

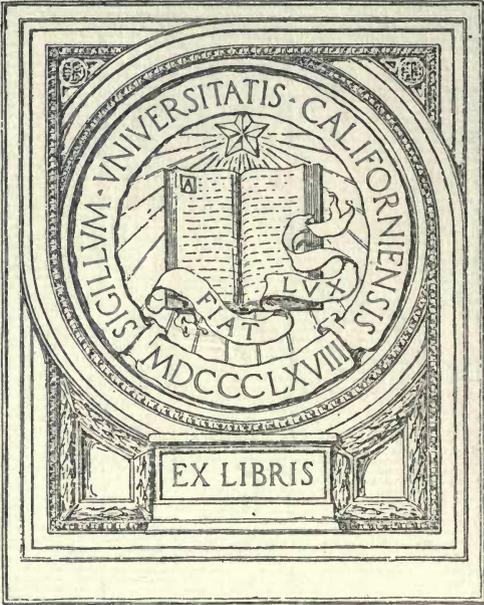
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THE FAUNA OF THE POTTSVILLE FORMATION OF
OHIO BELOW THE LOWER MERCER
LIMESTONE

BY
HELEN MORNINGSTAR, M. A.

EXCHANGE
28 1921

A dissertation submitted to the faculty of Bryn Mawr College
in partial fulfillment of the requirements for the
degree of Doctor of Philosophy



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ABSTRACT

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INTRODUCTION

This report on the fauna of the Pottsville formation of Ohio below the Lower Mercer limestone is a portion of a much more extensive investigation which deals with the entire Pottsville fauna of Ohio, a large portion of which is at present in manuscript form. The field of study is practically new, as up to the present time very little work has been done on the Pottsville fauna of this State, with the exception of a few papers which treat of the Lower Mercer fossils of Flint Ridge and the vicinity. The formation as developed in Ohio includes thirteen fossiliferous horizons, of which six are marine limestones, four iron ores which contain marine faunas, and three shale horizons associated with coal beds which contain fresh or brackish water fossils.

The collections were made chiefly during the summers of 1918 and 1919, and the manuscript was prepared during the summer of 1920 and the following university year. In most instances large quantities of fossiliferous rock were collected, from which the fossils were later obtained and prepared for use in the laboratory. The collections used in the preparation of this investigation are the property of the Geological Survey of Ohio, and all types, figured specimens, and other forms of interest have been placed in the Geological museum of The Ohio State University.

ACKNOWLEDGMENTS

The writer wishes to express her indebtedness to Dr. J. A. Bownocker, State Geologist of Ohio, for a position on the Geologic Survey of Ohio while the necessary field work was being carried on, and for the many helpful suggestions which he has given her concerning the work. She is likewise much indebted to Mr. Wilber Stout of the Geologic Survey of Ohio, not only for his aid in the collecting of fossils and for the suggestion of localities where collections could be made, but also for his help with the stratigraphy of the Pottsville formation and for the kindly interest which he has taken in every phase of the work. It is a great pleasure to the writer to acknowledge her obligation to Dr. George H. Girty of the United States Geological Survey for the valuable assistance which he has so freely given in the verification of new species and of obscure or doubtful forms. The writer wishes to thank Mr. Raymond E. Lamborn by whom the collections of fossils from Stark and Mahoning counties were made, Miss Charlotte Morningstar for her assistance in collecting fossils, and Dr. Florence Bascom and Mr. M. H. Bissel of Byrn Mawr College for reading and correcting the manuscript.

REVIEW OF THE STRATIGRAPHY OF THE FOSSIL-IFEROUS MEMBERS OF THE POTTSVILLE FORMATION¹ BELOW THE LOWER MERCER LIMESTONE

PENNSYLVANIA SYSTEM

The rocks of the Pennsylvanian system outcrop in southeastern Ohio over an area of approximately 11,125 square miles. They are divided into four formations: the Pottsville, Allegheny, Conemaugh, and Monongahela, and together their entire thickness in the State averages 1,100 feet. The present report deals only with the oldest formation of the Pennsylvanian system, the Pottsville.

Pottsville Formation

The Pottsville formation, occurring at the base of the Pennsylvanian system, includes all the rocks between the Mississippian system below and the Allegheny formation of the Pennsylvanian system above; or between the Maxville limestone, or the Waverly formation where the former is wanting, and the Brookville coal, which forms the basal member of the Allegheny formation. In many places, especially in the central part of the outcrop, there is no sharp line of demarcation between the Pottsville and Allegheny formations, as shales form the upper members of the Pottsville and the lower members of the Allegheny, so that there is a gradual transition from one formation to the other. The outcrop of the formation is extensive and crosses the southeastern portion of the State, bordering the younger Pennsylvanian formations on the west, northwest, and north. Beginning at the Ohio River in Scioto and Lawrence counties, the rock exposures extend northeastward as far as Wayne and Stark counties, and then eastward crossing the Ohio-Pennsylvania state line from Mahoning County. The formation is found in the following counties: Lawrence, Scioto, western Gallia, Jackson, eastern Pike, Vinton, western Athens, Hocking, Perry, Muskingum, eastern Licking, Coshocton, eastern Knox, Tuscarawas, Holmes, Wayne, Stark, eastern Medina, Summit, Geauga, Portage, southern Trumbull, and Mahoning.

Between the Mississippian and Pennsylvanian systems, or at the base of the Pottsville formation, there exists everywhere a great unconformity, as is shown by the extremely irregular upper surface of the Mississippian rocks. The basal members of the Pottsville formation rest sometimes on varying thicknesses of Maxville limestone and sometimes directly upon the Logan formation which occurs below the Maxville limestone. The Maxville limestone is found in patches, which, as shown by W. C. Morse, are undoubtedly the rem-

¹The main divisions of the Pennsylvania system—the Pottsville, Allegheny, Conemaugh, and Monongahela—are here given the rank of formations, while the subdivisions of each are called members, according to the usage adopted by the Geological Survey of Ohio. In other States, different values are sometimes assigned to the divisions of the Pennsylvanian system.

nants of a once continuous deposit laid down at the end of Mississippian time.¹ Uplift, however, caused the withdrawal of the sea, and for a long period the region was subjected to erosion. The duration of this period of erosion was great enough to remove most of the Maxville limestone, and in some places streams had cut for considerable distances into the Logan formation. Remnants of the Maxville limestone appear at the present time only as isolated patches or islands surrounded by younger rocks of Pottsville age. At the end of these land conditions, the region was again submerged and the basal members of the Pottsville formation, the Harrison ore and the Sharon conglomerate, were deposited in the low troughs and basins.

The Pottsville formation varies in thickness from 100 to 350 feet, but averages about 255 feet. The deposit thickens toward the south, and in southern Ohio attains its maximum development; there is also a general thickening from the western to the eastern part of the outcrop. The extremely irregular line of contact between the Pottsville formation and the Mississippian system below is responsible for the great variation in the thickness of the formation in different regions. Where the Maxville limestone has been largely or entirely eroded, the lowest members of the Pottsville formation, the Harrison ore and the Sharon conglomerate, are present, while successively higher members form the base of the formation where increasing thicknesses of Maxville limestone are found. In Hopewell Township, Muskingum County, on Poverty Run, the Quakertown coal forms the base of the Pottsville, while elsewhere any of the horizons from the Harrison ore to the Quakertown coal may be in contact with rocks of Mississippian age.

The Pottsville formation in Ohio is composed for the most part of shales and sandstones, interbedded with clays, coals, iron ores, and marine limestones. The accompanying generalized section of the formation shows the succession of the various members and their relations to each other. The members vary greatly in character and thickness from place to place. Some, such as the Black Flint at the top of the formation, are local in their occurrence and are found only in the southern part of the outcrop; others, such as the McArthur limestone and Sciotoville clay, are more extensively developed in southern Ohio but to the northward become thin and finally disappear. There are certain strata, however, of great importance for stratigraphic study, as they are very persistent and can be traced from the Ohio river northward along the Pottsville outcrop to the Ohio-Pennsylvania state line. At the base occurs the Sharon conglomerate which, although patchy in appearance, can be found everywhere in the deepest troughs eroded in pre-Pottsville times. Among the coals, the Quakertown or No. 2 coal, the Lower Mercer or No. 3 coal, the Middle Mercer or No. 3a coal, and the Tionesta or No. 3b coal are the well-defined stratigraphic units. By far the best devel-

¹Morse, W. C., *Geol. Sur. Ohio, Fourth Ser., Bull. 13*, p. 99, 1910.

oped and most persistent horizons, however, are the Lower and Upper Mercer limestones with their accompanying iron ores; these members, especially the Lower Mercer, are found in every county where they may be expected, and form datum planes of extreme importance for determining the stratigraphic relations of the overlying and underlying formations.

Economically the Pottsville formation is of considerable value, and it has added much to the natural resources and wealth of the State. Most of the iron ores which have been worked for the purpose of smelting in the old charcoal furnaces, particularly in Scioto, Lawrence, Jackson, and Vinton counties, were from this formation. The Lower and Upper Mercer ores especially are of sufficient thickness and are high enough in iron content to be of some importance commercially. However, they in no way rival the ores of the Lake Superior region, and at the present time are used only to a very limited extent. The coals are utilized mostly for local purposes, but a few beds, such as the Sharon coal and particularly the Quakertown or No. 2 coal, have been mined for commercial use for the past forty years and have been important factors in the development of industry in southern Ohio. In Jackson County, the Quakertown coal is of good quality and thickness, and is responsible for the rapid growth of Jackson, Wellston, and other towns in the mining district. Pottsville clays are also of importance economically, and the Sciotoville clay has been used for many years in Scioto and Jackson counties for the manufacture of refractory wares, for which purpose it sets a standard of excellence.

A study of the Pottsville fossils shows that with the exception of the coal formations, the members are marine in origin for the most part. The marine conditions which produced these members alternated with the swamp conditions under which the coal was deposited. During six periods marine conditions favored the deposition of limestone, and the first six members of the series of limestones of the Pennsylvanian system were laid down, namely the Lowellville (Poverty Run), Boggs, Lower Mercer, McArthur, and Black Flint members. The marine sediments were deposited in shallow waters, and as they grew in thickness the water level was approached until swamp conditions, necessary for the formation of coal, were brought about. A slow depression, however, successively brought the swamp conditions to an end and shallow marine waters again occupied the region, and another series of marine sediments was deposited. The slow, periodic sinking of the region and the subsequent building up of the sea bottom to the water level were necessary for the alternation of marine sediments and coals.¹

In the following discussion the faunal horizons of the Pottsville formation are treated successively, so as to show the stratigraphic relations, character, and extent of each of these strata.

¹ Stout, W., Manuscript on Clays in Ohio.

GENERAL COMPOSITE SECTION OF THE POTTSVILLE FORMATION
IN OHIO

System	Thickness of Pottsville Formation	MEMBER	GENERAL DESCRIPTION	Thickness	
				Ft.	In.
PENNSYLVANIAN	POTTSVILLE 225 ± FEET	Brookville	Clay, not persistent	4	0
		xBlack Flint	Ore, nodular, sparingly fossiliferous Flint, black, or Limestone, very fossiliferous, very local . . . . .	..	6
				1	0
		Homewood	Shale and Sandstone	11	0
		xMcArthur	Shale, in places sparingly fossiliferous Limestone, impure, or Shale, calcareous, not persistent, very fossiliferous	4	0
				1	6
		Tionesta or No. 3b	Coal, rather continuous, usually thin	2	0
			Clay, light, siliceous	5	0
			Shale and Sandstone	16	0
		xUpper Mercer	Ore, nodular, sparingly fossiliferous, locally present Shale, in places fossiliferous Limestone, dark blue, or Flint, black, fossiliferous, not persistent . . . . .	..	5
				..	7
				1	0
		Bedford	Coal, not persistent	1	0
			Clay, variable	2	0
			Shale and Sandstone	7	0
		xSand Block	Ore, nodular, siliceous, in places sparingly fossiliferous . . . . .	..	3
			Shale and Sandstone	4	6
		Upper Mercer or No. 3a	Coal, not persistent	1	0
			Clay, not persistent, siliceous	2	6
			Shale and Sandstone	9	0
		xLower Mercer	Ore, kidney, sparingly fossiliferous, local . . . . .	..	3
			Shale	4	6
		xLower Mercer	Limestone, blue, very fossiliferous, very persistent	2	0
		Middle Mercer	Coal, thin, rather persistent . . . . .	..	6
			Clay, siliceous	3	6
			Shale and Sandstone	5	0
		Flint Ridge	Coal, not persistent, thin . . . . .	..	6
			Clay, flint, blue, local	1	0
			Clay, siliceous, light	3	0
			Shale and Sandstone	5	0
		xBoggs	Limestone, blue, or Ore, fossiliferous, local . . . . .	..	6
			Shale	1	0
Lower Mercer or No. 3	Coal, not persistent	1	0		
	Clay, siliceous	3	0		
	Shale and Sandstone	21	0		
xLowellville (Poverty Run)	Shale, calcareous, very fossiliferous Limestone, hard, ferruginous, fossiliferous, very local	1	0		
		..	6		
	Shale	1	6		
Vandusen	Coal, thin, often wanting	1	0		
	Clay, impure	2	0		
	Shale and Sandstone	15	0		

GENERAL COMPOSITE SECTION OF THE POTTSVILLE FORMATION
IN OHIO—(Continued)

System	Thickness of Pottsville Formation	MEMBER	GENERAL DEECRIPTION	Thickness	
				Ft.	In.
PENNSYLVANIAIAN	POTTSVILLE 225 ± FEET	xBear Run	Shale, blue, locally fossiliferous	2	0
			Coal, not persistent	1	6
			Clay, siliceous, impure	3	0
			Shale and Sandstone	24	0
		xQuakertown or No. 2	Coal, locally well developed	3	0
			Clay, siliceous	2	0
			Shale and Sandstone	20	6
		Guinea Fowl	Ore, siliceous, very local		6
			Shale	3	0
		xAnthony	Shale, bony, in places fossiliferous		3
			Coal, local		3
		Sciotoville	Clay, flint, plastic, not persistent	4	0
			Shale and Sandstone	19	0
		xSharon	Ore, fossiliferous, seldom present		6
			Shale	5	6
		Sharon or No. 1	Coal, locally well developed	3	0
			Clay, siliceous	2	0
	Shale, usually wanting	5	0		
Sharon	Conglomerate, not persistent	20	0		
xHarrison	Ore, seldom present, fossiliferous		6		
	(Note—The horizons from which fossils were collected are marked x.)				

HARRISON ORE

Stratigraphy and Extent

The oldest fossiliferous member of the Pottsville formation, the Harrison ore, occurs at the base of the Pennsylvanian system and marks the line of contact between that system and the underlying Mississippian system. Although the ore is extremely patchy in its occurrence, it is of comparatively wide extent and has been traced from Scioto County on the south, where it is best developed in Hamilton Township, northward through eastern Pike, Jackson, western Vinton, and Muskingum counties. It is also present in the Killbuck and Walhonding valleys of Coshocton County. In thickness it varies from 6 inches in Scioto County to a maximum of 4 feet in Jackson County¹; to the northward in central Ohio it thins again, attaining a thickness of 10 inches in Muskingum County.²

The Harrison ore is of especial interest on account of its position with reference to the Mississippian-Pennsylvanian unconformity, for it consists of the first materials deposited after the long period of erosion at the end of Mississippian time. The ore lies directly upon

¹Stout, W., Geol. Sur. Ohio, Fourth Ser., Bull. 20, pp. 28, 481, 1916.
²Stout, W., Geol. Sur. Ohio, Fourth Ser., Bull. 21, p. 48, 1918.

the eroded Mississippian surface,—sometimes upon the Maxville limestone, or where that formation has been entirely removed, upon the Logan shales. In places it is so intimately associated with the Maxville limestone that it was formerly considered the upper part of that formation;¹ but Morse in his detailed work on the Maxville of Muskingum and Perry counties proves the horizon to be of Pennsylvanian age.² In southern Ohio at most localities, the ore appears as a distinct horizon above the Mississippian-Pennsylvanian unconformity.

In lithologic character the Harrison ore varies greatly from place to place. It is generally coarse in texture, and is composed of a conglomeratic mass of quartz pebbles, cherty material, and fragments of sandstone which have been cemented together by iron oxides. The cherty material seems to have been derived from the Maxville limestone which had been weathered into small fragments during the long period of erosion after the withdrawal of the Mississippian sea. These products of decomposition were later reworked by the incoming Pennsylvanian sea and were cemented by iron compounds. Many of the rounded quartz pebbles resemble those of the Sharon conglomerate which lies only a few feet above the ore or sometimes rests directly upon it. The member is generally poor in fossils, and where these occur, they appear mostly as internal casts and present an extremely dwarfed aspect.

The Harrison ore is too poor in iron content to be of economic importance; its high percentage of silica and patchy outcrop also render it undesirable for commercial use. At present it is nowhere used commercially, although in the early history of the State it was utilized to a very limited extent in the charcoal furnaces of Scioto, Jackson, and Muskingum counties.

Description of Geological Sections and Collecting Localities

Scioto County.—In Scioto County the ore is found only in Harrison Township, from which locality it was named by Stout in 1916.³ The following geologic section, measured on Munn Hill, in Section 32, shows the variable character of the deposit:⁴

<u>Pottsville formation</u>	Ft.	In.
Shaly sandstone	20	..
Coal, bony, <i>Anthony</i> . . . . .	..	6
Clay, flint, <i>Sciotoville</i>	3	6
Shales and parts covered	38	..
Conglomerate zone, flint, boulders, shale, ferruginous clay, <i>Harrison horizon</i>	2	..
Logan formation		

Jackson County.—The Harrison ore outcrops in the stream bed and valley walls of a small tributary which the Little Scioto River

¹Orton, Edward, Geol. Surv. Ohio, Vol. V, pp. 373-379, 1884.

²Morse, W. C., Geol. Surv. Ohio, Fourth Ser., Bull. 13, pp. 35-55 and elsewhere, 1910.

³Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 481, 1916.

⁴Idem, p. 482.

receives from the south, in the central part of Section 22, Hamilton Township. Excellent collecting is afforded from the bed of the stream below the house of Phillip Meldick, as the fossils are abundant, well preserved, and easily obtained. The deposit is buff or red in color, coarse-grained, siliceous, and filled with numerous soft, decomposed pebbles, resembling to a marked extent the Sharon ore above. The collection of fossils from this locality is the only one made from the Harrison ore. These fossils were *not* found in fragments of older Mississippian rock enclosed in the Harrison ore, and therefore are distinctly of Pennsylvanian age. The following section was measured here:¹

		Ft.	In.
Sandstone, coarse-grained, ferruginous..	} Sharon conglomerate equivalent	1	10
Shale, blue.....		..	1
Sandstone, coarse-grained, ferruginous...		1	10
Ore, composed of small nodules, <i>Harrison</i>			10
Clay shale, light.....		2	..
Sandstone, with parts covered.....	} Logan	15	..
Shale, soft, yellowish.....		1	6

The fossils collected from the Harrison ore at this locality are listed below.

