

ART. XXII.—*The Waverly Group in Central Ohio*; by L. E. HICKS, Professor of Natural Sciences in Denison University.

IN this paper I propose to enumerate and describe the strata lying between the Huron Shales (Devonian) and the base of the Coal Measures, and to consider briefly their stratigraphical relations. I shall use names derived from localities in Licking and Delaware Counties—not that I wish to add to the already profuse nomenclature of this group, but as a matter of necessity until the application of the names proposed by other geologists has been definitely settled. The section contains five well defined members, named below in descending order.

5. Licking Shales	100 to 150 feet thick.
4. Black Hand Conglomerate and Granville Beds	85 “ 90 “
3. Raccoon Shales	300 “
2. Sunbury Black Slate	10 “ 15 “
1. Sunbury Calciferous Sandrock..	90 “ 100 “

The Licking Shales, No. 5, are well developed in the hills bordering Licking River from Newark to Black Hand. They lie seventy to eighty feet above the water level, forming the middle of the slope of these hills, the base being composed of the massive Black Hand Conglomerate and the upper slopes and summit of the various strata of the Coal Measures, of which the Coal Conglomerate and Massillon Sandstone produce the most conspicuous effects in the landscape. At or near the top of No. 5 there is usually a stratum of compact, fine-grained, drab sandstone, which is quarried to some extent, having a thickness of three to ten feet. Below this are friable, earthy, gray or olive shales; and at the bottom, comprising about one-third of the whole, shaly drab sandstones. These, and the compact sandstone at the top, are fossiliferous. *Spirijera Carteri*, *Aviculopecten Winchelli*, *Allorisma pleuropistha*, and other characteristic species of the Ohio Subcarboniferous, have been obtained from this horizon.

Wherever the Coal Measures Conglomerate exists it forms the upper limit of the Licking shales, which is then well defined. In the absence of the Conglomerate the only means of determining its extent upward is the position of the compact sandstone and the presence of Subcarboniferous fossils. Frequently the sandstone is overlaid by shales differing scarcely at all from those below it. The lower limit, however, is perfectly defined by the upper surface of the next stratum, which is one of the most distinctive and well-marked of the whole group.

The Black Hand Conglomerate, No. 4, is seen at its best about Hanover, though the Black Hand locality is better known, probably because the cliffs at that point are more conspicuous to the railway passenger. Only about half its thickness is seen in these cliffs. At Hanover the bottom layers (which, owing to the eastward dip, are buried out of sight at Black Hand) come into view and reveal a total thickness of eighty-five to ninety feet. It is generally a rather fine pudding-stone, the pebbles of the size of peas. Occasionally they are an inch in diameter, and, in one case, I found a quartzite boulder six inches long and three inches thick imbedded in the sandy matrix. In some places beds many feet thick are merely coarse sandstone, but the partings are pebbly. The prevailing color is light yellow or buff; sometimes nearly white, again brick-red. This stratum is highly ferruginous, but less so than the Coal Conglomerate, the upper layers of which are sometimes a siliceous iron ore. It also contains more earthy matter and less pure silica than the Coal Conglomerate. These characters, together with the presence of fossil nuts (*Cardiocarpon*, *Trigonocarpon*, etc.) in the upper, and their absence, so far as yet observed, in the lower, might serve to distinguish these conglomerates if they were in contact, instead of being separated by the Licking Shales.

No. 4 is evidently a shore deposit, and it exhibits the typical structure of a sea-beach better than any other rock with which I am familiar. There is, in the first place, the regular beach slope of four to ten degrees, which for six miles along the Licking River is tolerably constant in direction, viz: N. 10° to 45° E. Then there are subordinate lines of oblique lamination dipping in all directions. These last do not, however, interfere with quarrying. The rock splits along the beach slope as if that was the dip, and comes out in regular blocks of any size desired. In durability it is unsurpassed, while it is not destitute of beauty as a building stone. Its great value for canal locks, bridge abutments, foundations, etc., has long been recognized; and its capabilities for massive and elegant superstructures have been shown in the erection of the cathedral at Columbus.

