirteen and a half feet long and three to six feet in diameter, which has fallen from a dark recess in the ceiling; it leans against and partly covers its opposing stalagmite, an obtusely conical monster, ten feet in diameter and eleven feet high, decked with shelly plaits along its fluted sides, which, when gently struck, give out soft, musical notes, Immediately beyond this passage is a fluted stalagmite, eighteen feet high and two and a half in diameter, which supports or opposes a succession of stalactites reaching seven feet back, connected by a heavily folded stone curtain fretted with white coral work; behind this curtain some exquisite cave decorations are seen on the "Corinthian Column," a straight, symmetrical shaft which springs from floor to ceiling, nine and a half feet long and scarce three inches in diameter; a number of slender, tubular stems cluster around the capital of this column, each terminated with a drop of water, which glistens in the artificial light like a well cut diamond. The remainder of the room is crowded from floor to roof with a profusion of lime work, representing curtains, fringes, columns, mouldings, cornices, etc. Twenty yards beyond is a small chamber forty feet long, twelve wide and high, containing a single stalactite and two stumpy stalagmites, succeeded by a long, low passage, once the lair of beasts. In the vault beyond is the "Tomb of Moses," a coffin-shaped mass of rock twelve feet long, four wide and three feet high; stalagmitic tapers have grown up at the head, and from above is suspended a cluster of points all tipped with water, which, in the lamplight, glow like fire. With the conviction that there is no mistake about Moses or the reality of his alleged tomb you pass on to the most brilliant illustration of dreamy cave life, a combination of all the peculiar, weird, startling, fascinating forms, pillars, columns, obelisks, spires, minarets and domes, built up in Parian whiteness or opalescent alabaster, promiscuously crowded into a space sixty feet long, fifteen to thirteen feet wide and ten to fifteen high.

Some of the ornaments are colossal, with robust strength, others are delicate and slender, as if a mere snow line, all enriched with fringes of pearly tubes, tipped with the ever-present, sparkling drops; crystal alcoves, elfin recesses and fairy bowers are hidden in every nook. The name of "Pantheon" has been suggested for this "Crystal Palace." "Jupiter" reigns on the "Pillar of Clouds," "Venus" sleeps in Parian marble, "Diana" aims at a shadowy doe, "Ceres" waves her golden sheaves, but dearer to Saxon hearts are the elfs and fays that hold festival in a hundred nooks and crannies; last "Cupid," with his arrows tipped with fire, is ever ready to transfix twin hearts and register troths plighted before his pearly shrine.

The whole of the Pantheon is a group of wonders, demanding long study to be fully understood and appreciated.

ECONOMIC GEOLOGY.

There is room for improvement in the agriculture of this county. The river bottoms are highly productive, and with judicious rotation of crops will prove fertile for years to come; the level plateau covering the elevated region on the eastern side of the county may be referred to lacustral origin. It has a close, cold soil, which in dry seasons, or when well drained, shows great strength, producing good crops of hay, wheat, etc. This may be greatly enlarged, and the crops wonderfully increased by a judicious system of tile and open-air drains, and thus the value of the farms brought up to an average with more favored regions. The soil in the hilly regions of the western part of the county is, as a rule, composed of fine siliceous material, easily exhausted, and requires careful management. Exhaustive crops should be avoided, the stalks, straw and chaff of all the crops should invariably be returned to the soil as manure, and a large area devoted to fruit and orchard grass for permanent pastures and clover. Exhausted fields may be profitably treated every five years with a dressing of thirty to fifty bushels of lime to the acre. Experiments through a series of years in adjoining counties show that the application of 150 to 200 pounds of bone dust per acre, costing from twenty to twenty-two dollars per ton, gives an increase of 75 to 100 per cent. in the yield of wheat, corn, etc., and its use proves remunerative.