- Crinoid segments
- Orbiculoidea stoutella n.sp.
- Orbiculoidea capuliformis (McChesney)?
- Schizophoria sp.
- Spiriferina kentuckyensis (Shumard)?
- Hustedia mormoni (Marcou)
- Composita subtilita (Hall)
- Nucula subrotundata Girty mss.
- Nucula beyrichi von Schauthroth
- Nuculopsis ventricosa (Hall)
- Parallelodon tenuistriatus (Meek and Worthen)
- Myalina pernaformis Cox var.
- Schizodus affinis Herrick
- Schizodus subcircularis Herrick
- Aviculopecten coxanus Meek and Worthen
- Bellerophon crassus Meek and Worthen?
- Euphemus carbonarius (Cox)
- Pleurotomaria ornatiformis n.sp.
- Pleurotomaria, three or more species, undet.
- Schizostoma catilloides (Conrad)
- Sphaerodoma humilis (Keyes)?

Muskingum County.—The section below, measured on the land of Frank Fink, southeastern part of Section 13, Hopewell Township, shows the character of the member in Muskingum County as well as its relation to the underlying Maxville limestone.²

Pottsville formation	Ft.	In.
Shale, blue.....	3	..
Shale, dark, fissile.....	..	10

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 29, 1916.

²Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, p. 49, 1918.

		Ft.	In.
Clay, siliceous.....		1	10
Ore, siliceous.....	} Harrison	..	3
Shale.....		..	1
Ore, siliceous.....		..	3
Maxville limestone.....		0 to 6	..

SHARON ORE

Stratigraphy and Extent

The next fossiliferous member of the Pottsville formation above the Harrison ore, namely the Sharon ore, is of very limited outcrop, and with the exception of Mahoning and Trumbull counties, is found only in the extreme southern part of Ohio,—in the eastern part of Scioto and Pike counties and in Jackson County.¹ The ore is very patchy and uncertain, and where present, either lies directly on the Sharon coal (Jackson Shaft coal, or Coal No. 1) or is separated from it by not more than 15 or 20 feet of sandstone and shale. In Jackson County it forms a deposit from 4 to 6 inches thick, while in Pike and Scioto counties it reaches a thickness of 10 inches to 1 foot 6 inches. The ore is buff or brown in color, highly siliceous, and coarse in texture, and is filled with numerous decomposed fragments of Mississippian material. Living conditions during the period of deposition of the Sharon ore were such as to support an abundant fauna, which, however, is small and dwarfed in aspect, owing probably to the high percentage of iron which the waters contained. The fossils which are for the most part well preserved generally occur as casts of the interior as in the case of the Harrison ore.

Description of Geologic Sections and Collecting Localities

Scioto County.—In Section 14, Porter Township, at the mouth of Lick Run, the ore is exposed on the farm of Joseph Jenkins, where it is extremely fossiliferous and furnishes good collecting material; the fossils resemble to a marked degree those of the Harrison ore both in species and condition of preservation. The deposit is brown in color and contains much soft, light brown, chalky material formed by the decomposition of inclosed pebbles. The section at this locality follows:²

	Ft.	In.
Pottsville formation		
Ore, <i>Guinea Fowl</i>.....	..	6
Shale.....	3	..
Covered.....	3	..
Ore, soft, siliceous, <i>Sharon</i> , very fossiliferous.....	1	..
Covered.....	3	..
Shale.....	6	..
Ore, with flint and pebbles, <i>Harrison</i>	1	..
Waverly formation		
Sandstone, <i>Vinton</i>	22	..

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, pp. 71, 455, 493, 1916.
²Idem, p. 494.

The collection of fossils made at this locality includes the following forms:

- Crinoid segments
- Pustula pertenuis* (Meek)
- Spiriferina kentuckyensis* (Shumard)?
- Composita subtilita* (Hall)
- Solenomya* ?? *sharonensis* n.sp.
- Solenomorpha lamborni* n.sp.
- Nucula elongata* n.sp.
- Nucula subrotundata* Girty mss.
- Nucula lunulata* Girty mss.
- Nuculopsis ventricosa* (Hall)
- Leda inflata* Girty mss.
- Anthraconeilo bownockeri* n. sp.
- Aviculopecten coxanus* Meek and Worthen
- Pleurophorus oblongus* Meek
- Bellerophon crassus* Meek and Worthen?
- Euphemus carbonarius* (Cox)
- Pleurotomaria ornatformis* n.sp.
- Pleurotomaria*, three or more species undet.
- Schizostoma catilloides* (Conrad)
- Sphaerodoma primigenia* (Conrad)?
- Orthoceras* n.sp.
- Coloceras* ? sp.
- Phillipsia trinucleata* Herrick

In the northern part of Section 15, Madison Township, near the head of Higgins Run, specimens of the fresh or brackish water pelecypod, *Naiadites ohioense* n.sp., were found in the dark shales which lie directly above the Sharon coal; they are not abundant, however, and constitute the only fossil discovered at this locality. The samples of shale which were examined were taken from the roof of the mine on the farm of John Alexander, where the geologic section below was measured:

Pottsville formation	Ft.	In.
Shale, gray.....	10	..
Shale, dark, sparingly fossiliferous.....	2	..
Coal, <i>Sharon</i>	2	2
Sandstone, <i>Sharon conglomerate</i> equivalent.....	30	..
Waverly formation		
Sandstone and shales.....	40	..

In the western part of Section 15, Madison Township, *Naiadites elongata* Dawson was obtained from the Henry Odle mine in the creek bed, where the dark shales afford good material for collecting. This fossiliferous shale is also present at the other mines in the vicinity. In Section 11, the Sharon ore is present above the shales, but it was not examined for fossils. The ore is 10 inches thick and lies nearly 10 feet above the Sharon coal. This bed was formerly mined in Section 22, Madison Township, for use in the charcoal furnaces.

Jackson County.—At the old, abandoned Glen Nell mine in Section 21, Washington Township, about 4 miles northwest of Well-

ston, the Sharon ore lies practically on the Sharon coal. It is very sparingly fossiliferous, and a diligent search in the coal dumps around the mouth of the mine revealed only a few specimens of *Orbiculoidea stoutella* n.sp. The geologic section at the Glen Nell mine is given below: ¹

	Ft.	In.
Sandstone, coarse-grained	12	..
Ore, <i>Sharon</i> , in places irregularly bedded with pebbles ..	7	7
Shale, dark, carbonaceous . . . . .	..	4
Coal, <i>Sharon</i>	3	1

In the central part of Section 34, Hamilton Township, the ore horizon is replaced by black bone shales which contain abundant fossil remains. Collections were made from the shales outcropping in the road just east of Tattle Creek, where the following section was measured:

	Ft.	In.
Shale, gray	5	..
Shale, bony, black, fossiliferous, <i>Sharon ore</i> equivalent . .	..	8
Shale and covered	2	..
Sandstone, <i>Sharon conglomerate</i> equivalent	3	..

The fossils listed below were obtained at this place:

- Lingula carbonaria Shumard
- Orbiculoidea capuliformis (McChesney)?
- Marginifera muricata var. missouriensis Girty
- Phillipsia trinucleata Herrick.

Trumbull and Mahoning counties.—In the southcentral part of Trumbull and in the north-central part of Mahoning County along Mineral Ridge, the Sharon coal is reported to be accompanied by a layer of black band ore which is doubtless the equivalent of the Sharon ore of southern Ohio. ² The ore varies in thickness from 6 to 10 inches and overlies 2 feet of black shale; both the ore and the shale divide the Sharon coal into two beds. Remains of the fresh water, bivalve crustacean, *Estheria*, are said to occur in great abundance.

Summary

The complete list of fossils collected from the Sharon member follows:

- Crinoid segments
- Lingula carbonaria Shumard
- Orbiculoidea stoutella n.sp.
- Orbiculoidea capuliformis (McChesney)?
- Pustula pertenuis (Meek)
- Marginifera muricata var. missouriensis Girty
- Spiriferinia kentuckyensis (Shumard)?
- Composita subtilita (Hall)
- Solenomya ?? sharonensis n.sp.
- Solenomorpha l'amborni n.sp.
- Nucula elongata n. sp.
- Nucula subrotundata Girty mss.

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 71, 1916.
²Newberry, J. S., Geol. Surv. Ohio, Vol. III, p. 790, 1878.

Nucula lunulata Girty mss.
Nuculopsis ventricosa (Hall)
Leda inflata Girty mss.
Anthraconeilo bownockeri n.sp.
Naiadites elongata Dawson
Naiadites ohioense n.sp.
Aviculopecten coxanus Meek and Worthen
Pleurophorus oblongus Meek
Bellerophon crassus Meek and Worthen?
Euphemus carbonarius (Cox)
Pleurotomaria ornatiformis n.sp.
Pleurotomaria, 3 or more species undet.
Schizostoma catilloides (Conrad)
Sphaerodoma primigenia (Conrad)?
Orthoceras n.sp.
Coloceras ? sp.
Phillipsia trinucleata Herrick
Estheria sp.

ANTHONY COAL

Stratigraphy and Extent

The Anthony coal horizon consists of a thin deposit of coal and interbedded carbonaceous shales, lying directly over the Sciotoville clay. Although not a continuous deposit, it has been traced from the Ohio River through eastern Scioto and Pike, Jackson, Hocking, Perry, and eastern Licking counties, as far northward as southwestern Muskingum County.¹ In Scioto County, where the lowest members of the Pottsville formation are present,—including the Harrison ore, the Sharon conglomerate, coal, and ore, with their associated sandstones and shales,—the Anthony coal and the underlying Sciotoville clay occur as much as 60 feet above the base of the formation. In Jackson County the interval is only one-half as great, while in Hocking County at Logan the Anthony coal lies a few feet above the Logan sandstone, and rests directly upon the Maxville limestone at Maxville in Perry County.

The Anthony coal does not form a continuous, well-marked horizon, and where present, is thin, varying from a mere trace to 3 feet in thickness. It attains its maximum development in Scioto and Jackson counties, where the thickness averages less than a foot, but it is often represented by a layer of only 2 or 3 inches. A trace was noted in two localities in Vinton County;² near Logan in Hocking County and at Maxville in Perry County a few inches of shaly coal were reported, while in Muskingum County a thin layer of carbonaceous shale or sometimes only a soot streak marks the horizon. The coal, where thick, is of good quality and is in many places cannel; it is, however, generally shaly or interbedded with dark, carbonaceous shales. In a few places in Scioto and Jackson counties, it is mined for household use.

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, pp. 73, 455, 543, 1916; Bull. 21, p. 55, 1918.

²Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 86, 1916.

Description of Geological Sections and Collecting Localities

Scioto County.—At the mine of the Wm. E. Dee Clay Product Company near Scioto Furnace, the dark carbonaceous shales on the Anthony coal horizon were found to be fossiliferous. Small, excellently preserved specimens of *Lingula* occur in great profusion between the layers, and with the exception of a few other obscure forms, are the only fossils found. The section at this locality follows:

	Ft.	In.
Shale	15	..
Shale, dark, fossiliferous .....	..	4
Coal, <i>Anthony</i> .....	..	4
Clay, flint	} <i>Sciotoville</i> {	1
Clay, semi-flint		2
Clay, "pink eye"		1
		7
		8
		..

The fossils collected here are listed below:

- Lingula carbonaria* Shumard
- Naiadites* sp.

At the mine of the Buckeye Fire and Clay Co., at Scioto Furnace, the black bone shale above the Anthony coal also contains an abundance of *Lingulas*. The coal occurs about 25 feet above the Waverly formation. The following section was measured at this place:

	Ft.	In.
Sandstone	10	..
Shale, bony, with softer layers, partly fossiliferous	4	..
Coal, <i>Anthony</i> .....	..	2
Clay, impure, <i>Sciotoville</i> .....	..	..

The fossils from this locality include:

- Plantae
- Lingula* sp.

Summary

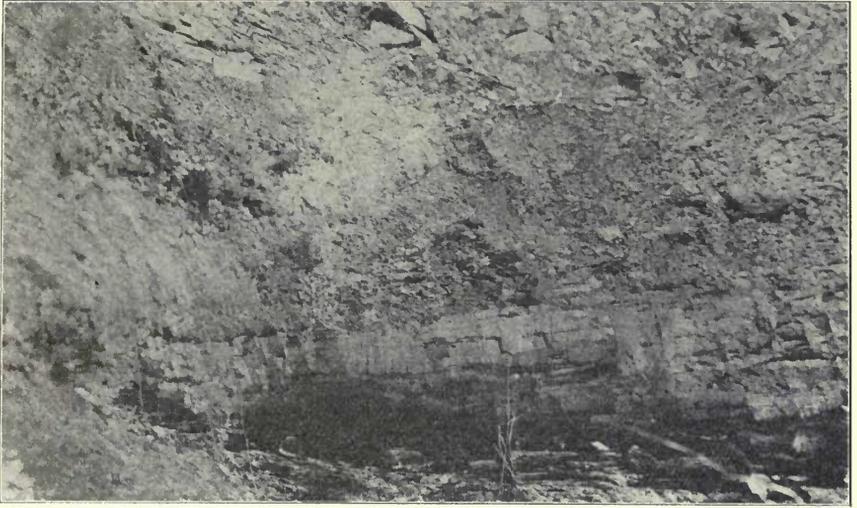
The complete list of fossils from the Anthony coal horizon follows:

- Plantae
- Lingula carbonaria* Shumard
- Lingula* sp.
- Naiadites* sp.

QUAKERTOWN OR NO. 2 COAL HORIZON

Stratigraphy and Extent

The next horizon above the Anthony coal in which fossils are found is the Quakertown or No. 2 coal, the fossils occurring in the dark, tough shales immediately overlying the coal. The deposit is of very wide extent, and is present in every county where the Pottsville rocks occur, although except in northern Jackson and southern Vinton counties, it is of importance for stratigraphic purposes only. In the latter counties, however, where the member attains its greatest development, the coal forms one of the most valuable beds in Ohio,



A—Sciotoville Clay with Anthony Coal above. Along Baltimore and Ohio Southwestern Railroad near Gephart, Scioto County.



B—Breccia of Maxville limestone on Harrison ore horizon. Lucasville, Pike County.

and adds materially to the wealth and economic resources of the State. Jackson County owes much of its development to the presence of this bed which has been mined for over fifty years.

At its southern limit in Scioto County, the Quakertown coal lies half-way between the Anthony coal below, and the Bear Run coal above, the average interval in each case being 35 feet. Northward in Jackson County the latter interval varies from 20 to 30 feet, while that between the Quakertown coal and the Sciotoville clay averages 40 feet.¹ In Muskingum County the horizon measures from a few to 70 feet above the base of the Pennsylvanian system, the variation being due to the irregular upper surface of the Mississippian rocks.² At the extreme northeastern extension of the Pottsville formation in Mahoning County, the Quakertown varies from 50 to 80 feet above the Sharon coal.³

The Quakertown coal reaches its maximum development in Coal and Milton townships, Jackson County, where it is mined over an area of forty square miles. Among the principal mining centers are Wellston, Coalton, and Glenroy. The bed reaches a thickness of 4 feet in places, but averages for the county 2 feet 6 inches. It is of excellent quality, and for the most part is free from shaly partings, though shales form the roof of the coal except where they are occasionally replaced by sandstone. The productive field extends northward into southern Vinton County as far as Allensville, Elk Fork, and Vinton Furnace. To the north and south the bed becomes thin and of slight economic value although it is mined in places for local domestic use. In Scioto County it is often wanting, but where present reaches a maximum thickness of 1 foot 10 inches, while in Muskingum County the average thickness measures 1 foot 8 inches. Its value in the latter county, however, is lessened by shaly partings $\frac{1}{2}$ to 6 inches thick. Farther northward carbonaceous shales with very thin coal layers mark the horizon, while in Mahoning County, Dr. Newberry reports that the member consists of alternating gray and black shales and sandstones with an occasional thin coal bed.⁴

The shales which form the roof of the Quakertown coal in Jackson County have been found to be very sparingly fossiliferous. A diligent search in the shales associated with the Quakertown coal at various localities in southern Ohio was rewarded by only a few crushed specimens, all of the same species, from three places in Coal Township, Jackson County. With the exception of *Lingulas* from one locality in Summit County, these forms constitute the only fossils discovered on the horizon.

Description of Geological Sections and Collecting Localities

Lawrence and Scioto counties.—In Lawrence County the Quakertown coal does not appear at the surface and is known only from

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, pp. 90-114, 550-552, 1916.

²Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, pp. 56-60, 1918.

³Newberry, J. S., Geol. Surv. Ohio, Vol. III, pp. 793-794, 1878.

⁴Idem., p. 793.

well records. In Scioto County, however, the member is locally well developed. The following section measured on the land of William Tripp, Section 14, Bloom Township, shows its relation to the Sciotoville clay below and to the Bear Run coal above. ¹

	Ft.	In.
Coal blossom, <i>Bear Run</i> .....	..	6
Clay shales, dark	3	6
Shales, gray, and parts covered	28	..
Sandstones, flaggy and medium bedded	13	..
Coal outcrop, <i>Quakertown</i> , seen to the south	1	8
Shales and covered	33	..
Sandstones	7	..
Coal, <i>Anthony</i> .....	..	2
Clay, flint, dark, <i>Sciotoville</i>	6	..

Jackson County.—With the exception of Summit County, this is the only county from which fossils were obtained, all of them being from Coal Township. Specimens are very rare, and all belong to the fresh or brackish water pelecypod, *Naiadites elongata* Dawson. Collections were made from the Wilson mine, northeastern part of Section 32; from the Twin-Ada mine, central part of Section 35; and from the Grace mine, just east of Davisville in the northeastern part of Section 10. The following section was measured in the mine and in the hollow east of the latter place: ²

		Ft.	In.
Limestone	} <i>Lower Mercer</i>	..	11
Shale, dark		1	10
Limestone		1	
Covered		9	..
Coal, cannel, <i>Lower Mercer</i> .....		..
Covered		1	6
Top of shaft			
Covered		97	..
Coal, <i>Quakertown</i>		3	..

Summit County.—No other fossils were found on the Quakertown coal horizon except in the extreme eastern part of Summit County where *Lingula carbonaria* Shumard is present in great abundance in the fossiliferous shales associated with a thin coal bed at Mogadore Station, five miles east of Akron.

Summary

The fossils collected from the Quakertown or No. 2 coal horizon are:

Lingula carbonaria Shumard
Naiadites elongata Dawson

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 551, 1916.
²idem, p. 146.

BEAR RUN COAL HORIZON

Stratigraphy and Extent

The shales and black band ore associated with the Bear Run coal constitute the next fossiliferous horizon above the Quakertown coal. Although absent in some localities, the stratum is fairly persistent in southern Ohio, and extends from Scioto County through Jackson and Vinton as far north as Muskingum County.¹ In Scioto County the interval between the Bear Run coal horizon and the Sciotoville clay with the associated Anthony coal varies from 62 to 86 feet with an average of 71 feet; northward in Jackson County the interval is somewhat less,—from 20 to 80 feet with an average of about 60 feet.² In Muskingum County this distance measures about 45 feet.