Like almost all Conglomerates, No. 4 thins and disappears, or passes into fine sediments when traced far from its typical exposures. Black Hand is near the east line of Licking County. The Conglomerate appears in full force for seven or eight miles, to some distance west of Clay Lick station on the Baltimore and Ohio Railroad. Thence through the center of the county its horizon is occupied by an entirely different set of beds, of which only one, and that thin, bears any resemblance to the rock at Black Hand. These beds are character-

istic and important enough to merit a full description and a separate name. They are well exposed at Granville, and we may for convenience designate them as the Granville beds, remembering that they are only a local modification of No. 4, or the next highest member of the Waverly group. Following is the section of these beds in descending order:

No. 4d. Coarse sandstone and conglomerate	----	3 to 18 feet.
“ 4c. Fucoid layer	-----	7 “ 12 “
“ 4b. Compact drab sandstone (argillaceous)	.15	“ 21 “
“ 4a. Shaly “ “ and shales	---	60 “

The upper member, No. 4d, thickens and grows coarse and pebbly eastward, and tapers to a knife-edge westward. Hence I was at first disposed to regard it alone as the equivalent of the Black Hand conglomerate, and to suppose that the rest of the Granville beds dipped under that stratum. But careful measurements have shown that the bottom of the Granville beds near Newark is nearly the same distance below Coal I. as the bottom of the conglomerate at Black Hand; so that, if the latter is superimposed upon the former, there must be a sudden thickening of the whole series to the extent of eighty or ninety feet. The general regularity of the dip renders this highly improbable.

The Fucoid layer, No. 4c, is composed of brown, gray, and blue, earthy shales, filled with the remains of *Spirophyton cauda galli*. At some points these plants are so numerous that the whole rock becomes a tangled mass of sea-weeds. It weathers black by the oxidation of its manganese. The upper half is more friable than the lower, and falls to pieces in being removed; the workmen in some quarries call it “soapstone.” The lower half, “nigger-head,” requires blasting, being quite compact in the quarry, from which it has to be “stripped” to get at the next layer, No. 4b; but it soon falls to pieces under the action of the elements and lays bare the rich treasures of its molluscan fauna, which the quarrymen call “bugs” and “butterflies.”

This layer is so well defined and persistent that it furnishes a reliable means of determining the dip. This has been found to be on the average twenty-one feet ten inches per mile, nearly due east. Instead of being uniform, however, this general eastward slope is broken into small waves, which correspond to the greater ones in the Appalachian mountain system, both in direction and in having their western slope steeper than the eastern.

No. 4b is a fine-grained, easily-wrought sandstone, extensively quarried at Newark and Granville. The shaly sandstone below it also thickens in some places into layers suitable for quarrying, but it is not reliable.

All the Granville beds are fossiliferous. They have, in fact, yielded a richer harvest to the paleontologist than any other member of the Waverly. Not less than seventy-five species, many of them new to science, have been found in them in a tolerable state of preservation; and several more have been seen, but only in fragments too imperfect for identification or description. In the upper layer, No. 4*d*, the remains of mollusks and crinoids have supplied enough calcareous matter to convert portions of the rock into an impure limestone. The carbonate of lime dissolves out on exposure to the weather, leaving a rusty, rotten sandstone full of fossils, but seldom furnishing a perfect or entire specimen. In the compact sandstone the fossils are fairly preserved, but generally as "casts." From the Fucoïd layer, however, beautifully perfect shells are obtained with both valves entire and in position, the matrix crumbling away on exposure.