The following was reported as average crops:

Wheat, upland	5 bushels per acre.
Wheat, bottoms	11 bushels per acre.
Corn, upland	20 bushels per acre.
Corn, bottom	30 bushels per acre.
Onions	200 to 300 bushels per acre.
Potatoes	150 to 300 bushels per acre.

From Leavenworth the following shipments of farm products were reported for 1876:

Onions, 4,000 bushels, at 50 cents per bushel	$2,000
Potatoes, 4,500 bushels, at 50 cents per bushel	2,750
Dried apples, 5,000 bushels, at $1 per bushel	5,000
Apples, 30,000 barrels, at $1 per barrel	30,000
Apple brandy, 20,000 gallons, at $1.40 per gallon	28,000
Sorghum syrup, 18,330 gallons, at 33 cents per gallon	6,100
Cider, 1,100 barrels, at $4 per barrel	4,400
Cabbages, 40,000 heads, at 5 cents per head	2,000
Chestnuts, 25 bushels, at $2.50 per bushel	62
Total	$80,312

Small fruits and the peach seem well adapted to the hilly uplands, and with fair culture a failure is rare. Apple orchards are numerous, produce well, and with diligent management are highly remunerative. At the county seat an establishment for canning and drying fruit, with improved steam fixtures, would, with reasonable certainty, prove profitable to farmers and operators.

The following exhibit of the production of apples in 1877 is made up from reports of Messrs. Roberson, Ellsworth and Panky:

APPLE CROP OF 1877.

	Barrels.
Union township	50,000
Johnson township	8,000
Patoka township	12,000
Sterling township	65,000
Liberty township	20,000
Whiskey-run township	60,000
Jennings township	100,000
Ohio township	150,000
Boone township	15,000
	480,000

Much of this fruit is consumed by stock on the farm; it is sold on the trees for fall and winter feeding at ten to fifteen cents per bushel, and when delivered at Leavenworth the price ranges from fifteen to twenty cents per bushel; not more than ten per cent. of the crop is shipped out of the county.

Either the nature of the soil is injurious to burrowing grubs, or the sulphurous character of the atmosphere, derived from sulphur springs, gas seeps and the decomposition of pyritous shales, protects fruit from many pests, elsewhere so injurious to such crops. A vineyard of sixty acres has been planted by Brown & Co. on the summit of the high knob near Leavenworth, with good prospects.

BUILDING MATERIALS.

Building materials are abundant; clay of excellent quality is found and used in almost every part of the county; sand for plastering and mason's uses is obtained from bars along the creeks and river, and beds, furnishing excellent samples for this purpose and for the manufacture of glass, occur at Pilot Knob, near Brownsville, and other places, where the lower strata of the Conglomerate is in a disintegrating condition.

The massive beds of Chester sandrock may be recommended as furnishing, at low prices, good material for foundations, piers, rouble masonry, grindstones and whetstones; this stone is of good quality, and may be more readily quarried and shipped than any other rock observed in this part of the State.

Paving stones, so ripple-marked as to give adhesion to the foot, are easily accessible and of remarkable endurance.

Beds of oolitic limestone are of great thickness near Milltown, and thinner ledges occur on Little Blue river and at Leavenworth; it is almost snow white or of a creamy tint, nearly pure, and capable of a high finish, and of sufficient strength to bear the heaviest burdens. Samples from a neighboring quarry give the resistance to crushing weight at 10,250 pounds per square inch, a cubic foot weighs 149.59 pounds, and the ratio of absorption is 1 to 27.

This limestone has no equal for making quick-lime; on account of its superior purity the attention of lime burners is called to this stone.

ANALYSIS OF OOLITIC LIMESTONE.

	Per cent.
Water dried at 212° F	0.50
Silicates	0.31
Ferric oxide	0.18
Alumina	0.14
Lime	54.93
Magnesia	None.
Carbonic acid	43.17
Sulphuric acid	0.25
Chlorides	0.40
Combined water and loss	0.12
	100.00

The timber supply is good. Large quantities of oak, hickory, poplar and walnut lumber are shipped; the forests are extensive and can supply a large demand.