The Bear Run coal attains its greatest development in the Dever Valley in Hamilton Township, Jackson County, where it is of good quality and has been mined for local use for many years. Its thickness varies from 1 foot to 2 feet 6 inches, with an average of almost 2 feet. The character of the deposit varies greatly from place to place, and the coal may be interbedded with or replaced by shales and black band ore. In Scioto County the coal is thin or is replaced entirely by carbonaceous shales, while along Tattle Creek, south of the Dever Valley, the deposit gives way to sandstone. In Lick Township, Jackson County, the coal is interbedded with dark fissile shales and black band ore; in Muskingum County the member is thin and is usually represented by dark, carbonaceous shales. Fossils are fairly abundant in number of individuals, but with the exception of a single fish plate, all the specimens discovered belong to a single species of the fresh or brackish water pelecypod,—*Naiadites elongata* Dawson. Collections were made from various parts of Scioto and Jackson counties.

Description of Geologic Sections and Collecting Localities

Scioto County.—In Section 3, Bloom Township, on the land of H. H. Stevenson, *Naiadites elongata* Dawson occurs in the dark shales overlying the Bear Run coal. The following section was measured here:³

	Ft.	In.
Sandstone, massive	6	0
Shale, blue, tough, lower part fossiliferous	7	0
Coal, <i>Bear Run</i> , upper part somewhat bony	2	4

Jackson County.—Along the Dever Valley in the southern part of Hamilton Township, the shales above the coal are everywhere fossiliferous, and collections of *Naiadites elongata* were made at various places along the valley. One of the best collecting localities was

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 15, 1916; Bull. 21, p. 60, 1918.

²Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, pp. 115, 552, 1916.

³Idem, p. 556.

found on the land of Edward Toffin, in the southern part of Section 25, where the geologic section below was measured: ¹

	Ft.	In.
Coal blossom, <i>Tionesta</i>	1	..
Covered	40	..
Ore, <i>Sand Block</i> .....	..	4
Covered	133	..
Shale, blue	10	..
Shale, blue, tough, lower part fossiliferous	} <i>Bear Run</i> {	2
Coal, good		1
Coal, bony .....		..
Shale, black, carbonaceous .....		..
		7
		3
		6

In Lick Township, several miles northeast of Jackson, the same fossil occurs in the fissile shales and black band ore interbedded with the coal. In the western part of Section 21, at the mouth of an old coal mine on the land of D. D. Evans, good collecting material is supplied by the piles of shale thrown out from the mine. The section below was made at this place: ²

	Ft.	In.
Shale	35	..
Coal, part cannel	} <i>Bear Run</i> {	1
Bone, shale, tough, fissile .....		..
Ore, black band .....		..
Bone, shale, tough, fissile .....		..
		8
		8
		10
		4

Black band ore with *Naiadites elongata* is exposed in the stream bed on the property of Mrs. John Butts in the central part of Section 5. The material is shaly, red or gray in color, and slabs containing fossils can be obtained easily from the stream bed. The following members constitute the geologic section here: ³

	Ft.	In.
Shale, dark	4	..
Coal, cannel nature	} <i>Bear Run</i> {	..
Shale .....		..
Coal, cannel .....		..
Ore, black band, fossiliferous .....		..
Coal, bituminous .....	..	4
Sandstone	4	..
Shale	10	..
Coal blossom .....	..	3
Shale, blue, sandy	3	9
Shaly sandstone, plant marked	1	3
Shale, sandy, with carbonate ore nodules	5	10
Coal, bony	} <i>Quakertown</i> {	..
Coal, good .....		..
		4
		9

Vinton County.—The black band ore above the Bear Run coal is sparingly fossiliferous on Elk Fork, in the western part of Section 6, Elk Township. The ore occurs about 100 feet below the Lower

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 116, 1916.

²Idem, p. 121.

³Idem, p. 122.

Mercer limestone. The geologic section with the fossils collected here follow:

	Ft.	In.
Sandstone, shaly	10	..
Ore, black band, sparingly fossiliferous . . . . .	..	2
Coal, <i>Bear Run</i> . . . . .	..	2
Clay	1	..
<i>Naiadites elongata</i> Dawson		
Fish plate		

Specimens of *Naiadites elongata* Dawson were obtained from the black shales of the Bear Run coal horizon three-fourths of a mile south of Stella, in the northern part of Section 14, Jackson Township.

LOWELLVILLE (POVERTY RUN) LIMESTONE

Stratigraphy and Extent

The Lowellville limestone is the next faunal horizon above the fossiliferous shales associated with the Bear Run coal, and is the oldest of the series of marine limestones which occur in the Pennsylvanian system. The limestone was named *Poverty Run* by Stout in 1918 because excellent outcrops of the limestone occur along a stream of that name in Hopewell Township, Muskingum County, and this name has been used in the report of the Geological Survey on Muskingum County.¹ It is present locally in the western part of Muskingum County and extends northward into the southwestern part of Coshocton, where it has been outcropping in Opossum Hollow, Washington Township.² No other outcrops are reported to the north except in Mahoning County where G. F. Lamb describes a "black, very hard, tough" limestone which "seems to lie just below the horizon of the Quakertown coal," to which in 1910 he gave the name *Lowellville limestone* from exposures in the town of Lowellville, in the eastern part of the county.³ This limestone apparently forms the northeastern extension of the Poverty Run limestone of Muskingum County, and the two deposits are alike not only lithologically, but also faunally, as a comparison of their fossil content shows. In Muskingum County along Poverty Run the member is found about 37 feet above the base of the Pottsville formation and 55 feet below the base of the Pottsville formation and 55 feet below the Lower Mercer limestone; the latter interval averages for the county 52 feet.⁴ At Lowellville in Mahoning County, the horizon lies 64 feet above the Sharon coal and 83 feet below the Lower Mercer limestone.⁵

Where typically developed in Muskingum County, the Poverty Run limestone consists of several divisions, the lowest of which is an extremely hard, gray, fossiliferous limestone with a maximum thickness of 6 inches. It is characteristically affected by two systems of

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, p. 65 and elsewhere, 1918.

²Idem., p. 64.

³Lamb, G. F., Pennsylvanian Limestones of Northeastern Ohio below the Lower Kittanning Coal, Ohio Naturalist, Vol. 10, March, 1910, pp. 128, 129.

⁴Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, p. 65, 1918.

⁵Lamb, G. F., Pennsylvanian Limestone in Northeastern Ohio below the Lower Kittanning Coal, Ohio Naturalist, Vol. 10, March 1910, pp. 128, 129.

joints causing the limestone to break up into comparatively small blocks. In places concretions of iron ore are present, and on Poverty Run these are especially numerous and resemble the stems of plants. Fossils, although abundant, consist largely of fragments, and it is difficult to find specimens in a condition perfect enough to permit identification. The extreme hardness of the limestone also makes work with the fossils difficult. On top of the limestone, however, there occurs a soft friable, black, calcareous shale, generally about 1 foot in thickness, which contains a wealth of fossils, at least in number of individuals. Collecting is good as the fossils are easily obtained and well preserved. For the most part the shells are white in color and show up remarkably well against the dark background. In some places a thin layer of iron ore not more than 4 inches thick overlies the shale. It is reported to be sparingly fossiliferous, but no collections were made from it.

In Mahoning County the Lowellville limestone was first referred to by Dr. Newberry as "dark, siliceous limestone" in his section¹ on Grindstone Run at Lowellville, where he ascribes to it a thickness of 1 foot. Professor Lamb describes the deposit at Lowellville thus: "The limestone is black, very hard, tough, and apparently in one layer. It is 2 feet or more in thickness—and full thickness not being obtained due to a sharp dig downstream concealing the base. It is very fossiliferous, the white shells and crinoid stems presenting a striking appearance in the black matrix. A few species of brachiopods and fragments of crinoid stems predominate. The latter are often 6 to 8 inches long,—and lying horizontally, with the section markings showing plainly, they somewhat resemble worms"²

Description of Geologic Sections and Collecting Localities

Muskingum County.—The type exposure of the Poverty Run limestone is found in Hopewell Township on Poverty Run, a small stream which flows into the Licking River from the southwest. The following section was measured on land of Della Wise, Section 18, about two miles northwest of Mt. Sterling.³ Collections were made from the limestone and from the overlying dark, fossiliferous shale, both of which outcrop in the bed of the stream. The shale furnishes especially good collecting material.

Allegheny formation	Ft.	In.
Limestone, nodular, fossiliferous, <i>Putnam Hill</i>	1	..
 Pottsville formation		
Shale and covered	9	6
Shale, in part light	7	..
Coal . . . . .	..	1

¹Newberry, J. S., Geol. Surv. Ohio, Vol. III, opp. p. 804, 1878; Lamb, G. F., Pennsylvania Limestones in Northeastern Ohio below the Lower Kittanning coal, Ohio Naturalist, Vol. 10, March, 1910, p. 128.

²Lamb, G. F., *Idem.*, p. 128.

³Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, Section given in part on page 62, 1918.

		Ft.	In.
Clay and clay shale		4	11
Coal blossom		..	2
Clay		1	0
Shale, gray, with scattered nodules of ore		4	4
Flint, black, fossiliferous, <i>Upper Mercer</i>		..	9
Shale		..	3
Coal, semi-cannel, <i>Bedford</i>		1	6
Clay, light		3	..
Clay, shale		3	..
Coal, <i>Upper Mercer or No. 3a</i>		..	6
Clay		2	6
Sandstone		4	..
Covered		4	..
Limestone, blue, fossiliferous	} <i>Lower Mercer</i>	..	8
Limestone, blue, fossiliferous		..	8
Clay, light		3	..
Shale and shaly sandstone		5	..
Clay, flint, dark		1	4
Clay, siliceous, light		5	8
Covered		5	..
Ore, kidney, fossiliferous	} <i>Boggs</i>	..	3
Flint, dark, fossiliferous		..	4
Sandstone, ferruginous, hard		..	3
Clay shale		2	..
Sandstone, shaly		5	..
Shale and covered		19	..
Shale, gray		7	..
Shale, dark, calcareous, very fossiliferous, with scattered nodules of fossiliferous limestone	} <i>Poverty Run</i>	1	..
Limestone, blocky, fossiliferous		..	3
Shale, siliceous, light		..	10
Sandstone, light		..	10
Shale, gray, with thin sandstones interbedded		5	8
Coal, <i>Vandusen</i>		..	10
Clay, light, siliceous		3	8
Shale, argillaceous		2	..
Shale, blue		3	..
Shale with thin coal bands, <i>Bear Run</i>		..	3
Sandstone, hard, plant marked		..	3
Clay shale, light gray		3	..
Shale, siliceous, blue		4	..
Shale, gray		3	0
Sandstone, ferruginous, conglomeratic		..	6
Clay shale		2	..
Shale, blue		3	..
Shale, dark, fissile	} <i>Quakertown</i>	..	8
Shale, black, bony		..	2
Clay, siliceous		1	10
Ore, siliceous	} <i>Harrison</i>	..	3
Shale		..	1
Ore, siliceous		..	3

Waverly formation

Limestone, <i>Marville</i>	6	..
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The limestone from this locality is extremely hard and contains many fragments of fossils, which are for the most part too poorly preserved to be identified. The list includes the following identifiable forms:

- Crinoid segments and plates
- Fenestella* sp.
- Derbya crassa* (Meek and Hayden)
- Chonetes choteauensis* Mather
- Pustula punctatus* (Martin)
- Marginifera muricata* var. *missouriensis* Girty
- Spirifer opimus* Hall
- Composita subtilita* (Hall)

The fossils below were collected from the black shale above the hard limestone on Poverty Run:

- Crinoid segments
- Orbiculoidea missouriensis* (Shumard)
- Derbya crassa* (Meek and Hayden)
- Chonetes choteauensis* Mather
- Productus cora d'Orbigny*
- Pustula nebraskensis* (Owen)
- Maginifera muricata* var. *missouriensis* Girty
- Rhipidomella pecosi* (Marcou)
- Spiriferina kentuckyensis* (Shumard)
- Ambocoelia planoconvexa* Shumard var.
- Edmondia* sp.
- Leda bellistriata* Stevens
- Parallelodon obsoletus* Meek?
- Aviculopecten pellucidus* Meek and Worthen
- Aviculopecten coxanus* Meek and Worthen
- Enchondria neglecta* (Geinitz)
- Pleurophorus tropidophorus* Meek
- Astartella concentrica* (Conrad)?
- Schizostoma catilloides* (Conrad)
- Pseudorthoceras knoxense* (McChesney)

In Fall Township on the land of E. G. Marshall, the Lowellville (Poverty Run) limestone outcrops in the bed of a small stream which flows into the Licking River at Holbein from the northeast. Collections of fossils were made from the limestone and from a dark shale at an undetermined distance above. The geologic section here shows the following members:¹

	Ft.	In.
Limestone, shaly . . . . .	..	7
Limestone, hard, blue . . . . .	..	5
Shale, calcareous . . . . .	..	2
Limestone, blue, hard	1	4
Coal, clay, and covered	10	6
Sandstone, shaly	5	..
Sandstone, massive	10	..
Sandstone, shaly, with siliceous shales	11	..
Shale, gray	3	..

} Lower Mercer

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, p. 62, 1918.

	Ft.	In.
Clay shale with widely spaced papery coal.....	5	..
Clay, siliceous.....	3	..
Sandstone, massive, cross-bedded.....	13	10
Disconformity		
Shale, calcareous.....	2	5
Shale, hard, black, fossiliferous.....	} <i>Poverty</i>	4
Limestone, gray, very fossiliferous.....		4
Limestone, dark, carbonaceous.....	} <i>Run</i>	1
Shale, dark, carbonaceous.....		2	6
Shale, black, fissile, horizon <i>Vandusen</i> coal.....	7	..

The fossils listed from the limestone follows:

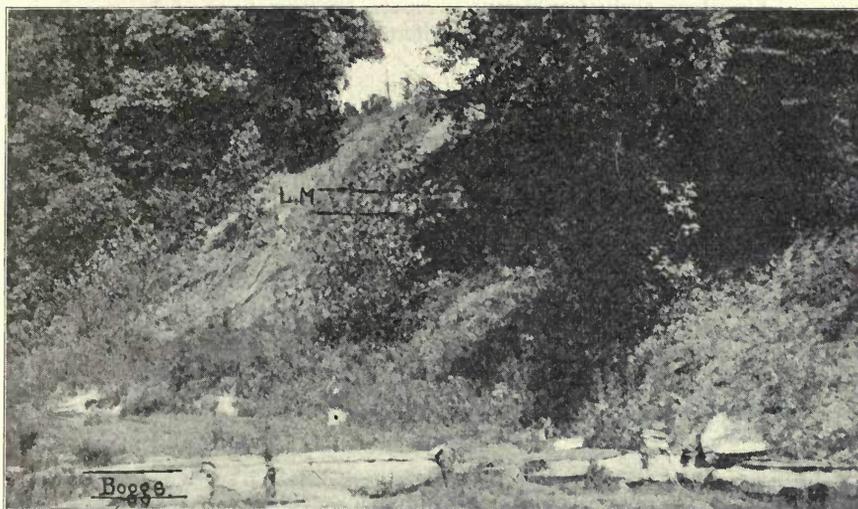
- Crinoid segments
- Fenestella shumardi* Prout?
- Derbya crassa* (Meek and Hayden)
- Chonetes choteauensis* Mather
- Productus cora d'Orbigny*
- Productus semireticulatus* (Martin)
- Marginifera muricata* var. *missouriensis* Girty
- Marginifera wabashensis* (Norwood and Pratten)
- Spiriferina kentuckyensis* (Shumard)
- Spirifer opimus* Hall
- Composita subtilita* (Hall)

A black shale containing much carbonaceous material and layers of pyrite, one-eighth of an inch thick, occurs above the Lowellville limestone, but its exact stratigraphic position was not determined. The following fossils were obtained from this shale:

- Cordaites* sp.
- Calamites* sp.
- Crinoid stems
- Lingula carbonaria* Shumard
- Orbiculoidea missouriensis* (Shumard)
- Derbya crassa* (Meek and Hayden)
- Marginifera muricata* var. *missouriensis* Girty
- Spiriferina kentuckyensis* (Shumard)
- Astartella* sp.
- Posidonia girtyi* n.sp.
- Pseudorthoceras knoxense* (McChesney)
- Orthoceras* n.sp.
- Fish teeth

In Madison Township this limestone occurs in several places. Fossils were collected from the hard limestone which outcrops along the east bank of the Muskingum River about one-half mile north of Symmes Ford. The member here is 4 inches thick, and protrudes prominently from the bank about 6 feet above water level. The section below was measured along the Muskingum River near Symmes Ford:

	Ft.	In.
Limestone and flint, fossiliferous, <i>Upper Mercer</i>	2	6
Coal, bony, <i>Bedford</i>	1	..
Covered.....	3	..



A—Boggs Limestone in stream bed; Lower Mercer limestone protruding from bank.
Blunt Run, Muskingum County (Locality 27.)



B—Boggs limestone below with Lower Mercer limestone and Middle Mercer Coal
above. Exposure along cut of Wheeling and Lake Erie Railroad,
Muskingum County, (Locality 28.)

	Ft.	In.
Sandstone, shaly	7	6
Limestone, shaly, fossiliferous	} <i>Lower Mercer</i> {	9
Limestone, somewhat shaly, fossiliferous		9
Limestone, blue, fossiliferous		1
Limestone, blue, fossiliferous		1
Limestone, blue, fossiliferous		7
Shale, dark	4	4
Coal, fair, <i>Middle Mercer</i>	1	1
Clay, light, plastic	3	7
Sandstone, shaly	4	..
Shale	7	..
Limestone, dark, fossiliferous	} <i>Boggs</i> {	2
Ore		2
Limestone, dark blue, fossiliferous		1
Covered		8
Shale, gray		7
Shale, dark	1	..
Limestone, gray, fossiliferous, <i>Poverty Run</i>, .....	..	4
Coal, <i>Vandusen</i> .....	..	4

The fossils from this locality are:

- Crinoid segments
- Derbya crassa* (Meek and Hayden)
- Chonetes choteauensis* Mather
- Productus cora* d'Orbigny
- Productus semireticulatus* (Martin)
- Spirifer opimus* Hall
- Composita subtilita* (Hall)
- Pseudorthoceras knoxense* (McChesney)

The member is also well exposed along Symmes Creek about 1 mile from its mouth, where it has a thickness of 6 inches, but no collections of fossils were made.

Coshocton County.—The member outcrops near the head waters of Opossum Run in the southwestern part of Washington Township, and is composed of the following strata:¹

	Ft.	In.
Ore, siliceous, sparingly fossiliferous, thickens to 8 inches in places .....	..	3
Shale, gray	} <i>Poverty Run</i> {	1
Shale, dark, calcareous, fossiliferous .....		..
Shale, dark, calcareous, fossiliferous		10
Limestone, gray, very fossiliferous .....		..
Coal, bony, <i>Vandusen</i> .....	..	3
	..	8

Mahoning County.—The only known outcrops of Lowellville limestone, north of Coshocton County, are found in Mahoning. At Lowellville fossils were collected from the limestone and the associated dark shale, where they occur in great abundance and in an excellent state of preservation. The section given by Dr. Newberry in 1878 from Grindstone Run, Lowellville, follows:²

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, p. 64, 1918.