The unity of the Granville beds with the Black Hand conglomerate, constituting under local modifications a single member of the series, appears not only in that they occupy the same stratigraphical horizon, but that there is unity and harmony in their topographical effects. Both combine to produce the picturesque hilly region extending through the central and eastern part of Licking County. These effects are intensified at Hanover and Black Hand by the Coal Conglomerate, or, in its absence, the Massillon sandstone, in the upper slopes and summits of the hills, whose rugged aspect is further heightened by mural cliffs and by the presence of hemlock, laurel and other species which usually affect a mountainous habitat. West of Granville the hilly region terminates somewhat abruptly, only a few comparatively gentle swells beyond rising and sinking into the general level of the flat, monotonous country underlaid by the Raccoon shales.

This stratum, No. 3, appears in force all along Raccoon Creek and its tributaries, and extends westward into Franklin and Delaware Counties. An estimate based upon the breadth of its outcrop and the dip, as ascertained from the Fucoïd layer, makes its thickness three hundred feet. It is composed of blue and gray shales full of concretionary masses of iron ore, which are, however, mere shells filled with marl or sand. Near the bottom some layers are massive enough for quarrying. No animal remains have been observed in it; but there are abundant impressions of two species of sea-weeds, one with square stem branching at right angles, the other with round stem branching in the usual manner.

The next stratum, No. 2, as much exceeds the last in interest as it falls short of it in thickness. It is a black, bituminous shale containing shells of *Lingula* and *Discina*, and spines,

scales and teeth of fishes. But one outcrop of it is known in Delaware County, and that was revealed only by a systematic search of a day and a half. This discovery, which I made in May, is recorded in the July number of this Journal. An equally diligent search would, I am confident, result in tracing the same stratum much farther north; and thus the identity of one at least of the Waverly beds in southern, central and northern Ohio, would be established beyond a peradventure.

The last member, No. 1, consists of shaly sandstone, compact sandstone (somewhat calcareous) and at the bottom a few feet of alternate shales and siliceous limestones. The calcareous matter is abundant enough to charge the water percolating through the rock and form extensive deposits of travertine on the banks of Rattlesnake and Walnut Creeks. The forest trees drop their leaves upon the surface of this travertine; they are caught in the petrifying mass and leave their models exact to the minutest detail. I have collected many beautiful specimens of oak, chestnut, maple and beech leaves from this locality.

The rock which furnishes the material for the travertine is itself non-fossiliferous, at least as regards the remains of animals. It contains two species of sea-weeds distinguished by their position in the stone, one standing vertical, the other lying flat. The Portage sandstone of New York has two species which are distinguished in the same way. They belong, however, to different horizons, the vertical one being found in the upper beds only, and thus furnishing a basis of subdivision. In the Waverly no difference in their vertical distribution has been observed.

The quarries in the lower Waverly at Sunbury, Delaware County, furnish an excellent quality and inexhaustible quantity of flagging and building stone. Ripple marks are so abundant that thousands of feet of flagging have been sold, every slab of which would be a good cabinet specimen.

Near the junction of No. 1 with the Huron shale is a stratum of Calcareous sandrock lying in huge, rough, concretionary masses. Below this are blue shales interstratified with thin layers of siliceous limestone, the lowest of which rests directly upon the surface of the Huron. Here we reach an unmistakable Devonian stratum, and our task of enumerating and describing the component members of the Waverly group is completed.

It remains to discuss the stratigraphical relations and names of the beds described above, which is by no means the easiest part of my undertaking.

Let us first inquire what is the relation of the several members constituting the Waverly in central Ohio to those in Dr. Newberry's section at Cleveland, which is as follows:

The Conglomerate.