The water power is largely in excess of local necessities, and many valuable sites are unoccupied, and those on Blue river are worthy of examination by millers and manufacturers; the river is fed by cave springs, hence the summer stream is reliable, and the pure water is admirably adapted to the manufacture of white paper and chemical products.

DOMESTIC ANIMALS.

The breeding of improved stock does not receive that attention in this county that is given to it in regions where large areas are devoted to permanent pastures. The horses, as in all hilly countries, are hardy, patient and well muscled. Hogs are extensively grown, the large biennial crop of acorns accounts for the immense productions of pork for the favored years, a difference of $50,000 to $75,000 being reported.

MINERAL SPRINGS.

These springs have an enviable local character for curative power. The White Sulphur waters are declared, by resident physicians, to have specific efficacy in diseases of the kidneys, skin, liver and mucous membranes, and also highly remedial in cases of dyspepsia, rheumatism, scrofula and kindred diseases.

The following analyses of waters from Crawford county were made by Dr. G. M. Levette in the laboratory of the Geological Survey, and show the chemical value of these waters:

ANALYSIS OF WATER FROM EATON'S WHITE SULPHUR WELL.

(Southeast quarter Sec. 35, Town. 3 south, Range 1 west.)

One imperial gallon (ten pounds) contains 316.241 grains of solid matter.

The water was transported from the spring to the laboratory in stone jugs, and at the time of examination had lost a portion of sulphydric acid and carbonic acid gases originally in it. Sulphydric acid found at the time of examination, 2.35 cubic inches per gallon.

The mineral constituents found are given in grains in one imperial gallon:

	Grains.
Ferric oxide	1.480
Lime	27.830
Magnesia	23.890
Potash	3.500
Soda	5.700
Sodium	59.190
Sulphuric acid	53.693
Carbonic acid	49.615
Chlorine	91.343
	316.241

The above constituents are probably combined as follows:

	Grains.
Carbonate of protoxide of iron	2.384
Bicarbonate of lime	57.021
Bicarbonate of magnesia	20.160
Sulphate of lime	13.744
Sulphate of magnesia	52.775
Sulphate of soda	13.145
Sulphate of potash	6.479
Chloride of sodium	150.533
	316.241

For medicinal qualities of the above water see page 444.

ANALYSIS OF WATER FROM THE "TAR SPRING."

(Southeast quarter Sec. 15, Town. 3, Range 1 west.)

This water had a slight odor of petroleum, with a few globules of oily matter floating on the surface. It contained no sulphydric acid or chlorine.

Total solid matter in one imperial gallon, 50.003 grains, composed of the following:

	Grains.
Ferric oxide	2.800
Lime	10.080
Magnesia	4.380
Potash	1.100
Soda	1.850
Sulphuric acid	10.522
Carbonic acid	19.271
	50.003

The above constituents are probably combined as follows:

	Grains.
Carbonate of protoxide of iron	4.511
Bi-carbonate of lime	25.925
Bi-carbonate of magnesia	2.495
Sulphate of magnesia	10.799
Sulphate of soda	4.237
Sulphate of potash	2.036
	50.003

For medicinal properties of the above water see page 445.

ANALYSIS OF WATER FROM OTT'S SALT WELL, AT MIFFLIN POSTOFFICE.

(Sec. 32, Town. 2 south, Range 1 west.)

This water has a strong smell of sulphydric acid, and still held 3.2 cubic inches to the gallon after standing in a jug for four or five weeks.

Total solid matter in one imperial gallon: 5328.75 grains.