²Newberry, J. S., Geol. Surv. Ohio, Vol. III, opp. p. 804, 1878. The words in parentheses have been supplied by the writer.

	Ft.	In.
Earth with drift boulders		
Limestone, <i>Putnam Hill</i>	14	..
Shale and sandstone	50	..
Coal		8
Fire clay	2	..
Shale	32	..
Coal		6
Fire clay	2	..
Coal	1	..
Fire clay	2	..
Limestone (<i>Upper Mercer</i>)	3	..
Coal	1	3
Fire clay	8	
Shale and sandstone	36	..
Limestone (<i>Lower Mercer</i>)	2	..
Gray shale	20	..
Coal	3	..
Fire clay	2	..
Drab shale	50	..
Dark, siliceous limestone (<i>Lowellville</i>)	1	..
Shale	20	..
Black shale and iron ore	5	..
Drab shale	50	..
Sandstone	15	..
Mahoning River		

The fossils below were obtained from the Lowellville limestone at Lowellville:

- Crinoid segments
- Orbiculoidea missouriensis* (Shumard)
- Derbya crassa* (Meek and Hayden)
- Chonetes choteauensis* Mather
- Productus cora d'Orbigny*
- Pustula nebraskensis* (Owen)
- Marginifera muricata* var. *missouriensis* Girty
- Marginifera wabashensis* (Norwood and Pratten)
- Spiriferina kentuckyensis* (Shumard)
- Spirifer opimus* Hall
- Composita subtilita* (Hall)
- Parallelodon sangamonensis* (Worthen)
- Pseudorthoceras knoxense* (McChesney)

Summary

The complete list of fossils collected from the Lowellville limestone follows:

- Cordaites* sp.
- Calamites* sp.
- Crinoid segments and plates
- Fenestella shumardi* Prout?
- Fenestella* sp.
- Lingula carbonaria* Shumard
- Orbiculoidea missouriensis* (Shumard)
- Rhipidomella pecosi* (Marcou)
- Derbya crassa* (Meek and Hayden)

Chonetes choteauensis Mather
 Productus cora d'Orbigny
 Productus semireticulatus (Martin)
 Pustula nebraskensis (Owen)
 Pustula punctatus (Martin)
 Marginifera muricata var. missouriensis Girty
 Marginifera wabashensis (Norwood and Pratten)
 Spiriferina kentuckyensis (Shumard)
 Spirifer opimus Hall
 Ambocoelia planoconvexa Shumard var.
 Composita subtilita (Hall)
 Edmondia sp.
 Leda bellistriata Stevens
 Parallelodon obsoletus (Meek)?
 Parallelodon sanganonensis (Worthen)
 Posidonia girtyi n.sp.
 Aviculopecten pellucidus Meek and Worthen
 Aviculopecten coxanus Meek and Worthen
 Euchondria neglecta (Geinitz)
 Pleurophorus tropidophorus Meek
 Astartella concentrica (Conrad)?
 Astartella sp.
 Schizostoma catilloides (Conrad)
 Pseudorthoceras knoxense (McChesney)
 Orthoceras n.sp.
 Fish teeth

BOGGS MEMBER

Stratigraphy and Extent

The Boggs member is the next fossiliferous horizon above the Lowellville limestone, and in ascending order forms the second limestone of the Pottsville formation. It either directly overlies the Lower Mercer coal (No. 3 coal) or is separated from it by an interval of not more than 3 feet. In Muskingum County it is found about 20 to 25 feet above the Lowellville limestone and about 22 feet below the Lower Mercer limestone. In northern Tuscarawas County the latter interval is increased to 34 feet, while at the southern extension in Scioto County the average distance between the Boggs ore and the Lower Mercer limestone is about 47 feet. The horizon has been traced from eastern Scioto, western Lawrence, and Jackson counties on the south, where its appearance is patchy and uncertain,¹ northward through central and western Muskingum County where it attains its greatest thickness.² It has also been observed in eastern Licking County, and has been recorded as far north as northern Tuscarawas County.³

The Boggs member varies greatly in lithologic character from place to place. In Scioto, Lawrence, and Jackson counties, the horizon is marked only by iron ore irregularly bedded in shales. It is found in isolated patches, and varies in thickness from 1 to 6 feet

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, pp. 141, 292, 567, 1916.

²Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, pp. 70-75, 1918.

³Orton, Edward, Geol. Surv. Ohio, Vol. V, p. 68, 1884.

in Scioto and Lawrence counties, with an average of 3 feet; however, in Jackson County only about 6 inches are present. Formerly this ore was used commercially to a large extent in charcoal furnaces especially in Jackson and Scioto counties, although at the present time it is no longer utilized for this purpose. Northward in Muskingum County the typical Boggs deposit consists of limestone, but iron ore, shales, sandstone, or flint may be present with the limestone or may entirely replace it. The limestone, where present, is often bluish-gray, very hard, and very fossiliferous, closely resembling the Lower Mercer limestone in lithologic character. The fossils, although essentially similar to those of the Lower Mercer, are much larger and more robust in appearance. The member is here less than 2 feet in thickness. In Tuscarawas County a blue limestone was reported by Dr. Edward Orton to occur occasionally at what appears to be the Boggs horizon,—about 34 feet below the Lower Mercer member; it has a thickness of 1 foot 6 inches near Bolivar in the northern part of the county. Further stratigraphic studies may reveal the presence of the Boggs member in the counties to the northeast.

Description of Geological Sections and Collecting Localities

Scioto County.—The following section was measured on the William M. Galligher farm, in the southwestern part of Section 24, Bloom Township. No fossils were found in the Boggs ore of southern Ohio, but they were discovered to be present sparingly in the shales associated with the ore:¹

	Ft.	In.
Shale.....	5	..
Coal, <i>Upper Mercer, No. 3a</i>	1	4
Covered.....	54	..
Sandstone, with finger coal at bottom.....	15	..
Unconformity		
Shale, dark, fissile.....	1	3
Ore.....	} <i>Boggs</i> {	4
Shale.....		2
Ore.....		11
Shale, blue.....	3	..

The fossils collected from the dark shales on the William M. Galligher farm are:

- Lepidodendron**
- Naiadites elongata Dawson**

Along the road on the long ridge east of Pine Creek, one and one-half miles southeast of Lyra, Vernon Township, *Lingula carbonaria* Shumard was found in great abundance in the dark shales above the Lower Mercer or No. 3 coal, which occupies the Boggs ore horizon. The section here follows:

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, 1916. Given in part on page 568.

	Ft.	In.
Ore, <i>Lower Mercer</i> .....	..	4
Shale and shaly sandstone	35	2
Shale, dark	1	..
Shale, hard, fossiliferous .....	..	1
Coal, part bony, <i>Lower Mercer</i> .....	..	7
Clay, siliceous	1	..
Sandstone	10	..

Jackson County.—Along the road west of Hamden in Section 13, Washington Township, the Boggs ore is also typically exposed. The section at this locality follows:¹

	Ft.	In.
Limestone, <i>Lower Mercer</i> .....	..	10
Clay shale	2	..
Coal .....	..	2
Shaly sandstone and covered	14	..
Ore, <i>Boggs</i> .....	..	6
Shale and shaly sandstone	3	..
Sandstone .....	..	3
Coal, <i>Lower Mercer</i>	1	1
Clay and covered .....	..	..

Vinton County.—At some localities in Vinton County the Boggs ore is well represented, although it is generally sparingly fossiliferous. In the black band ore, which outcrops in Spook Hollow in the bed of Elk Creek, one and one-half miles east of McArthur, *Lingula carbonaria* Shumard is fairly abundant. The section below was measured in Spook Hollow:

	Ft.	In.
Coal, <i>Brookville</i> , formerly mined .....	..	..
Clay	1	..
Flint, gray to black, <i>Black Flint</i>	1	8
Covered	52	..
Sandstone and covered	40	..
Ore, black band, <i>Boggs</i> .....	..	3
Coal, <i>Lower Mercer</i> , No. 3 .....	..	2

The fossils collected here are:

- Plant leaves
- Lingula carbonaria* Shumard
- Fish teeth and plates

Muskingum County.—Where the Boggs member is typically developed in Muskingum County, it consists of a limestone associated with or replaced by shale, flint, iron ore, or sandstone. On the land of Della Wise, Hopewell Township, flint and iron ore mark the horizon.² The limestone phase is shown on the land of Delard Fink, Section 18 of the same township, where the following section was measured, but no collections were made.³

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 20, p. 148, 1916.

²See page 23 of this report for geologic section on land of Della Wise.

³Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, p. 148, in part, 1918.

	Ft.	In.
Coal, <i>Brookville</i> . . . . .	..	4
Clay, light, part covered	6	4
Sandstone, light, argillaceous	3	..
Clay, light, siliceous	5	10
Shale, dark	1	..
Coal, bony, semi-cannel, <i>Tionesta No. 3b</i>	1	..
Clay and covered	5	..
Limestone, flinty, fossiliferous, <i>Upper Mercer</i> . . . . .	..	8
Coal blossom, <i>Bedford</i> . . . . .	..	4
Covered	6	..
Shale	6	8
Coal, <i>Upper Mercer, No. 3a</i> . . . . .	..	4
Clay	1	..
Sandstone	4	..
Covered	3	..
Limestone, blue, fossiliferous	} <i>Lower Mercer</i>	..
Limestone, blue, fossiliferous		1
Covered	10	..
Shale and covered	14	..
Limestone, blue, hard, fossiliferous	} <i>Boggs</i>	..
Limestone, siliceous, ferruginous, fossiliferous . . . . .		..
		10

On the land of O. J. Riggle in the northeastern part of Section 18, Hopewell Township, the limestone is coarse and siliceous in character, and exceedingly fossiliferous. Extensive collections were made in the bed of the small stream just west of the road. Collecting is good as the fossils are abundant, well preserved, and easily obtained.

	Ft.	In.
Limestone, blue, hard, fossiliferous	} <i>Lower Mercer</i>	..
Limestone, blue, hard, fossiliferous		1
Coal and shale, <i>Middle Mercer</i> . . . . .	..	6
Clay and covered	5	6
Shale, siliceous	5	..
Coal smut, <i>Flint Ridge</i> . . . . .	..	1
Clay, flint, dark	14	..
Clay, light, siliceous	2	4
Sandstone, light, argillaceous	3	..
Shale and covered	4	..
Ore, yellow, nodular	{ ..	2
Limestone, dark gray, ferruginous, very fossiliferous	} <i>Boggs</i>	1
Limestone, dark gray, ferruginous, very fossiliferous . . . . .		..
Shale	2	2
Coal, <i>Lower Mercer</i> . . . . .	..	3
Clay, light, part siliceous	2	5

The fossils listed below were collected from this locality:

- Crinoid segments
- Tabulipora ohioensis* (Foreste)
- Orbiculoidea capuliformis* (McChesney)
- Derbya crassa* (Meek and Hayden)
- Chonetes choteauensis* Mather

Productus cora d'Orbigny
Productus semireticulatus (Martin)
Productus semireticulatus (Martin) var.
Pustula nebraskensis (Owen)
Spiriferina kentuckyensis (Shumard)
Spirifer boonensis Swallow?
Composita subtilita (Hall)
Composita sp.
Edmondia ? *peroblonga* Meek and Worthen
Edmondia sp.
Leda prolongata n.sp.
Leda bellistriata Stevens
Parallelodon carbonarius (Cox)
Aviculopinna americana Meek
Myalina pernaformis Cox
Schizodus amplus Meek and Worthen
Schizodus curtus Meek and Worthen
Schizodus wheeleri Swallow
Schizodus affinis Herrick
Aviculopecten coxanus Meek and Worthen
Deltopecten scalaris (Herrick)
Acanthopecten carboniferous (Stevens)
Astartella concentrica (Conrad)?
Ephemus carbonarius (Cox)
Pleurotomaria sp.
Schizostoma catilloides (Conrad)
Naticopsis altonensis (McChesney)
Pseudorthoceras knoxense (McChesney)
Temnocheilus forbesianus (McChesney)

In Muskingum Township along Blunt Run, a small stream which flows into the Muskingum River from the west, the Boggs member is a limestone similar in lithologic character and composition to the Lower Mercer. The stratum is extremely fossiliferous and outcrops in the bed of the stream where conditions are especially good for collecting. The section along Blunt Run on the land of Carl Crabtree follows:

	Ft.	In.
Limestone, shaly, fossiliferous	1	..
Limestone, hard, fossiliferous . . . . .	..	8
Limestone, shaly, fossiliferous . . . . .	..	3
Limestone, hard, fossiliferous	1	8
Shale, with coal bands . . . . .	..	6
Coal, bony, <i>Middle Mercer</i> . . . . .	..	8
Sandstone . . . . .	..	10
Clay, siliceous	1	6
Sandstone, shaly	4	10
Shale, dark blue	7	6
Ore, kidney . . . . .	..	2
Shale, dark, siliceous, fossiliferous	4	..
Limestone, dark gray, fossiliferous	1	3
Shale with thin coal bands . . . . .	..	2
Clay, light, siliceous	3	..

The collection of fossils from Blunt Run includes the following forms:

- Crinoid segments
- Eupachyrinus moorei (Whitfield), spines
- Fenestella shumardi Prout?
- Rhombopora lepidodendroidea Meek
- Orbiculoidea missouriensis (Shumard)
- Derbya crassa (Meek and Hayden)
- Chonetes mesolobus Norwood and Pratten
- Chonetes choteauensis Mather
- Productus cora d'Orbigny
- Productus semireticulatus (Martin)
- Productus semireticulatus (Martin) var.
- Pustula nebraskensis (Owen)
- Pustula punctatus (Martin)
- Marginifera wabashensis (Norwood and Pratten)
- Spiriferina kentuckyensis (Shumard)
- Spirifer boonensis Swallow?
- Composita subtilita (Hall)
- Composita sp.
- Edmondia sp.
- Parallelodon tenuistriatus (Meek and Worthen)
- Myalina pernaformis Cox
- Schizodus curtus Meek and Worthen
- Aviculopecten coxanus Meek and Worthen
- Deltopecten occidentalis (Shumard)
- Crenipecten foerstii Herrick

In the exposures along the Wheeling & Lake Erie Railroad, just north of Rock Cut, Muskingum Township, the Boggs limestone is flinty, dark in color, with abundant fossils. The relations of the Boggs, Lower Mercer, and Upper Mercer limestones are exceptionally well shown in this locality, and collections were made from all three members.

	Ft.	In.
Shale	5	..
Flint, black, fossiliferous, <i>Upper Mercer</i>	2	..
Coal, with shale bands	} <i>Bedford</i>	8
Coal, somewhat bony		4
Clay, siliceous	1	6
Sandstone, part shaly	7	..
Sandstone, shaly	5	..
Shale	1	..
Limestone, shaly, fossiliferous	} <i>Lower Mercer</i>	6
Limestone, hard, fossiliferous		1
Limestone, hard, fossiliferous		10
Shale, dark .....	..	4
Shale, with bony coal	} <i>Middle Mercer</i>	6
Coal, bony		1
Clay	4	..
Shale, dark gray, siliceous	6	..
Limestone, flinty, dark, fossiliferous, <i>Boggs</i> .....	..	10
Coal, <i>Lower Mercer</i> .....	..	8
Clay, light, siliceous	3	..

The list of fossils which were collected from the Boggs limestone along the railroad cut is given below:

- Crinoid segments
- Fenestella shumardi Prout?
- Septopora biserialis (Swallow)
- Chonetes choteauensis Mather
- Productus cora d'Orbigny
- Productus semireticulatus (Martin)
- Productus semireticulatus (Martin) var.
- Pustula nebraskensis (Owen)
- Pustula punctatus (Martin)
- Marginifera wabashensis (Norwood and Pratten)
- Spiriferina kentuckyensis (Shumard)
- Spirifer boonensis Swallow?
- Composita subtilita (Hall)
- Composita sp.
- Myalina pernaformis Cox
- Schizodus affinis Herrick
- Pseudorthoceras knoxense (McChesney)

The Boggs limestone also outcrops along Symmes Creek in Madison Township. At the crossroads, two miles from the place where the creek empties into the Muskingum River and a short distance from the mouth of North Branch, the dark, ferruginous limestone is exposed in the bed of the creek where good collecting material is furnished. The section near the cross-roads follows:¹

	Ft.	In.
Limestone, shaly	1	8
Limestone, hard . . . . .	..	10
Limestone, shaly . . . . .	..	8
Limestone, hard	1	6
Shale, dark . . . . .	..	6
Coal, bony	1	6
Covered	16	4
Limestone, dark, fossiliferous, <i>Boggs</i>	1	8
Clay	1	..
Covered	1	..
Sandstone, shaly	10	..
Shale, gray, siliceous	4	..
Limestone, fossiliferous, gray, <i>Poverty Run</i> . . . . .	..	6
Shale, dark . . . . .	..	4
Coal, <i>Vandusen</i> . . . . .	..	6

The fossils collected from the Boggs limestone along Symmes Creek are:

- Crinoid segments
- Fenestella shumardi Prout?
- Rhombopora lepidodendroidea Meek
- Derbya crassa (Meek and Hayden)
- Chonetes choteauensis Mather
- Productus cora d'Orbigny
- Productus semireticulatus (Martin)

¹Stout, W., Geol. Surv. Ohio, Fourth Ser., Bull. 21, p. 64, 1918.

Pustula nebraskensis (Owen)
Marginifera wabashensis (Norwood and Pratten)
Spirifer boonensis Swallow?
Squamularia perplexa (McChesney)
Composita subtilita (Hall)
Schizodus amplus Meek and Worthen

The Boggs member occurs as an iron ore in Jackson Township, where it is found on the ridges of Frazeyburg.

Licking County.—The Boggs limestone extends westward from Muskingum County into Licking. Isolated patches of cherty limestone from 3 inches to 1 foot in thickness were observed at several places along the ridges south of Toboso and north of Black Run. In a few localities the limestone is replaced by siliceous iron ore.

Tuscarawas County.—The blue limestone by Dr. Edward Orton, two miles northwest of Bolivar in northern Tuscarawas County on the farm of Joseph Hair and elsewhere in the county, belongs undoubtedly to the Boggs horizon. The geologic section northwest of Bolivar is given below:¹

	Ft.	In.
1. <i>Gray or Putnam Hill limestone</i>	2	..
2. Concealed	25	..
Coal—1 ft. 8 in.		
3. Slate—9 in.		
Coal—2 ft. 4 in.		
} <i>Tionesta</i> {	4	9
(<i>No. 3b</i>)	4	9
4. Concealed	15	..
5. <i>Dark-blue limestone</i> , Upper Mercer	3	..
6. Coal, thin, 4 to 6 in. ....	..	6
7. Concealed	30	..
8. <i>Blue limestone</i> , Lower Mercer	4	..
9. Dark shale	2	..
10. Coal, thin .....	..	..
11. Dark shale	2	..
12. Fire-clay	6	..
13. Concealed	20	..
14. Blue limestone (occurs occasionally at this horizon)		
Boggs	1	6
15. Concealed to canal	15	..