1. Cuyahoga Shale, 150 to 250 feet thick,	} Waverly Group.
2. Berea Grit, 60	
3. Bedford Shale, 75	
4. Cleveland Shale, 21 to 60	
Erie Shale (Chemung),	

The Cleveland Shale has been assumed by the Ohio geologists to be equivalent to the Waverly Black Slate, which is undoubtedly the same as that at Sunbury (Newberry, Ohio Reports, vol. ii, p. 93. Orton, *ibid.*, p. 624). At the time I discovered the outcrop at Sunbury I supposed there was no doubt of the correctness of this assumption. Now, however, Dr. Newberry asserts positively that there is *no evidence* that they are identical. Until further explorations are made north of Delaware County, we shall therefore have to be content with hypothetical statements respecting the relation of Waverly beds in central and northern Ohio. For instance, if the Sunbury black slate is identical with the Cleveland shale, then the Sunbury Calciferous sandrock is equivalent to the Erie shale, and the three upper members in Licking County are collectively equivalent to Bedford, Berea and Cuyahoga, though it would not be safe to assert distributively that Bedford=Raccoon, Berea=Black Hand and Cuyahoga=Licking. Again, if Professor N. H. Winchell was correct in pronouncing the Sunbury quarry stone Berea grit, then the Cuyahoga shales alone represent all the four upper members in central Ohio, and the Chocolate shale described by President Orton as constituting the upper part of the Huron may be of the same age as the Bedford shales, as they were supposed to be by Dr. Newberry. But such conditional statements are hardly worth the utterance. In the present state of our knowledge the problem of exactly synchronizing any of the subdivisions of the Waverly seems to be insoluble.

A more important problem is that which pertains to the general synchronism of the whole group: Is it Carboniferous? or Devonian? or partly one and partly the other?

It is no new thing for the intervening strata between two great formations to be the subject of much discussion before their true relations are settled; or, if not settled, at least *let alone*, the advocates of opposite theories either dying off or tacitly agreeing to disagree. If the question proves incapable of solution there are several ways of *dodging* it. One mode of doing this is to call the disputed strata "beds of passage." This is not, however, eminently satisfying and calming to a logical mind. The same may be said of that other expedient of enumerating the members acknowledged to belong to each formation, and then placing the bone of contention in an ambiguous position half way between, as is often done with the Oriskany

sandstone. Still another plan is to compound the names of the underlying and overlying formations, and apply the compound to the disputed rocks, as in the case of the Cambro-Silurian of Great Britain, a term which recalls the long and hot Sedgwick-Murchison controversy. After all, though, these expedients are in some measure philosophical and reasonable, though not strictly logical. Logic is in fact more rigid than nature. She demands clean-cut divisions, hard-and-fast lines of separation, in the classificatory sciences. But it is a melancholy fact for logic-choppers that nature is *not* rigidly logical. Whether in geology, biology, or what you will, the facts and objects of nature refuse to yield to the systematist group which are, in all cases, sharply defined. Thus room is always left for differences of opinion in regard to the propriety of this or that being classed here or there. All we ought to demand, therefore, of the systematist, is that he shall not run counter to the plain and emphatic deliverances of nature herself; and where the evidences are nicely balanced we may well concede to him some degree of arbitrary power in the construction of his groups. The convenience of having *some* classification may make it expedient to accept his work, though, at certain points, logical considerations have driven him to draw sharper lines than exist in nature. If we approach this problem bearing these considerations in mind, we shall be more likely to view it broadly and judicially.

The Waverly was long regarded as Devonian. When the present Geological Survey of Ohio was organized, one of the first announcements made by its chief, Dr. Newberry, was that the Waverly was Carboniferous. This decision covered only what we may conveniently call the Cuyahoga sub-group, i. e., Cuyahoga shales, Berea grit, Bedford shales, and Cleveland shales. That part of the Waverly which is probably equivalent to the Erie shales would still fall to the Devonian if Erie is Devonian; and that was tacitly admitted by the chief geologist, though he now claims that he placed it there out of deference to the prevalent classification, all the while believing that the true boundary of the Carboniferous was at the base of the Erie in Ohio and of the Portage sandstone in New York. His statements in the first volume of the Ohio Reports, p. 166, and vol. ii, p. 82, justify this claim and exonerate him from the charge of reversing his own decision in affirming, as he now does, that the whole of the Waverly, the Erie, the Portage, the Chemung and the Catskill are Carboniferous.