Quantitative analysis gave the following:

	Grains.
Ferric oxide	9.100
Lime	235.460
Magnesia	65.220
Potash	6.000
Soda	12.660
Sodium	1846.760
Sulphuric acid	65.444
Carbonic acid	238.105
Chlorine	2850.001
	5328.750

The above constituents are probably combined as follows:

	Grains.
Carbonate of protoxide of iron	14.661
Bi-carbonate of lime	401.089
Bi-carbonate of magnesia	107.035
Sulphate of lime	26.347
Sulphate of magnesia	42.754
Sulphate of soda	28.996
Sulphate of potash	11.107
Chloride of sodium	4696.761
	5328.750

For description of the above well and water see page 448.

ANALYSIS OF WATER FROM BENHAM'S CARBURETTED SALINE WELL.

(Sec. 4, Town. 3 south, Range 1 west.)

Total solid matter in one imperial gallon 7240.8 grains, consisting of:

	Grains.
Ferric oxide	6.650
Lime	323.790
Magnesia	102.100
Potash	15.160
Soda	11.280
Sodium	2461.800
Sulphuric acid	117.632
Carbonic acid	638.495
Chlorine	3563.893
	7240.800

The above constituents probably exist in the water in the following combinations:

	Grains.
Carbonate of protoxide of iron	10.713
Bicarbonate of lime	795.910
Bicarbonate of magnesia	215.232
Sulphate of lime	34.818
Sulphate of magnesia	104.537
Sulphate of soda	25.836
Sulphate of potash	28.063
Chloride of sodium	6025.691
	7240.800

For description of the above well and water see page 450.

ANALYSIS OF WATER FROM HARTFORD SULPHUR SPRING.

(Sec. 13, Town. 2 south, Range 1 west.)

This water, as received from the spring with those above described, had a slight odor of sulphydric acid, and yielded 0.785 of a cubic inch per gallon.

Total solid contents in one imperial gallon, 144.2 grains, consisting of:

	Grains.
Ferric oxide	1.400
Lime	12.500
Magnesia	8.480
Potash	0.850
Soda	4.220
Sodium	28.648
Sulphuric acid	20.151
Carbonic acid	23.741
Chlorine	44.210
	144.200

The above constituents are probably combined in the water as follows:

	Grains.
Carbonate of protoxide of iron	2.255
Bicarbonate of lime	24 691
Bicarbonate of magnesia	11.355
Sulphate of lime	7.042
Sulphate of magnesia	14.761
Sulphate of soda	9.665
Sulphate of potash	1.573
Chloride of sodium	72.858
	144.200

For medicinal qualities of this water see page 450.

COAL.

The coals of this county are outcrops of coal A, the lowest seam in the Indiana coal field. They are generally thin, and the coal, as a rule, is impure and sulphurous. A few openings were exceptionally pure, as that at Knight's bank, which is a rich, caking coal, excellent for stove and blacksmiths' use; banks of similar quality may be expected in neighboring localities. There is no surplus for shipment. The under clays of this coal will furnish abundant supplies of fire clay for bricks, potteries, tiles and terra cotta wares.

SALT.

Salt was formerly made at the Ott and Benham wells; the brine was rich, producing twenty barrels of salt per day, and the salt was pure, but not in sufficient quantity to defray the expense of the fixtures for evaporation, etc. Boring to a greater depth will not increase the quantity of brine, but probably reduce its strength by dilution and decomposition.

PETROLEUM.

Petroleum, or mineral tar, has been found on the surface at springs and seeps in small quantities at more than twenty localities. During the "oil excitement," from 1864 to '68, ten wells were bored in this county, and almost every one yielded a "show" of oil, but in no case could a yield of more than a pint a day be heard of, and in some cases only a few oily drops upon the surface of thousands of barrels of water was found to reward the toil and capital of enthusiastic seekers after "more light." The oil supplying rocks of this vicinity are so limited that there is hardly a possibility of striking a paying well, and money invested in such an enterprise will be literally "sunk." Some of the white sulphur fountains now running from wells bored for oil are more valuable than any oil well possible in the county.

MARL.