Summary

The Boggs member, although occurring in patches, has been traced from the Ohio River as far north as Tuscarawas County. In Muskingum County it is the second fossiliferous limestone in the Pottsville formation, and where characteristically developed, is less than 2 feet in thickness, hard, blue, and fossiliferous, closely resembling the Lower Mercer limestone, from which it is separated by an interval of about 22 feet. It is very variable in character, however, and may be interbedded with or replaced by flint, shale, sandstone, or iron ore. North of Frazeyburg it is entirely replaced by iron ore, while in Tuscarawas County, it is represented by limestone. In southern

¹Orton, Edward, Geol. Surv. Ohio, Vol. V, p. 68, 1884. The word Boggs has been supplied by the writer.

Ohio the Boggs member is an iron ore varying in thickness from 6 inches to 6 feet. It is of good quality, and was formerly mined for smelting in the old charcoal furnaces.

A list of the fossils collected from the Boggs member follows:

Plant leaves
Lepidodendron sp.
Crinoid segments
Eupachyrinus mooresi (Whitfield)
Tabulipora ohioensis (Foreste)
Fenestella shumardi Prout?
Septopora biserialis (Swallow)
Rhombopora lepidodendroidea Meek
Lingula carbonaria Shumard
Orbiculoidea missouriensis (Shumard)
Orbiculoidea capuliformis (McChesney)
Derbya crassa (Meek and Hayden)
Chonetes choteauensis Mather
Chonetes mesolobus Norwood and Pratten
Productus cora d'Orbigny
Productus semireticulatus (Martin)
Productus semireticulatus (Martin) var.
Pustula nebraskensis (Owen)
Pustula punctatus (Martin)
Marginifera wabashensis (Norwood and Pratten)
Spiriferina kentuckyensis (Shumard)
Spirifer boonensis Swallow?
Squamularia perplexa (McChesney)
Composita subtilita (Hall)
Composita sp.
Edmondia peroblonga Meek and Worthen
Edmondia sp.
Leda bellistriata Stevens
Leda prolongata n.sp.
Parallelodon carbonarius (Cox)
Parallelodon tenuistriatus (Meek and Worthen)
Aviculopinna americana Meek
Myalina pernaformis Cox
Naidites elongata Dawson
Schizodus affinis Herrick
Schizodus amplus Meek and Worthen
Schizodus curtus Meek and Worthen
Schizodus wheeleri Swallow
Aviculopecten coxanus Meek and Worthen
Deltopecten scalaris Herrick
Deltopecten occidentalis (Shumard)
Acanthopecten carboniferous (Stevens)
Crenipecten foerstii Herrick
Astartella concentrica (Conrad)?
Euphemus carbonarius (Cox)
Pleurotomaria sp.
Schizostoma catilloides (Conrad)
Naticopsis altonensis (McChesney)
Pseudorthoceras knoxense (McChesney)
Temnocheilus forbesianus (McChesney)
Fish teeth and plates

TABLE SHOWING RANGE OF THE LOWER POTTSVILLE FAUNA IN OHIO

FOSSILS OF THE POTTSVILLE FORMATION BELOW THE LOWER MERCER LIMESTONE

	Harrison	Sharon	Anthony	Quakerstown	Bear Run	Lowellville	Boggs
Plantae			x				x
Cordaites sp.						x	x
Calamites sp.						x	x
Lepidodendron sp.							x
Crinoid segments	x	x				x	x
Eupachyrinus mooresi (Whitfield)							x
Tabulipora ohioensis (Foerste)							x
Fenestella shumardi Prout?						x	x
Fenestella sp.						x	x
Septopora biserialis (Swallow)							x
Rhombopora lepidodendroidea Meek							x
Lingula carbonaria Shumard		x	x	x		x	x
Lingula sp.		x	x				
Orbiculoidea stoutella n.sp.	x	x	x				
Orbiculoidea capuliformis (McChesney)	x?	x?					x
Orbiculoidea missouriensis (Shumard)							x
Rhipidomella pecosi (Marcou)						x	x
Schizophoria sp.	x						
Derbya crassa (Meek and Hayden)						x	x
Chonetes choteauensis Mather						x	x
Chonetes mesolobus Norwood and Pratten						x	x
Productus cora d'Orbigny						x	x
Productus semireticulatus (Martin)						x	x
Productus semireticulatus (Martin) var.						x	x
Pustula nebraskensis (Owen)						x	x
Pustula pertenuis (Meek)		x					x
Pustula punctatus (Martin)						x	x
Marginifera wabashensis (Norwood and Pratten)						x	x
Marginifera muricata var missouriensis Girty		x				x	x
Spiriferina kentuckyensis (Shumard)	x?	x?				x	x
Spirifer boonensis Swallow?						x	x
Spirifer opimus Hall						x	x
Ambocoelia planoconvexa (Shumard) var.						x	
Squamularia perplexa (McChesney)							x
Hustedia mormoni (Marcou)	x						
Composita subtilita (Hall)	x	x				x	x
Composita sp.							x
Solenomya ?? sharonensis n.sp.		x					
Solenomorpha lamborni n.sp.		x					
Edmondia? peroblonga Meek and Worthen?							x
Edmondia sp.						x	x
Nucula elongata n.sp.		x					
Nucula subrotundata Girty mss.	x	x					
Nucula lunulata Girty mss.		x					
Nucula beyrichi von Schauroth	x						
Nuculopsis ventricosa (Hall)	x	x					
Leda bellistriata Stevens						x	x
Leda prolongata n.sp.							x
Leda inflata Girty mss.			x				
Anthraconeilo bownockeri n.sp.		x					
Parallelodon tenuistriatus (Meek and Worthen)	x						x
Parallelodon obsoletus (Meek)						x?	
Parallelodon carbonarius (Cox)							x
Parallelodon sangamonensis (Worthen)						x	
Aviculopinna americana Meek							x
Myalina pernaformis Cox							x
Myalina pernaformis Cox var.	x						x
Posidonia girtyi n.sp.						x	
Naiadites elongata Dawson		x		x	x		x
Naiadites ohioense n.sp.		x					
Naiadites sp.			x				
Schizodus affinis Herrick	x						x
Schizodus amplus Meek and Worthen							x
Schizodus curtus Meek and Worthen							x
Schizodus subcircularis Herrick	x						
Schizodus wheeleri Swallow							x
Aviculopecten coxanus Meek and Worthen	x	x				x	x
Aviculopecten pellucidus Meek and Worthen						x	
Deltopecten scalaris Herrick							x
Deltopecten occidentalis (Shumard)							x
Acanthopecten carboniferous (Stevens)							x
Crenipecten foerstii Herrick							x
Euchondria neglecta (Geinitz)						x	
Pleurophorus oblongus Meek		x					
Pleurophorus tropidophorus Meek						x	
Astartella concentrica (Conrad)?						x	x
Astartella sp.							x

TABLE SHOWING RAROE OF THE LOWER POTTSVILLE
FAUNA IN OHIO

(CONTINUED)

FOSSILS OF THE POTTSVILLE FORMATION BELOW THE LOWER MERCER LIMESTONE	Harrison	Sharon	Anthony	Quakertown	Bear Run	Lowellville	Bozets
Bellerophon crassus Meek and Worthen?	x	x					
Euphemus carbonarius (Cox)	x	x					x
Pleurotomaria ornatiformis n.sp.	x	x					
Pleurotomaria, 3 or more species, undetermined	x	x					
Pleurotomaria sp.	x	x					x
Schizostoma catilloides (Conrad)	x	x				x	x
Naticopsis altonensis (McChesney)						x	x
Sphaerodoma humilis (Keyes)?	x						
Sphaerodoma primigenia (Conrad)?		x					
Orthoceras n.sp.		x					
Orthoceras n.sp.		x					
Pseudorthoceras knoxense (McChesney)						x	x
Coloceras ? sp.	x					x	
Temnocheilus forbesianus (McChesney)							x
Phillipsia trinucleata Herrick		x					
Estheria sp.		x					
Fish teeth and plates					x	x	x

REGISTER OF COLLECTING LOCALITIES

1. Jackson County: Section 22, Hamilton Tp.; Harrison ore in stream bed of tributary of Little Scioto River, below house of Phillip Meldick.
2. Scioto County: Section 14, Porter Tp.; Sharon ore near mouth of Lick Run, on farm of Joseph Jenkins.
3. Scioto County: northern part of Section 15, Madison Tp.; shale above Sharon coal from roof of mine on farm of John Alexander, near head of Higgins Run.
4. Scioto County: western part of Section 15, Madison Tp.; shale above Sharon coal from Harry Odle mine in creek bed.
5. Jackson County: Section 21, Washington Tp.; Sharon ore from coal dump at mouth of Glen Nell mine.
6. Jackson County: central part of Section 34, Hamilton Tp.; bone shales on Sharon ore horizon from road just east of Tattle Creek.
7. Scioto County: near Scioto Furnace, shale on Anthony coal horizon from mine of Wm. E. Dee Clay Product Co.
8. Scioto County: Scioto Furnace, bone shale above Anthony coal at mine of Buckeye Fire & Clay Co.
9. Jackson County: northeastern part of Section 32, Coal Tp.; shales on Quakertown coal horizon from Wilson mine.
10. Jackson County: central part of Section 35, Coal Tp.; shales on Quakertown coal horizon from Twin-Ada mine, at Glenroy.
11. Jackson County: northeastern part of Section 10, Coal Tp.; shales on Quakertown coal horizon from Grace mine just east of Davisville. (Lower Mercer limestone and Lower Mercer ore also collected in vicinity of Grace mine.)
12. Summit County: eastern county line, shale from Quakertown coal horizon near Mogadore Station, five miles east of Akron.
13. Scioto County: Section 3, Bloom Tp.; shales overlying Bear Run coal on land of H. H. Stevenson.
14. Jackson County: southern part of Section 25, Hamilton Tp.; shales above Bear Run coal on land of Edward Toffin, in Dever Valley.
15. Jackson County: western part of Section 21, Lick Tp.; fissile shales interbedded with black band ore on Bear Run coal horizon, at mouth of old coal mine on land of D. D. Evans.
16. Jackson County: central part of Section 5, Lick Tp.; black band ore on Bear Run coal horizon in stream bed on property of Mrs. John Butts.

17. Vinton County: western part of Section 6, Elk Tp.; shales on Bear Run coal horizon in Elk Fork.
18. Vinton County: northern part of Section 14, Jackson Tp.; shales on Bear Run coal horizon, three-fourths mile south of Stella.
19. Muskingum County: Section 18, Hopewell Tp.; Lowellville limestone and shale on Poverty Run, two miles northwest of Hopewell P. O., from the land of Della Wise. (Type locality for Poverty Run limestone.)
20. Muskingum County: Fall Tp.; Lowellville limestone and shale (?) in bed of small stream flowing into the Licking River at Holbein, on land of E. G. Marshall.
21. Muskingum County: Madison Tp.; Lowellville limestone on east bank of the Muskingum River, one-half mile north of Symmes Ford.
22. Mahoning County: Poland Tp.; Lowellville limestone and shale from Grindstone Run at Lowellville. (Type locality for Lowellville limestone.)
23. Scioto County: southwestern part of Section 24, Bloom tp.; shales associated with Boggs ore on William M. Galligher farm.
24. Scioto County: Vernon Tp.; shale on Boggs ore horizon along road east of Pine Creek, one and one-half miles southeast of Lyra.
25. Vinton County: southeastern part of Section 23, Elk Tp.; Boggs ore from Spook Hollow in Elk Creek bed, one and one-half miles east of McArthur.
26. Muskingum County: northeastern part of Section 18, Hopewell Tp.; Boggs limestone in bed of small stream on land of O. J. Riggle, one mile north of Hopewell P. O.
27. Muskingum County: Muskingum Tp.; Boggs limestone in bed of Blunt Run on land of Carl Crabtree. (Fossils from Lower Mercer limestone also collected on Blunt Run.)
28. Muskingum County: Muskingum Tp.; Boggs limestone exposure along Wheeling & Lake Erie railroad cut, just north of Rock Cut. (Fossils from Lower and Upper Mercer limestones also collected.)
29. Muskingum County: Madison Tp.; Boggs limestone from bed of Symmes Creek at the crossroads near the mouth of North Branch. (Fossils from Lower and Upper Mercer limestones also collected.)

DESCRIPTION OF SPECIES¹

PHYLUM ECHINODERMATA

Class Crinoidea

Genus *Eupachyrcrinus* Meek and Worthen

Eupachyrcrinus mooresi (Whitfield)

Pl. III, Figs. 1, 2

1882 *Zeacrinus mooresi*. Whitfield, Ann. N. Y. Acad. Sci., Vol. 2, p. 227.

Coal Measures: Carbon Hill, Hocking Co., Ohio.

1895 *Zeacrinus mooresi*. Whitfield, Geol. Surv. Ohio, Vol. VII, p. 483, Pl. 11, Figs. 6-10.

Coal Measures: Carbon Hill, Hocking Co., Ohio.

Description.—Spines of a crinoid closely resembling those described by Whitfield on the second radial plates of *Z. mooresi* are not uncommon in the members of the Pottsville formation above and including the Boggs limestone. Whitfield's description of these spines, which were obtained from Carbon Hill, Hocking County, is quoted below:²

“The second radial plates present the strong specific feature of the species, and are large and spine-bearing, as in *Zeacrinus mucrospinus* McChesney. The spines are long, much thickened, and bulbous in the lower part, presenting in this respect a strong contrast with those of that species. The cicatrix for the attachment of the arm plates is very large, showing that the plates above were of large size.

The species has been quite abundant, as the spines are found in great numbers, and vary considerably in size, according to the width of the first radial plates upon which they have rested. But all are thickened and bulbous, and many of them are more than an inch in length. They are seldom found attached to the calyx, but are scattered through the shale in the bed where found.”

At no locality in the Pottsville formation from which collections were made for the present report, are these spines found as abundantly as at Carbon Hill.³ The close resemblance of the spines in question to those described above, combined with stratigraphic and geographic evidence, points to identification with the Carbon Hill species, although no other portions of the calyx have been discovered. The figured specimen of a calyx of *E. mooresi* from Carbon Hill is included to show the attachment of the second radial plates and spines to the first radial plates.

¹In the descriptions of the Pottsville species the following symbols are used: aa, very abundant; a, abundant; c, common; r, rare.

²Whitfield, R. T., Geol. Surv. Ohio, Vol. VII, p. 483, 1893.

³The exact stratigraphic position of the horizon from which the Carbon Hill fauna described by Whitfield came, cannot be stated definitely at present, although it is known to be either upper Pottsville (probably McArthur) or basal Allegheny. After the completion of additional field work, the Carbon Hill fauna will be described in a separate paper, a portion of which is now in manuscript.

Horizon and locality.—Boggs limestone: Blunt Run, Muskingum County (Locality 27), c. Rather common in the Lower Mercer and McArthur members.

PHYLUM MOLLUSCOIDEA

Class Bryozoa

Genus *Tabulipora* Young

Tabulipora ohioensis (Foerste)

1887 *Stenopora ohioensis*. Foerste, Bull. Den. Univ., Vol. 2, p. 85, Pl. 7, Figs. 12a-e.
Coal Measures: Flint Ridge, Ohio.

Although rare in the Boggs member, this bryozoan is common in higher horizons, but is particularly abundant and characteristic in the Lower Mercer limestone.

Horizon and locality.—Boggs limestone: near Hopewell P. O., Muskingum County (Locality 26), r.

Genus *Fenestella* Lonsdale

Fenestella shumardi Prout?

1858 *Fenestella shumardi*. Prout, Trans. St. Louis Acad. Sci., Vol. I, p. 232.
Carboniferous L.S.: Organ Mts., New Mexico.

1872 *Fenestella shumardi*? Meek, U. S. Geol. Surv. Nebr. p. 153, Pl. 7, Figs. 3a-c.
Upper Coal Measures: Nebraska City, Nebraska.
Lower Coal Measures: Ohio.

A very small, delicate species of *Fenestella* is found in the Lowellville and Boggs limestones as well as throughout the higher members of the Pottsville formation, which has been referred with some doubt to *F. shumardi*, a form originally described from a far distant locality. However, this form agrees very closely with Meek's interpretation and figures of Prout's species, and is also reported by him to be present in the Lower Coal Measures of Ohio. If Meek's form is really identical with *F. shumardi*, there seems little doubt that the Ohio forms likewise belong to that species.

Horizon and locality.—Lowellville limestone: near Holbein, Muskingum County (Locality 20), r; Boggs limestone: Blunt Run, Muskingum County (Locality 27), r; Rock Cut, Muskingum County (Locality 28), c; Symmes Creek, Muskingum County (Locality 29), r; throughout upper members of the Pottsville formation.

Genus *Septopora* Prout

Septopora biserialis (Swallow)

1858 *Synocladia virgulacea* (?) Swallow, Trans. St. Louis Acad. Sci., Vol. I, p. 179.
(Not *S. virgulacea* Phillips).
Lower Permian: Valley of the Cottonwood, Kansas.

An abundant and widely distributed bryozoan in the Pottsville formation of Ohio. It makes its appearance in the Boggs mem-

ber and continues throughout the formation, but occurs most abundantly on the Lower Mercer and Black Flint horizons.

Horizon and locality.—Boggs limestone: Rock Cut, Muskingum County (Locality 28), r. Abundant in middle and upper Pottsville formation.

Genus *Rhombopora* Meek

Rhombopora lepidodendroidea Meek

1866 *Stenopora columnaris* (pars). Geinitz, Die Carb. und Dyas in Nebraska, p. 66.
(Non Schloth, 1813)

Coal Measures: Wyoming and Nebraska.

1872 *Rhombopora lepidodendroides*. Meek, U. S. Geol. Surv. Nebraska, p. 141, Pl. 7,
Figs. 2a-f.

Upper Coal Measures: Wyoming, Nebraska, Kansas, Iowa, Missouri, Illinois.

Description.—This small, delicate, branching bryozoan with its wide geographic and stratigraphic range in the Pennsylvanian rocks of North America is common in the Pottsville formation of this State above and including the Boggs member. It occurs most abundantly, however, in the Lower Mercer and McArthur limestones. The diameter of the largest fragment studied is 2 mm., but the average width varies from 1 to 1.5 mm. Only one bifurcation was observed on any of the fragments examined, the longest of which measures 18 mm.

Horizon and locality.—Boggs limestone: Blunt Run, Muskingum County (Locality 27), c; Symmes Creek, Muskingum County (Locality 29), c. Common in middle and upper Pottsville formation.

Class *Brachiopoda*

Genus *Lingula* Bruguiere

Lingula carbonaria Shumard

Pl. III, Figs. 3, 4, 5

1858 *Lingula carbonaria*. Shumard, Trans. St. Louis Acad. Sci., Vol. 1, p. 215.
Coal Measures: Clark County, Missouri.

1873 *Lingula mytiloides* ? Meek and Worthen, Geol. Surv. Ill., Vol. 5, p. 572,
Pl. 25, Fig. 2.

Coal Measures: Illinois.