While it may be true that this is no real change, though it is an apparent one, in Dr. Newberry's opinions, it is certainly a great and radical change in the classification of American rocks, and the reasons for it merit our closest scrutiny. These alleged

reasons are: 1st. A physical break at the close of the Hamilton, the previous movement of elevation being then reversed and a new cycle of deposition begun which culminated in the deposition of the Subcarboniferous Limestone. 2d. "A change of fauna; the fossils of the Chemung and Upper Portage, that is Erie, show great development of the *Productus* family, and other fossils of Carboniferous type."*

A physical break of some magnitude and a marked change of fauna are certainly the two things, and the only two, upon which to base the boundaries of formations. But the break here appealed to is only one of a number of such changes, and of no greater magnitude than some others in the same series. For instance, at the close of the Chemung a large area in central and western New York was raised above the sea-level, not again to be submerged, thus checking and reversing the subsidence which began with the Portage. Dana states the nature of the transition from the closing period of the Devonian to the opening of the Carboniferous as follows: "The former was a period in which the grand Appalachian subsidence (as in other parts of the Devonian) reached north into the State of New York, while in the latter it hardly passed the limits of Pennsylvania. The former was characterized by dry land, over a large portion of the great Interior Continental basin; the latter, by a wide-spread and clear, though not deep, sea, growing Crinoids and forming limestones." (Manual of Geology, p. 281.) In this passage a contrast of physical conditions is indicated which is certainly equal, if not superior in importance, to the physical break at the close of the Hamilton period.

As regards the change of fauna it was not general enough to be of commanding importance. The Carboniferous aspect of Chemung fossils is confined to those from western New York and Pennsylvania. Those from the eastern part of both these States are strongly Devonian in their prevailing types. Still higher than the Chemung is the Old Red Sandstone containing both a fauna and flora which have respectable claims to be regarded as Devonian.

I freely admit that there is no hard-and-fast line of separation between the Carboniferous and Devonian. Fix the boundary where you will, there will be room for caviling and dissent. The English geologists have even proposed to wipe out the Devonian as an independent formation, giving its components to the Carboniferous and Silurian. It is to be hoped that will never be done, for it would open the door to endless controversies respecting the new boundary. When we remember that all classification must be somewhat arbitrary; that the logical rhythm of any system often demands the *accentuation* of

* From a letter to the writer.

certain distinctions, so that their apparent value in the scheme exceeds their absolute value in nature ; that names and groups are, in some degree, matters of usage, of comity, and of convenience, we may well pause before we precipitate the inconveniences of unsettling a long established and generally received classification, especially if our substitute only accentuates another set of distinctions of no greater absolute value than the former. Unless there is a decided preponderance of evidence in favor of the new, the old is entitled to prevail by right of priority and possession.

Professor Lesley's identification of the Bedford shale with the Old Red Sandstone, and Cleveland shale with Oil Sands and Chemung, thus dividing the Cuyahoga group in the middle and giving its two lower members to the Devonian, seems to me to lack sufficient grounds to justify it. In his note on the "Comparative Geology of Northern Ohio, Northwestern Pennsylvania, and Western New York" (2d Geological Survey of Pa., 1874, i,) where this opinion is announced, no distinct line of argument in its behalf is indicated. The local red color of the Bedford is of such small significance that I cannot believe *that* had any weight in the mind of so experienced a geologist. The Cuyahoga, Berea, Bedford and Cleveland, including the few feet of limestone under the latter, constitute a compact and natural group, holding substantially the same fauna throughout. I hope to show this more in detail in a subsequent paper on the vertical distribution of the fossils of this group. Then again, the fossils of the Cleveland shale, at the bottom of the series, are of decidedly Carboniferous types. These facts constitute a sufficient reason for retaining the Cuyahoga sub-group in the Carboniferous, whatever may be done with the rest of the Waverly.