A pyritous shale of considerable thickness has been noted on preceding pages, lying above and beneath the Kaskaskia or upper limestone of the Chester group. On exposure it is pulverulent, and in this condition, on account of the sulphurous gases in the air and sulphates in the water, it is intolerant of vegetal life, and such exposures are black, barren spots, locally called "glades."

Strata of the same horizon in Grayson county, Kentucky, were examined by A. J. Norwood, who says:* "The shales or marls are valuable. Their position is in the Chester group, and are found, when developed, over a large portion of the western part of the State. The marls are wonderfully rich in potash and soda, and for that reason possess properties which should render them unexcelled for fertilizing worn out tobacco lands.

*Kentucky Geol. Rep., 2d series, Part VIII, Vol. IV.

"ANALYSIS OF CHESTER MARLS.

(After being dried at 212° F.)

	Per cent.
Oxide of iron, alumina, etc.	27.811
Carbonate of lime	0.880
Magnesia	0.824
Phosphoric acid	0.109
Potash	5.554
Soda	0.667
Silica and insoluble silicates	59.920
Water and loss	4.235
	100.000

Tested by farmers and gardeners in Crawford county, this decomposed shale is of little or no more value than an equal amount of common clay; applied to a worn, sandy soil, it acts mechanically to retain moisture, rather than as a fertilizer.

ROADS.

The highways and roads are not first-rate, they ought to be made better; there is great room for improvement. There can be no high realization of civic life, no full enjoyment of property and the fruits of labor without free social and commercial intercourse; this is impossible without improved highways, passable at all seasons of the year. Limestone makes good, durable roads, when broken and applied to well-drained road-beds. The great abundance and cheapness of this material in the region under discussion, would seem to insure, in a short time, its almost universal application. The citizen who constructs the first mile of stone road in this county will be, by example, a public benefactor.

The streets of Leavenworth might be raised above high water mark and piked. A practicable route commencing near the seminary, and gradually winding around the ravine leading by the cemetery to the summit, may be located by a competent engineer. From the top of the bluff, the great level plateau invites the construction of a good pike to Marengo, with branches to Milltown, Wyandotte, Grantsburg and Hartford. Such an enterprise, easily accomplished under intelligent direction, will largely increase the trade and importance of the county-seat, and be of unspeakable value and convenience to the farmers along the route, and citizens of interior villages. Experience shows that a beginning is often the herald of success.

It is proper to add that the lands of this county offer inducements to emigrants. Homes can be had very cheap. A thousand families could each secure a forty acre tract at less than two hundred dollars per tract, generally bearing enough timber to pay for the farm and improvements. The citizens earnestly invite attention to their cheap lands.

THANKS.

Acknowledgments are due to all the people of the county for uniform courtesy and assistance. My heartiest thanks are returned for hospitality, guidance and special favors, to the Louisville, New Albany & Chicago Railway Company, W. P. Everdone, W. M. Ellsworth, Dr. E. R. Hawn, the Messrs. Rothrock, S. T. Mann, H. W. Conrad, R. H. Sands, J. T. Crecilius, Samuel Mix, E. and O. Leavenworth, Hon. John Benz, E. Hostetter, M. T. Knight, A. M. Sipes, Judge McMikle, N. M. Morgan, Malachi Ott, J. J. Clark, H. B. Meylin, Messrs. Roberson, Edwin Finch, and many others whose names I do not now recall.

INDEX.

ERRATA.

Pages 323 and 332, read *Perischoechinidæ* for Perischoechinoidæ.

Page 324, read *Spiriferina* for Spirifrina.

Page 333, read *O. michelini* for O. michelina.

Page 334, read *royissi* for royissa.

Page 349, fifth line from bottom, erase *save*.

Page 371, third line from bottom, read *Pennington* for Remington.

Page 376, tenth line, erase *Niagara*.

Pages 389 and 391, read *Stictopora* for Ptilodyctia.

Page 489, thirteenth line, erase *of this Report*.

Passim, read *spinulosa* for spinulosus.