Description.—Shell varying in size from small to almost medium; subquadrangular-ovate in outline; ratio of length to width about 3:5. Beak minute, elevated; umbonal region and middle portion of valves moderately convex, becoming flattened toward the sides and front; posterior margin somewhat pointed, curving regularly into the sides, which are subparallel or slightly rounded; anterior margin sometimes slightly flattened, giving a quadrangular appearance to the shell. Outer covering usually preserved, thin, polished, and marked by fine concentric lines of growth which are crossed by fainter radiating striae, those extending from the beak to the anterior margin being most prominent.

Dimensions.—The great variation in the size of the species can be noted by the following measurements: a specimen of large size from the Upper Mercer member, length 12 mm., width 8 mm.; a large specimen from the Anthony coal horizon, length 11 mm., width 6.7 mm., a small specimen from the same horizon, length 7 mm., width 4.5; an individual of average size from the Quakertown coal horizon, length 6.5 mm., width 4.2 mm.

Remarks.—*Lingula carbonaria* is an important fossil of the Pottsville formation in Ohio as it is found on nearly every horizon, and on some in the greatest profusion. In the bone shales associated with the Anthony coal it is extremely abundant and forms the characteristic fossil of that member. It also occurs in similar numbers in the shales at various localities on other horizons, among which are the Quakertown, Boggs, Upper Mercer, and McArthur. *L. umbonata* Cox differs in having the greatest width about one-third the length of the shell from the posterior margin, from which point the shell contracts toward the front. *L. kanawhensis* Price is a much larger and relatively broader form.

Horizon and locality.—Sharon ore horizon: Hamilton Tp., Jackson County (locality 6), c. Anthony coal horizon: Scioto County (Locality 7), aa. Quakertown coal horizon: Mogadore Station, Summit County (Locality 12), aa. Lowellville member near Holbein, Muskingum County (Locality 20), aa. Boggs member: Pine Creek, Scioto County (Locality 24), a; Spook Hollow, Vinton County (Locality 25), a. Present in middle and upper Pottsville formation.

Lingula sp.

Description.—Large *Lingulas* of uncertain affinities are common in the black bone shales of the Anthony coal horizon, at the mine of the Buckeye Fire Brick & Clay Co., in Scioto County. Considerable variation exists in the form of the individuals, some being elongate and narrow enough to resemble *Lingula tighti* Herrick, while others are broader and suggest a possible identification with *Lingula kanawhensis* Price. The lateral margins are subparallel and the front, especially on the broader forms, flattened; the surface is apparently smooth. The material at hand, however, is too poor to permit satisfactory conclusions to be reached. Two distinct species may be present, or the differences in form may be due to compression, as the specimens are all much flattened, so that the original shape was probably intermediate between the long slender form and the broader one. The size is much greater than that of *L. carbonaria* Shumard, and although common, it does not occur in the extreme profusion of the latter species. It is of interest to note that the form under discussion was found within one mile of the Wm. E. Dee mine where *L. carbonaria* characterized the Anthony shales.

Dimensions.—An elongated, narrow form measures: length 16 mm., width 9.5 mm.; a broad variety: length 13 mm., width 8.5 m.m.

Horizon and locality.—Anthony shales: Scioto Furnace, Scioto County (Locality 8), a.

Genus *Orbiculoidea* d'Orbigny

Orbiculoidea stoutella n. sp.

Pl. III, Figs. 6, 7, 8

Description.—Shell large for specimens of this genus, subcircular in outline, gibbous, width slightly greater than length. Ventral valve unknown. Dorsal valve with widest portion a little anterior to middle of shell; anterior margin broadly rounded, posterior margin more narrowly rounded; greatest convexity about the middle of the valve; beak small, very inconspicuous and depressed, situated almost at the posterior margin of the shell; area posterior to beak sloping to the margin with a concave outline. Epidermis of shell where preserved, thick, with surface marked by fine, closely arranged, irregular, concentric lines of growth.

On the specimens at hand, which are for the most part casts of the interior, not only are internal markings of especial interest retained, but they are preserved in an unusual manner. A well-marked rhomboidal or lozenge-shaped visceral area is present in the posterior portion, extending anteriorly about one-third or more of the length of the shell. The posterior margin of this area includes the beak and is sharply marked, but is less well defined laterally and anteriorly. The anterior edge of the lozenge-shaped area is bordered by two shallow rather faintly defined grooves,—one on either side of a low median septum,—which extend diagonally upward toward the lateral angles of the area. These grooves were formed by ridges on the inside of the shell, which doubtlessly served for the attachment of muscles, and apparently correspond to the anterior muscular ridge of *Lindstroemella aspidium* as figured by Hall and Clarke.¹ On either side of the median septum and just above the muscular ridge is a sharply defined, large, elevated (therefore deeply impressed on the interior of the shell) muscular scar; while closer to the septum and on either side of it, is an irregular, less well-defined area of muscular attachments which probably represent the anterior adductor muscular scars. The writer has been unable to work out the function of the muscles which produced the more laterally placed pair of scars, although the possibility exists that they may represent the lateral scars shown in the figure of *Lindstroemella aspidium* cited above. The median septum is short, extending anteriorly one-half the length of the visceral area, but dying out a little posterior to it. From the two lateral angles a prominent, elevated (on the internal cast) vascular sinus extends obliquely forward to the anterior-lateral margins of the valve; the sides and front of the shell, as well as the region posterior to the beak, are marked by numerous fine, thread-like, radiating,

¹Hall and Clarke, Pal. New York, Vol. 8, Pt. I, Pl. 4E, Figs. 25, 26, 1892.

vascular lines, the coarser ones of which branch from the pair of main sinuses and are subjected to frequent subdivisions.

Dimensions.—The figured specimen of the cotype, preserved as an internal cast upon which the internal structure is imprinted, was obtained from the Harrison ore and shows the following measurements: length 23 mm., width 24 mm., convexity of dorsal valve 5 mm. (much flattened). The measurements of another cotype, which shows the external characters of the shell and the normal convexity are: length 22.5 mm., width 23 mm., convexity of dorsal valve 9 mm. This species of *Orbiculoidea* was also formed at one locality in the Sharon ore where it was the only fossil discovered. The size of the Sharon specimens is on the average considerably smaller than that of the forms from the Harrison ore. A large specimen from the Sharon ore measures: length 17 mm., width 18 mm., convexity of dorsal valve 4 mm. (somewhat compressed).

Remarks.—The distinctive features of this species are its circular form, its inconspicuous, depressed beak which overhangs the posterior margin, and its great convexity in the central part of the valve. It resembles *O. meekana* Whitfield in form, but the latter species has the beak elevated, forming the point of greatest convexity of the valve; it is also situated farther from the posterior margin,—about one-third the length of the shell. *O. munda* (Miller and Gurley) and *O. planidisca* Raymond are forms which have the beak almost marginal in position. The former is distinctly elliptical in form and has a beak much less depressed and inconspicuous than the species under consideration; the greatest convexity also occurs in the posterior third of the shell. *O. planidisca* is also elliptical, the width being only three-fourths as great as the length.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), c. Sharon ore: Glen Nell mine, Jackson County (Locality 5), r. The specific name has been given in honor of Mr. Wilber Stout of the Geological Survey of Ohio.

Orbiculoidea capuliformis (McChesney)

1860 *Discina capuliforma*. McChesney, Desc. New Pal. Fossils, p. 72.

1861 *Discina capuliformis*. McChesney, Trans. Chicago Acad. Sci., Vol. I, p. 23, Pl. 2, Fig. 20.

Coal Measures: Springfield, Illinois; 12 miles northwest of Richmond, Missouri.

Description.—Specimens of an *Orbiculoidea* are abundant in the black bone shale on the Sharon ore horizon and have been referred with some doubt to *O. capuliformis*. They show considerable variation in size, ranging from those only 6 mm. in diameter to forms which are relatively large; the outline of both valves is circular. The beak of the dorsal valve is slightly posterior to the center; as the specimens are greatly flattened, it is possible only to make conjectures concerning the convexity, which seems to have been moderate. The ventral

valve is also compressed, some specimens showing a slightly convex region surrounding the almost centrally located beak, the valve becoming concave toward the margins; a deep, broad slit extends from the beak posteriorly to a point about two-thirds the distance from the beak to the margin; slit widest in the central portion. The surface is marked by numerous fine, concentric striae which are regularly arranged; on a few forms very faint radiating markings are visible. Crushed specimens from the Harrison ore, similar to those just described, have been referred tentatively to the same species, while more perfect forms from the Boggs member agree closely with McChesney's description and are here identified with *O. capuliformis* with more confidence.

Dimensions.—The diameter of a small specimen is 7.5 mm.; of a large specimen 18 mm.

Remarks.—The doubtful forms from the Harrison and Sharon horizons may possibly be identical with *O. meekana* Whitfield, which is common and widely distributed in the higher Pottsville members of this State, but the material at hand is too crushed to show specific characters adequately. However, *O. meekana* has the beak of the dorsal valve eccentric, located about one-third of the length of the shell from the posterior margin, while that of the specimens under discussion is more central. *O. missouriensis* Shumard is in general a much smaller form, and also has the beak eccentric.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), r; Sharon horizon: Jackson County (Locality 6), a. Boggs member: near Hopewell P. O., Muskingum County (Locality 26), r.

Orbiculoidea missouriensis (Shumard)

1858 *Discina missouriensis*. Shumard, Trans. St. Louis Acad. Sci., Vol. 1, p. 221.
Middle Coal Measures: Lexington and Charbonnier, Missouri.

Shumard's description.—"Shell circular; small; upper valve depressed, conic, sloping gradually from the beak to the front, and rather abruptly to the cardinal edge; beak rounded at tip, not curved, situated about one-third the diameter from the posterior edge, its elevation equal to about one-third the diameter of the shell. Surface marked by fine, close striae, which are arranged in concentric, nearly parabolic curves, the extremities of which are directed to the front. Lower valve circular, flat or slightly concave, having a large, deep, elliptical depression at the bottom of which is an elliptical aperture. The surface is marked with rather strong, concentric lines of increase Length of average specimen, .33 (inches); height .10."

Remarks.—The small *Orbiculoideas* from the Lowellville and Boggs members are entirely comparable with Shumard's species in respect to size, form, and eccentric beak, but differs in having the beak slightly less depressed. A specimen of average size measures: diameter 6.5 mm., convexity 2.5 mm.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), c. Boggs limestone: Blunt Run, Muskingum County (Locality 27), r.

Genus *Rhipidomella* Oehlert

Rhipidomella pecosii (Marcou)

1859 *Orthis pecosii*. Marcou, Geol. N. Am., p. 48, Pl. 6, Fig. 14.
Mountain limestone: Pecos Village, New Mexico.

This small shell with its almost circular form and fine radiating lines is by no means common among the Pottsville fauna of Ohio, but it is found most often in the Lower Mercer limestone. In the Lowellville member it was represented only by a single ventral valve which measures: length 6.5 mm., width 7.7 mm., convexity 2 mm.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), r. Lower Mercer and upper Pottsville members.

Genus *Derbya* Waagen

Derbya crassa (Meek and Hayden)

- 1852 *Orthis umbraculum*? Hall, Stansb. Exped. Gt. Salt Lake, p. 412, Pl. 3, Fig. 6.
Carboniferous: Missouri River, above Fort Leavenworth.
- 1852 *Orthis umbraculum*? Owen, Geol. Rep. Wis., Iowa and Minn., Pl. 5, Fig. 11.
Carboniferous: Missouri River, near mouth of Keg Creek, and at Council Bluffs.
- 1852 *Orthis arachnoidea*. Roemer, Kreid. von Texas, p. 89, taf. 1, Figs. 9a, b.
Carboniferous: San Saba Valley, Texas.
- 1858 *Orthisina crassa*. Meek and Hayden, Proc. Acad. Nat. Sci. Phil., p. 261.
Coal Measures: Leavenworth, Kansas.
- 1892 *Derbya crassa*. Hall and Clarke, Pal. N. Y., Vol. 8, Pt. I, Pl. 10, Figs. 10, 11; Pl. 11A, Figs. 28-33; Pl. 11B, Figs. 23, 24; Pl. 20, Figs. 12, 13.
Upper Coal Measures: Near Kansas City, Missouri, and Winterset, Iowa.

Description.—Among the Pottsville fossils at hand are large collections of *Derbya crassa*, which is one of the most abundant, if not the most abundant, fossil of the entire formation. Although it has not been found below the Lowellville member, it is present in all of the marine limestones where it occurs with very few exceptions at every locality from which fossils were collected. The size is somewhat variable, but the measurements of an individual of average size from the Lowellville black shale on Poverty Run are: length 20.5 mm., length of hinge line 20 mm., maximum width 23.5 mm. The dorsal valves, when uncrushed, are quite convex, while the central valves are slightly convex in the umbonal region, becoming flattened toward the margins. The surface is characteristically covered with radiating lines, a coarse one alternating with two or three finer ones; crossed by fine, closely arranged, concentric lines which give a crenulated appearance to the shell, and also by a few coarse lines of growth.

Horizon and locality.—Of general distribution in the Lowellville (a) and Boggs (c) members; abundant and widely distributed in the Lower Mercer and higher members of the Pottsville formation.

Genus *Chonetes* Fischer

Chonetes choteauensis Mather

Pl. III, Figs. 11, 12

1915 *Chonetes choteauensis*. Mather, Bull. Den. Univ., Vol. XVIII, p. 150, Pl. 8, Figs. 9-10a.

Morrow formation: near Choteau and Fort Gibson, Oklahoma.

Description.—Shell small, subcircular to subquadrangular in outline; ratio of length to width about 3:5; hingeline equal to or slightly greater than the greatest width of the shell below. Ventral valve moderately convex, the greatest convexity being anterior to the middle of the valve and on either side of the shallow mesial sinus; ears flattened; extremities of the hinge line on some specimens slightly mucronate, on others just equal to the greatest width anteriorly; lateral margins forming an angle of 90 degrees with the hinge line, subparallel to a point below the middle of the valve, broadly rounded into the front; front flattened or very slightly concave; beak inconspicuous, not extending beyond the cardinal margin; cardinal area narrow with upper margin marked by four or five long, slender oblique spines on either side of the beak; a poorly defined, shallow mesial sinus, or rather a mere flattening becoming evident in the posterior half of the valve, widening toward the front. Dorsal valve concave, following the curvature of the opposite valve. Surface marked by very fine, rounded, radiating striae, crossed by concentric lines of growth which are fairly prominent near the anterior and lateral margins; finely punctate with spine bases arranged at regular intervals along the striae imparting to them a nodose appearance when examined microscopically.

Dimensions.—A specimen of average size from the Lowellville member measures: length 6.2 mm., width 10.2 mm., convexity 1 mm. The measurements of another specimen from the Boggs limestone, where the form is on the average larger than in the Lowellville limestone, are: length 8.5 mm., width 12 mm., convexity 2 mm.

Remarks.—In the Boggs member this species occurs most commonly as internal casts on which the muscular impressions and other internal markings are often well preserved. The Ohio forms differ from the typical *C. choteauensis* from Oklahoma in being less convex, with the mesial sinus or flattening correspondingly less pronounced. These variations, however, may be attributed largely to compression. It is abundant in the Lowellville and Boggs members, and in the former constitutes the most characteristic fossil.

Horizon and locality.—Lowellville limestone: Poverty Run, Muskingum County (Locality 19), a; near Holbein, Muskingum

County (Locality 20), c; Symmes Ford, Muskingum County (Locality 21), c; Lowellville, Mahoning County (Locality 22), a. Boggs limestone: near Hopewell P. O., Muskingum County (Locality 26), a; Blunt Run, Muskingum County (Locality 27), a; Rock Cut, Muskingum County (Locality 28), c; Symmes Creek, Muskingum County (Locality 29), c.

Chonetes mesolobus Norwood and Pratten

Pl. III, Figs. 9, 10.

1855 *Chonetes mesoloba*. Norwood and Pratten, Jour. Acad. Nat. Sci. Phil. 2nd Ser., Vol. 3, p. 27, Pl. 2, Figs. 7a-c.
Coal Measures: Bellville, Illinois; Charboniere, Missouri.

This common and characteristic fossil of wide distribution throughout the Pennsylvanian rocks of the United States, is rarely found in the lower Pottsville formation of Ohio, but is commonly and universally distributed in the members including and above the Lower Mercer limestone. It is, however, particularly characteristic of the Lower Mercer horizon in which it occurs in extreme abundance. *C. choteauensis* characterizes the Lowellville and Boggs members, while *C. mesolobus* has not been found on either horizon, with the exception of a few individuals from the Boggs limestone at a single locality. The former species seems to have disappeared almost entirely from the Pottsville sea by the advent of Lower Mercer time, for it has been discovered only in the Lower Mercer of Scioto County where it is of very rare occurrence. In its place *C. mesolobus* appears and is abundant and wide-spread, persisting throughout the remainder of the Pottsville and the Allegheny formations.

Horizon and locality.—Boggs limestone: Blunt Run, Muskingum County (Locality 27), r. Abundant and universally distributed throughout the Lower Mercer and upper Pottsville formation.

Genus Productus Sowerby

Productus cora d'Orbigny

1857 *Productus cora*. De Koninck, Monog. du Gen. Prod. et Chon., p. 50, Pl. 4, Figs. 4a, b; Pl. 5, Figs. 2a-d.
Carboniferous: Guernsey County, Flint Ridge, and Zanesville, Ohio; Indiana, Nova Scotia, Bolivia, etc., South America.

Description.—This species is a common one in the marine limestones of the Pottsville formation, but does not become abundant below the Lower Mercer member. Although it varies much in size, it is generally large, a representative specimen from the Lower Mercer limestone having the following measurements: length 47 + mm., length of hinge line 40 mm., width 50 + mm. The hinge line is commonly shorter than the greatest width of the valves, which are marked with fine, sinuous lines. Coarse, concentric wrinkles cover the visceral regions, but become still more deeply impressed on the ears. The

ventral valve is not marked by a sinus, but sometimes a slight flattening occurs in the mesial region. A few large spines are scattered over the surface.

Horizon and locality.—Universally distributed throughout the Lowellville (c) and Boggs (c) members; abundant in the middle and upper Pottsville members.

Productus semireticulatus (Martin)

1847 *Productus semireticulatus*. De Koninck, Monog. du Gen. Prod. et Chon. p. 83, Pl. 8, Figs. 1a-h; Pl. 9, Figs. 1a-d.

Carboniferous: Harrisville, Bagdad, Cuyahoga, Zanesville, Flint Ridge, Greensburg, and Antrim, Ohio; Missouri, Indiana, Illinois, Kentucky; Bolivia, South America.

Description.—This common and widely distributed *Productus* is one of the most abundant and characteristic fossils of the Pottsville formation of this State, especially in the middle and upper members. In size, however, it is considerably smaller than is generally the rule with members of the species. A typical specimen measures: length 35 mm., width at hinge line 46 mm., convexity 23 mm.

Horizon and locality.—Lowellville limestone: near Holbein, Muskingum County (Locality 20), c; Symmes Ford, Muskingum County (Locality 21), c. Boggs: universally distributed in the limestone phase, c. Abundant and widely distributed in the Lower Mercer and upper Pottsville horizons.

Productus semireticulatus (Martin) var.

Compare 1915 *Productus morrowensis*. Mather, Bull. Den. Univ., Vol. XVIII, p. 152, Pl. 10, Figs. 1-4a.

Hale formation: Arkansas and Oklahoma; Morrow formation; Oklahoma.

Description.—Associated with *Productus semireticulatus* there is another, less abundant form of the semireticulatus type, which may either represent a distinct species or may be only a variety of the above species. The contour is in no way different, although the size is generally less and the radiating costae finer and more regular.

Careful comparisons have been made by the writer with the type specimens of *P. morrowensis* Mather, borrowed for this purpose from the Walker Museum at the University of Chicago, and with one exception, no essential differences between the two forms could be noted. However, indications of the double row of spines on the cardinal slopes and main flanks which characterizes the Morrow species, were noted on only one of the Ohio specimens although a considerable amount of material was examined. It seems probable that this form represents an individual variation, rather than that the spines were originally present on all the specimens but were not preserved. But it may be added that none of the material at hand is in a first class condition, and that there is a gradual gradation between this form on the one hand and *P. semireticulatus* on the other.

Until more and better material can be obtained, it seems advisable to refer to this *Productus* as a variety of *P. semireticulatus*.

Horizon and locality.—Boggs member: near Hopewell P. O. (Locality 26), c; Blunt Run (Locality 27), c; Rock Cut (Locality 28), c, Muskingum County.

Genus *Pustula* Thomas

Pustula nebraskensis (Owen)

1852 *Productus nebraskensis*. Owen, Geol. Rep. Wisconsin, Iowa, and Minnesota, p. 594, tab. 5, Fig. 3.
Carboniferous limestone: Bellevue, Missouri River, Nebraska.

This common Pennsylvanian fossil occurs abundantly in the Pottsville formation of Ohio, and is among the most widespread forms. Although it characterizes the marine limestone horizons, it has not been found to occur below the Lowellville member. Much of the material in the collections studied is in an excellent state of preservation.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), r; Lowellville, Mahoning County (Locality 22), r. Common and widely distributed in the Boggs limestone. Abundant and widely distributed in the middle and upper Pottsville members.

Pustula pertenuis (Meek)

1866 *Productus cancrini*. Geinitz (non de Verneuil) Carb. und Dyas in Nebraska, p. 54, Pl. 4, Fig. 6.
Nebraska City, Nebraska.
1872 *Productus pertenuis*. Meek, U. S. Geol. Surv. Nebr, p. 164, Pl. 1, Fig. 14; Pl. 8, Fig. 9.
Upper Coal Measures: Nebraska City and Brownville, Nebraska; Grasshopper Creek, Kansas.

A few specimens of this small species of *Pustula* were found in the Sharon ore, although none were discovered on any other horizon of the Pottsville formation in the State. The small size, the very fine radiating lines, and the numerous concentric wrinkles covering the entire shell, together with a few scattered spine bases make the form easily recognizable.

Dimensions.—Length 8 mm., width 11 mm., convexity 4 mm.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), r.

Pustula punctatus (Martin)

1836 *Productus punctatus?* Morton, Am. Jour. Sci., 1st Ser., Vol. 29, p. 153, Pl. 26, Fig. 38.
Coal Measures: Ohio Valley.
1838 *Producta semipunctata*. Shepard, Am. Jour. Sci., 1st Ser., Vol. 34, p. 153, Fig. 9.
Limestone: Peru, Illinois.

Description.—*Pustula punctatus* is of somewhat rare occurrence in the Pottsville rocks of this State. It is generally well preserved

and can be distinguished by its large size and by the numerous, regular, concentric ridges covered with small spines which mark the surface. An almost perfect specimen from the Boggs limestone measures: length 40 mm., length of hinge line 30 mm., width 38 mm., convexity 22 mm.

Horizon and locality.—Boggs limestone: Blunt Run, Muskingum County (Locality 27), r; Rock Cut, Muskingum County (Locality 28), r.

Genus *Marginifera* Waagen

Marginifera muricata var. *missouriensis* Girty

Pl. IV, Figs. 1, 2, 3.

1915 *Marginifera muricata* var. *missouriensis*. Girty, Missouri Bureau Geol. and Mines, Vol. XIII, 2nd Ser., p. 350, Pl. XXX, Figs. 2-5a.

Description.—This little brachiopod is one of the most abundant and widely distributed forms of the Ohio Pottsville formation, as it is present in all the marine limestone horizons except the Boggs; it occurs in extreme profusion at some localities in the Lower Mercer member. The shells are small with the ventral valve gibbous, imparting a globular appearance to the form. The surface is marked by rather fine, regular costae, crossed by concentric wrinkles which on some specimens reach anteriorly two-thirds the length of the shell; spines are numerous on all parts of the shell. The slight, ill-defined fold near the anterior margin of the ventral valve, mentioned by Girty on the Missouri forms, is absent on the specimens from Ohio; this character, however, is not a constant one.

Dimensions.—The measurements of a ventral valve of average size are: length 11 mm., width 13.5 mm., convexity 3.2 mm.; of a dorsal valve: length 10.5 mm., width 12.5 mm.; convexity 3.2 mm.

Horizon and locality.—Lowellville limestone: universally distributed. Abundant throughout the Lower Mercer and higher horizons of the Pottsville formation.

Marginifera wabashensis Norwood and Pratten

Pl. IV, Figs. 4, 5.

1854 *Productus wabashensis*. Norwood and Pratten, Jour. Acad. Nat. Sci. Phil., 2nd Ser., Vol. 3, p. 13, Pl. 1, Figs. 6a-d.

Coal Measures: near New Harmony, Indiana.

1903 *Marginifera wabashensis* var. Girty, Prof. Paper, U. S. Geol. Surv., No. 16, p. 375, Pl. 5, Figs. 8, 8a.

Carboniferous: Colorado.

Description.—This common and characteristic fossil is found everywhere in the marine limestones of the Pottsville formation, although it is especially abundant in the Lower Mercer and McArthur limestones. It is generally found in an excellent state of preservation. The ventral valve is very gibbous or even globular, having the greatest curvature in the posterior third of the shell. The hinge line is extended forming the point of greatest width; the beak is small, depressed

and slightly incurved, while the visceral region is flattened. The shell is divided into two prominent lobes by a deep, narrow sinus, and the entire surface is covered with fine, often obscure, radiating striae, with small, indistinct concentric wrinkles covering the visceral region and ears; a few spines are scattered over the surface, two of which are generally located near the center of the valve, one on either side of the sinus.

Dimensions.—Length 12.7 mm., length of hinge line 14 mm., greatest width of valve below hinge line 13.5 mm., convexity 9 mm.

Remarks.—*Marginifera wabashensis* is the common Ohio fossil which has been described and figured in various Ohio reports as *Productus longispinus*.¹ It likewise agrees very closely with the geniculate forms from Colorado described and figured by Girty as *M. wabashensis* var.²

Horizon and locality.—Lowellville limestone: near Holbein, Muskingum County (Locality 20), r; Lowellville, Mahoning County (Locality 22) c. Boggs limestone: universally distributed, c. Abundant and universally distributed in the Lower Mercer and higher Pottsville members.

Genus *Spiriferina* D'Orbigny

Spiriferina kentuckyensis (Shumard)

1852 *Spirifer octoplicata* ? Hall, Stansb. Exped. to Gt. Salt Lake, p. 409, Pl. 4, Figs. 4a, b.

Carboniferous: Missouri River, near Weston.

1855 *Spirifer Kentuckensis*. Shumard, Geol. Rep. Mo., p. 203.

Coal Measures: On the Missouri River near Weston, and Grayson County, Kentucky.

Description.—This species is common in the Lower Mercer limestone and also in the higher members of the Pottsville formation but is rare in the lower horizons. It shows considerable variation in size and shape as well as in the length of the hinge line and the number of plications present. A number of small individuals from the Harrison and Sharon ores have been referred rather doubtfully to this species, all of which are in an imperfect state of preservation. The surface is finely punctate and is covered with concentric lamellae, while five plications are present on either side of the fold and sinus. The forms from the marine limestones can easily be recognized by the long, extended hinge line, by the prominent fold and sinus, marked centrally by a small furrow and plication respectively, and by the numerous regular concentric lines covering the surface. Eight to ten plications mark the area on either side of the fold and sinus.

Dimensions.—A specimen of average size from the Harrison ore measures: length 7 mm., width 11 mm., convexity of the ventral valve

¹Herrick, C. L., Bull. Den. Univ., Vol. 2, p. 48, pl. 2, Figs. 25, 27, 28, 1887.

Mark, C. G., Bull. Den. Univ., Vol. XVI, Pl. 8, Fig. 7, 1911.

Mark, C. G., Geol. Surv. Ohio, Fourth Ser., Bull. 17, p. 302, Pl. 13, Fig. 8, 1912.

²Girty, H. G., Prof. Paper, U. S. Geol. Surv., No. 16, p. 375, pl. 5, Figs. 8, 8a, 1903.

4 mm; one of the average size from the Lower Mercer limestone: length 9 mm., width 18.5 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), c. Sharon ore: Lick Run, Scioto County (Locality 2), c. Lowellville and Boggs members: generally distributed, r. Universal in distribution and common in the Lower Mercer and higher members of the Pottsville formation.

Genus *Spirifer* Sowerby

Spirifer boonensis Swallow?

Pl. III, Figs. 13, 14, 15, 16.

1860 *Spirifer boonensis*. Swallow, Trans. St. Louis Acad. Sci., Vol. 1, p. 646.

Lower Coal Measures: Boone, Randolph, and Monroe counties, Missouri.

1903 *Spirifer boonensis*? Girty, Prof. Paper, U. S. Geol. Surv., No. 16, p. 381, Pl. 6, Figs. 1-3.

Carboniferous: Colorado.

Description.—Shell large, subquadrate in outline, convex, ratio length to width about 2.3; hinge line produced, always forming the greatest width of the shell. Ventral valve strongly convex, beak highly elevated and incurved over the hinge line; cardinal area, broad, transversely striated; delthyrium large; mesial sinus well defined, becoming broad and deep toward the front, always marked by at least three strong, rounded ribs, but sometimes by five ribs, the lateral one on each side in the latter case being smaller and formed by the bifurcation of the ribs bounding the sinus. Dorsal valve less convex than the ventral, beak incurved and slightly elevated above the hinge line; mesial fold strongly elevated, consisting of four to six ribs, the two middle ones extending to the beak but bifurcating posterior to the middle of the valve, so that four plications always reach the front; two smaller, lateral plications sometimes originating by the further bifurcation of the outer ribs. Surface on either side of the fold and sinus marked by ten to twelve simple, rounded ribs which are covered with fine, radiating lines; crossed by a few faint concentric lines of growth near the front and lateral margins.

Dimensions.—The following measurements were made of four large specimens, two of which are ventral valves, and two, dorsal valves:

	<i>Ventral valves</i>	<i>Dorsal valves</i>
Length of hinge line (maximum width)	37 mm.	33 mm.; 41 mm. 35 mm.
Length of shell	20 mm.	19 mm.; 28 mm. 23 mm.
Convexity	4.5 mm.	4.5 mm.; 7 mm. 5.5 mm.

Remarks.—This species is common throughout the marine limestones of the Pottsville formation of this State including and above the Boggs member, but is especially abundant in the Boggs, Lower Mercer, and McArthur limestones. It appears identical with the

form from the *Humerosa* formation of Colorado, described and figured by Girty as *S. boonensis*? Both are characterized by their long hinge lines which form the greatest width of the shell, and by their coarse ribs of which three to five occupy the sinus and four to six the fold. In the Colorado form there are twelve to thirteen lateral plications, while the form from Ohio has ten to twelve on either side of the fold and sinus. There can be little doubt that the forms under consideration belong to *S. boonensis* as interpreted by Girty.

Horizon and locality.—Boggs limestone: Muskingum County, near Hopewell P.O. (Locality 26), a; Blunt Run (Locality 27), a; Rock Cut (Locality 28), a; Symmes Creek (Locality 29), a. Abundant in the marine limestones above the Boggs member.

Spirifer opimus Hall

Pl. III, Figs. 17, 18, 19, 20, 21, 22.

1858 *Spirifer opimus*. Hall, Geol. Iowa, Vol. 1, Pt. 2, p. 711, Pl. 28, Figs. 1a, b.
Coal Measures: Ohio, Maryland, Iowa, etc.

1915 *Spirifer opimus*. Mather, Bull. Den. Univ., Vol. XVIII, p. 185, Pl. 12, Figs. 7-7c.

Morrow formation: Arkansas and Oklahoma.

Hall's description: "Shell rotund, gibbous, length and width nearly equal; hinge line equaling or sometimes a little greater or less than the width of the shell below; valves nearly equally gibbous in their greatest convexity. Dorsal valve regularly convex, with a strong, well defined mesial fold which is simple at the apex, dividing a little below, and each division again dicotomizing, the two middle divisions stronger than the lateral ones, and separated by a well-defined groove; in some of the smaller shells, the lateral plications of the mesial fold are feebly or not at all developed: beak elevated a little above the hinge line, and incurving over a narrow defined area. Ventral valve most gibbous above the middle, and abruptly rounding toward the sides and front; mesial sinus well defined, simple above, and becoming marked by three small plications in the middle and lower part; beak much elevated and strongly incurved, covering the upper part of the large foramen; area high in the middle, slightly concave, continued to the extremities of the hinge line, vertically striated; foramen large, forming an equilateral triangle.

Surface marked by from eight to ten simple abruptly elevated plications (on either side of the fold and sinus)¹ which are equal to the spaces between, concentrically marked by strong imbricating lamellose lines of growth, and, on well-preserved specimens, by finer radiating and concentric striae."

The Ohio forms are uniformly small with the hinge line equal to or less than the greatest width of the shell below. The sinus of the ventral valve is marked by three to five bifurcating plications, of

¹The words in parenthesis have been applied by the writer.

which the middle one is generally larger than the lateral ones; the fold of the dorsal valve by four to six bifurcating plications, the two middle being most prominent. The plications on either side of the fold and sinus are invariably simple, and although generally ten in number, variations from eight to twelve were noted.

Dimensions.—The following measurements were taken of three specimens of typical size:

	1	2	3
Length	18 mm.	16 mm.	18 mm.
Length of hinge line	19.5 mm.	16 mm.	19 mm.
Maximum width below hinge line . .	20 mm.	19 mm.	20 mm.

Remarks.—As compared with *S. boonensis* which is more common, *S. opimus* is much smaller, and less transverse, with the length and width nearly equal; the hinge line is never extended as in the former species. Each, however, has the lateral plications simple and those of the fold and sinus bifurcated.

S. opimus has generally been regarded as a synonym of Marcou's species, *S. rockymontanus*, from the Mountain limestone of New Mexico. According to Mather's interpretation of Marcou's species from his study of certain forms from the Morrow formation of Arkansas and Oklahoma, *S. opimus* is really distinct from the latter species. He compares the two forms thus:¹ "This shell (*Spirifer rockymontanus*) one of the most abundant in the Morrow collections, is characterized by occasional bifurcations of the lateral plications in which it agrees with the larger specimen figured by Marcou.—*S. opimus* Hall is apparently a form ordinarily smaller than adult members of this species and its lateral plications are invariably simple, as inferred from figures and descriptions. It is not synonymous with *S. rockymontanus*."

An examination of Marcou's figures of *S. rockymontanus* show that his species is marked with numerous, rather fine plications, freely bifurcating on the sides as well as in the sinus and on the fold. On the right side of the fold on the large figure of the dorsal valve, there are four bifurcated plications, while on the large ventral valve one of the plications is apparently three-forked and at least sixteen lateral plications seem to be present. The hinge line as stated in the description is shorter than the greatest width of the shell. Compared with *S. opimus*, the contour is very similar as in both the length and width are nearly equal, but the plications are finer, more numerous and more freely bifurcating. It is of significance also that Hall cites his species as occurring in Ohio, while that of Marcou was described from a locality far distant.

¹Mather, K. F., Bull. Den. Univ., Vol. XVIII, p. 184, 1915. Dr. Mather has kindly examined some specimens of the form in question from Ohio, and states that they are identical with those which he identified as *S. opimus* from the Morrow fauna of Arkansas.

Horizon and locality.—Lowellville limestone: generally distributed throughout the member, a. Present in the Lower Mercer and higher Pottsville members.

Genus *Ambocoelia* Hall

Ambocoelia planoconvexa (Shumard) var.

1855 *Spirifer planoconvexa*. Shumard, Geol. Rep. Mo., p. 202.

Upper Coal Measures: On Missouri River, near mouth of Platte River.

Description.—A small brachiopod belonging to the genus *Ambocoelia* is common in the black shales on the Lowellville horizon along Poverty Run, Muskingum County. The form suggests identification with *A. planoconvexa* (Shumard), but fairly constant differences render such identification doubtful. The Lowellville form is small, about one-half the size of *A. planoconvexa*, narrower, with a shorter hinge line which equals only about one-half the greatest width of the shell. The beak of the ventral valve is somewhat broader and less elevated; it is marked by a faint, narrow sinus which becomes evident near the beak. However, occasionally specimens of *A. planoconvexa* are found on which the differences mentioned above are not very evident, so that a new species or even a new variety name for the Lowellville form may not be justifiable, especially as the material at hand is not in first-class condition.

Dimensions.—A large ventral valve measures: length 4.5 mm., width 5.5 mm., convexity 2.2 mm. A dorsal valve of average size measures: length 2.2 mm., width 2.7 mm.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), c.

Genus *Squamularia* Gemmellaro

Squamularia perplexa (McChesney)

1856 *Spirifer lineatus*. Hall, Pac. R. R. Rep., Vol. 3, p. 101, Pl. 2, Figs. 6-8 (Not *S. lineatus* Martin, 1809.)

Carboniferous: Pecos Village, New Mexico.

1860 *Spirifer perplexa*. McChesney, Desc. New Pal. Foss., p. 43.

Upper Coal Measures: Almost every part of the country where rocks of that age occur.

1899 *Reticularia perplexa*. Girty, U. S. Geol. Surv., Nineteenth Ann. Rept., Pt. 3, p. 577, Pl. 72, Fig. 1a.

Upper Coal Measures: McAlester quadrangle, Indian Territory.

1903 *Squamularia perplexa*. Girty, Prof. Paper, U. S. Geol. Surv., No. 16, p. 392, Pl. 6, Figs. 8-11c.

Description.—This is an abundant and widely distributed member of the marine limestones of the Pottsville formation above the Boggs member, although it is rare in the latter horizon. It occurs as a rule as internal casts on which fine concentric bands of spines or traces of them are usually visible. The Ohio specimens are somewhat larger than those described by McChesney which seldom obtain a width of more than five-eighths of an inch. A specimen of average

size from the Lower Mercer limestone measures: length 16 mm., width 19.5 mm., convexity 5 mm.

Horizon and locality.—Boggs limestone: Symmes Creek, Muskingum County (Locality 29), r. Abundant and generally distributed throughout the Lower Mercer limestone and the higher Pottsville horizons.

Genus *Hustedia* Hall and Clarke

Hustedia mormoni (Marcou)

1858 *Terebratula mormoni*. Marcou, Geol. North America, p. 51, Pl. 6, Fig. 11.
Mountain L.S.: Salt Lake City, Utah.

1894 *Hustedia mormoni*. Hall and Clarke, Int. to Study of Brach., Pt. 2, Pl. 37, Figs. 13-20.

Coal Measures: Near Kansas City, Missouri.

Although this little species is abundant and wide-spread in rocks of Pennsylvanian age, it is particularly characteristic of the upper part of the system, so that its appearance in the basal member of the Pottsville formation in Ohio is of interest,—especially as it has not been found in any of the higher members of that formation. The form is common in the Harrison ore, and with the exception of a few cases where the entire shell has been replaced by calcite, it occurs only as internal and external molds. Occasionally the spiralia and crura are preserved.

Dimensions.—A specimen of average size measures: length 7 mm., width 4.5 mm., convexity 4 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), c.

Genus *Composita* Brown

Composita subtilita (Hall)

1838 *Terebratula argentea*. Shepard, Am. Jour. Sci., 1st Ser., Vol. 34, p. 152, Fig. 8.
Limestone: Western Bluff of Little Vermilion River, Illinois.

1852 *Terebratula subtilita*. Hall, Stansbury's Exped. Great Salt Lake of Utah, p. 409, Pl. 2, Figs. 1, 2.

Carboniferous: Missouri River, near Weston.

This form constitutes without doubt the most widespread and one of the most abundant fossils of the Pottsville formation of Ohio. It is common in the Harrison and Sharon ores at the base, and is found in almost every other fossiliferous horizon to the Black Flint member at the top. It occurs in great profusion in the Lower Mercer and McArthur limestones. The specimens from the Harrison ore often have the spiralia and even the jugum preserved in an unusual manner. The measurements of a large specimen from the Harrison ore are: length 18 mm., width 16 mm., convexity of ventral valve 5 mm.; from the Lower Mercer limestone: length 24 mm., width 22 mm., convexity 12 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), c. Sharon ore: Lick Run, Scioto County (Locality 2), c. Abundant

and universally distributed in the Lowellville, Boggs, and higher members of the Pottsville formation.

PHYLUM MOLLUSCA

Class Pelecypoda

Genus *Solenomya* Lamark

Solenomya ?? *sharonensis* n.sp.

Pl. IV., Fig. 16

Description.—Shell small, transversely subovate, length about twice the height; convex, the point of greatest convexity being about two-fifths the width of the shell from the beak to the inferior margin; beak pointing obliquely forward, incurved, slightly elevated over the cardinal margin, situated about one-third the length of the shell from the anterior extremity; cardinal margin equal to one-half the length of the shell, sloping slightly downwards; ventral or inferior margin long, almost straight, rounding abruptly into the posterior extremity which is obliquely truncated above and forms an angle of 145 degrees with the hinge line, most extended below the middle of the shell; anterior extremity broadly rounded, slightly concave in outline anterior to the beak, most prominent about the middle of the valve or a little below; a prominent umbonal ridge extending from the beak to the posterior-ventral angle. Surface smooth except for a few obscure, concentric lines of growth; shell very thin and fragile.

Dimensions.—The measurements of the holotype are: length 13.5 mm., length of hinge line 6.2 mm., height 6.8 mm., convexity of right valve 2.4 mm.

Remarks.—There is much doubt concerning the generic identification of this shell for it is not very closely allied to any Pennsylvanian genus. It is very possible that it does not belong to the genus *Solenomya* which lacks the more prominent beak and umbonal development of the form under discussion; however, as the form appears most closely related to *Solenomya*, it seems best to place it provisionally with that genus. One would scarcely be justified in establishing a new genus from the material at hand which does not show the characters of the hinge and interior adequately. It is confined to one locality of the Sharon ore and has been found only as internal casts.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), r.

Genus *Solenomorpha* Cockerell

Solenomorpha *lamborni* n.sp.

Pl. IV., Fig. 6

Description.—Shell small, elongate, length about four times the height; convex with the maximum convexity in the anterior half of

the shell behind the beak; beak small, inconspicuous, depressed, directed anteriorly, scarcely distinct from the cardinal margin, situated about one-eighth the length of the shell from the anterior margin, separated from the anterior portion by a short, oblique groove; cardinal margin long, straight, extending posteriorly from the beak two-thirds the length of the shell; anterior margin broadly rounded dorsally, but narrowly rounded or slightly truncated ventrally, joining the ventral margin at a point one-third the length of the shell from the anterior end; ventral margin straight, parallel to the hinge line, forming an angle of about 70 degrees with the posterior extremity; posterior margin straight below, sharply truncated above, forming an angle of 155 degrees with the hinge line; a prominent umbonal ridge extending obliquely backward from the beak to the posterior inferior angle. Surface smooth except for a few faint concentric lines of growth near the margins.

Dimensions.—The holotype measures: length 22 mm., length of hinge line 13 mm., height 5.5 mm., convexity of right valve 1.5 mm.

Remarks.—This species has been found only as internal casts from the Sharon ore of a single locality in Scioto County, where it is of comparatively common occurrence. It is characterized by its elongate form, its small, inconspicuous, depressed beak, and its parallel dorsal and ventral margins. In the latter respect it differs from *Solenomorpha solenoides* (Geinitz) in which species the shell tapers posteriorly becoming bluntly pointed at the posterior extremity. The shell is extremely thin and fragile, although with care specimens in good condition can be obtained.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), c. The specific name is given in honor of Mr. Raymond E. Lamborn of the Geological Survey of Ohio, by whom the collections of fossils from the Pottsville rocks of Stark and Mahoning counties were made.

Genus Edmondia DeKoninck

Edmondia ? peroblonga Meek and Worthen?

1865 *Edmondia ? peroblonga*. Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 249.

Upper Coal Measures: Lasalle, Illinois.

1873 *Edmondia ? peroblonga*. Meek and Worthen, Geol. Surv. Ill., Vol. 5, p. 583, Pl. 27, Fig. 4.

Upper Coal Measures: Lasalle, Illinois.

A form closely related to *E. peroblonga* occurs in the Boggs limestone of Muskingum County, which is represented by a single specimen somewhat imperfect at the posterior extremity. The size is about two-thirds that of the specimen described and figured by Meek and Worthen, and the resemblance between the two forms is so close, that if they do not represent the same species, they at least show a very close relationship. They are probably not identical, as *E. ?*

peroblonga occurs much higher in the Pennsylvanian system, and the Boggs specimen is too imperfect to render identification with it at all conclusive. The dimensions of the Boggs specimen are: length 43 mm., height 20 mm., convexity of right valve 5 mm.

Horizon and locality.—Boggs limestone: near Hopewell P. O. (Locality 26), r.

Genus *Nucula* Lamarck

Nucula elongata n.sp.

Pl. IV, Figs. 10, 11, 12

Description.—Shell small, subtriangular, much produced anteriorly, length almost twice the height, greatest width slightly below the middle of the shell, gibbous in posterior portion, the greatest convexity occurring midway between the beaks and the ventral margin, shell flattened anteriorly. Umbonal region prominent, beak small, elevated and incurved over the hinge line, directed posteriorly, situated about one-fourth the length of the shell from the posterior margin; cardinal margin sloping from the beak to the extended anterior extremity; posterior extremity regularly rounded forming a continuous curve with the rounded ventral margin which anteriorly extends slightly upward; anterior extremity produced and pointed. Surface of internal cast smooth except for a few faint lines of growth; occasional indications of fine concentric lines.

Dimensions.—Considerable variation exists in the size of the individuals as may be seen by the following measurements, the first of which is the holotype:

Maximum length	11 mm.	9 mm.	7 mm.	6 mm.
Height from beak to opposite margin	6.2 mm.	5.5 mm.	4.5 mm.	3.5 mm.
Thickness of single valve	2 mm.	1.5 mm.	1.2 mm.	1 mm.

Remarks.—This species is common in the Sharon ore at a single locality in Scioto County where it occurs in an excellent state of preservation in the form of internal casts. It is related to *N. parva* McChesney and *N. beyrichi* von Schauroth, but can be easily distinguished from both species by its much more produced anterior end. It is associated with two other species of *Nucula* common in the Sharon ore—*N. subrotundata* Girty mss. and *N. lunulata* Girty mss.

Horizon and locality.—Sharon ore: Lick Run, Scioto county (Locality 2), c.

Nucula subrotundata Girty mss.

Pl. IV, Figs. 13, 14, 15

Description.—A species of *Nucula* from the Sharon ore of Ohio is identical with one described and figured in manuscript by Girty from the Morrow formation of Arkansas. Girty's manuscript description is quoted below.

"Shell small, subtriangular to subcircular in outline. The lower side is longest and is rather strongly curved, especially at the ends; the anterior side is somewhat shorter and is gently convex; the posterior side is much the shorter and is nearly straight or slightly concave. The inferior-posterior angle is rather narrowly, the inferior-anterior angle rather broadly, rounded. In a genus in which so many of the species are strongly convex the convexity of *N. subrotundata* is generally rather low, though it varies greatly in different specimens (partly due to the degree of maturity), and may be rather high. The chief flexures occur near the anterior and posterior margins along lines that make with each other an angle rather less than a right angle. The inflected parts are narrow and project but little. On the posterior side a "lunule" may be outlined by a faint sulcus which, if present, tends to produce a slight emargination in the outline. A few specimens referred under this species have the "lunule" distinctly defined in this way. The beaks are not very prominent. They are rather attenuated and are conspicuously turned backward.

The shell is for its size very thick and massive, and it is marked superficially by rather coarse, strong and regular concentric striae."

Remarks.—This species of *Nucula* is very abundant in the Sharon and less so in the Harrison ore, but as far as is known, it is confined in its occurrence in this State to these two horizons. It has, moreover, been found only at a single locality in each member, and only in the form of internal casts. The Ohio form differs from those of the Morrow formation of Arkansas in being on the average a little more gibbous. In the Sharon ore this species of *Nucula* is associated with *N. lunulata* Girty mss. as in the Morrow formation, and also with *N. elongata* n.sp.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), c. Sharon ore: Lick Run, Scioto County (Locality 2), a.

Nucula lunulata Girty mss.

Pl. IV, Figs. 7, 8, 9.

Description.—Another species of *Nucula* from the Sharon ore is the same as Girty's manuscript form from the Morrow formation of Arkansas, the description of which is quoted below:

"Shell small and conspicuously triangular in shape. The width and height are about equal. The convexity is great and the umbones are very prominent. The cardinal and posterior parts of the shell are strongly inflected along lines that are straight or slightly concave, and that make with one another an angle of considerably less than 90°. The inflected parts are so directed that they are concealed when the shell is viewed from either side. The inferior outline is gently convex and is directed to the two other sides in such a way that the height of the shell is nearly equal to the width and the posterior outline is distinctly shorter than the anterior outline. Owing to the high convexity and strong inflection of the margins a broad flattened surface

is formed on the cardinal and posterior ends. This surface on the posterior side is somewhat depressed and set off by angles, thus forming a large "lunule" which is very sharply defined. Nothing at all comparable to this is developed on the cardinal plane.

The surface is marked by very fine, regular, concentric striae.

This species resembles several that occur in such different stratigraphic and geologic relations that I would hesitate to regard them as the same without conclusive evidence of very close agreement. It is similar to the Mississippian *N. shumardiana*, but it is rather less elongated transversely, and it is readily distinguished by its higher convexity and more prominent umbones. *N. wewokana*, *N. levatiformis* var. *obliqua*, and *N. pulchella* are related but distinct species."

Remarks.—*N. lunulata* is common in the Sharon ore at one locality in Scioto County where it is associated with *N. subrotundata* Girty mss. and *N. elongata* n.sp. It occurs only as internal casts.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), c.

Nucula beyrichi von Schauroth

1866 *Nucula beyrichi*. Geinitz, Carb. und Dyas in Nebr., p. 21, tab. 1, Figs. 36, 37.
Coal Measures: Nebraska City, Nebraska.

This small *Nucula* is rare in the rocks of Pottsville age in Ohio and is represented in the collections studied by only a few individuals from the Harrison ore and the Lower Mercer and McArthur limestones. A single example has been found from the Harrison ore in the form of an internal cast, which, however, is so well preserved that it is referred to this species with some confidence.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), r.

Genus *Nuculopsis* Girty

Nuculopsis ventricosa (Hall)

1858 *Nucula ventricosa*. Hall, Geol. Iowa, Vol. 1, Pt. 2, p. 716, Pl. 29, Figs. 4, 5 a, b.
Coal Measures: Iowa.

1915 *Nuculopsis ventricosa*. Girty, U. S. Geol. Surv., Bull. 544, p. 117, Pl. XV, Figs. 1-8.
Wewoka formation, Oklahoma.

Nuculopsis ventricosa occurs in the basal member of the Pottsville and ranges throughout the entire formation, although individuals are by no means common. It is most often found in the Lower Mercer and McArthur members. In the Harrison ore it is associated with *N. subrotundata* Girty mss., and in the Sharon ore also with *N. lunulata* Girty mss. and *N. elongata* n.sp. A considerable variation exists in the size of the individuals; a specimen of average size from the Sharon ore measures: length 9.2 mm., height 7 mm., thickness of a single valve 3.5 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), r. Sharon ore: Lick Run, Scioto County (Locality 2), r.

Genus *Leda* Shumacher

Leda bellistriata Stevens

1858 *Leda bellistriata*. Stevens, Am. Jour. Sci., 2nd Ser., Vol. 25, p. 261.

Coal Measures: Danville, Illinois; Summit, Ohio.

1915 *Leda bellistriata*. Girty, U. S. Geol. Surv., Bull. 544, p. 122, Pl. XIV, Figs. 1-9a.
Wewoka formation: Oklahoma.

This shell with its fine, concentric markings appears in the Lowellville limestone and continues throughout the remainder of the Pottsville rocks, but has nowhere been found in considerable numbers. It is common in the Lower Mercer limestone, especially on Flint Ridge, where it was reported by Herrick to occur abundantly,¹ but in the collection from that locality studied for the present report, such was not found to be the case. The specimens from Ohio compare closely with those figured by Girty from the Wewoka formation of Oklahoma, but are on the average smaller. A large specimen from the Lowellville limestone measures: length 10.5 mm., height 5.5 mm.

Horizon and locality.—Lowellville limestone: Poverty Run, Muskingum County (Locality 19), r. Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), r. Throughout middle and upper Pottsville members.

Leda prolongata n.sp.

Pl. IV, Fig. 20

Description.—Shell large for specimens of this genus, elongate-ovate in outline with the posterior end greatly produced; depressed convex, the greatest convexity being in the anterior part below the umbones but becoming gradually and regularly less to the posterior tip. Beaks prominent and incurved, situated from one-third to one-fourth the length of the valve from the anterior margin; cardinal margin posterior to beaks strongly concave; anterior margin rounded and curving regularly into the rounded base; posterior portion slender, tapering to a sharp point, and greatly extended; umbonal ridge prominent and elevated. Surface of shell marked by very fine, regular, rounded concentric lines.

Dimensions.—The holotype from the Lower Mercer limestone measures: length 41 mm., height 16 mm., convexity of right valve 2.5 mm. (compressed); a single small individual from the Boggs limestone measures: length 22.5 + mm., height 9.5 mm., convexity 2.5 mm.

Remarks.—This species is characterized by its large size, its slender form, and its extended posterior portion. It is very rare and is represented in the Pottsville collections by only two individuals,—one from the Lower Mercer limestone, and another smaller specimen from the Boggs which is imperfect in lacking the posterior tip. Con-

¹Herrick, C. L., Bull. Den. Univ., Vol. 2, p. 40, 1887.

siderable doubt exists as to the advisability of creating a new species on the basis of the scanty material at hand which is none too well preserved. The holotype from the Lower Mercer member is evidently compressed; both specimens are in the form of internal casts although a small portion of the shell remains on the smaller. The form is more closely related to *L. arata* Hall than to any other described species. Comparisons have been made with specimens of the latter species from Missouri with the result that the Ohio species was found to be much larger, probably less convex, more slender, with the posterior portion more extended and the beaks less centrally located. The surface markings are also considerably finer. It can be distinguished from *L. bellistriata* Stevens by its much larger size, more slender produced posterior extremity, and less centrally placed beaks; from *L. meekana* Mark by its larger size and still more attenuated form.

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), r. Lower Mercer limestone: near Fairview School, Jackson township, Muskingum County, r.

Leda inflata Girty mss.

Pl. IV, Figs. 17, 18, 19.

Description.—Girty's manuscript description is quoted below.

"Shell small, rarely exceeding 8 mm. in width, transversely subovate. Basal margin gently convex, slightly sinuate behind, more rapidly curving in front. Anterior extremity rather regularly rounded below the prominent and backwardly turned beaks. Behind the beaks the outline is concave, strongly contracting with the base to form a pointed posterior extremity. Beaks slightly anterior to median line. Convexity high, declining rapidly behind the beaks where a sort of constriction occurs which produces more or less of a sinus in the basal outline and gives the posterior extremity a compressed appearance in contrast with the subglobose shape of the major part of the shell. Umbonal ridge high, forming the posterior-superior outline, the post-umbonal slopes being directed almost horizontally, though projecting somewhat at their juncture.

Surface finely and evenly striated.

It cannot be said that we know precisely what form the name *Leda bellistriata* was intended to cover, but from the shells commonly passing as that species *L. inflata* differs in its smaller size, its more rapidly tapering shape, and its more inflated anterior portion."

Remarks.—A small species of *Leda* from the Sharon ore of Ohio is in all probability the same form as that described above by Girty from the Morrow formation of Arkansas. Its association in this State with *N. subrotundata* and *N. lunulata*, with which it is also associated in the Morrow formation, helps to strengthen this conclusion. *L. inflata* is characterized by its small size, its short depressed posterior end, and its inflated anterior end. The Ohio form differs in having a somewhat less rapidly tapering posterior end, with less con-

trast between the compressed posterior and the inflated anterior ends. These differences, however, may be due to the fact that the Sharon specimens occur as internal casts, while the shell is preserved on the Morrow forms.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), c.

Genus *Anthraconeilo* Girty

Anthraconeilo bownockeri n. sp.

Pl. IV, Fig. 21

Description.—Shell small to almost medium in size, transversely ovate in outline, ratio of height to length about 2 : 3, maximum height about one-third the length of the shell from the posterior margin; moderately convex in umbonal region, becoming compressed anteriorly and slightly so at the posterior margin; beak directed posteriorly, prominent, elevated above hinge line and slightly incurved, situated about one-third the length of the shell from the posterior margin; anterior-dorsal margin long, sloping downwards from the beak to the anterior extremity which is bluntly pointed and considerably produced; posterior margin broadly rounded; ventral margin rounded sloping strongly upward anteriorly to meet the pointed anterior extremity. Surface of internal cast smooth.

Dimensions.—The measurement of the holotype are: length 18 mm., height 11 mm., convexity of left valve 3.5 mm.

Remarks.—This species of *Anthraconeilo* is of rare occurrence and has been found only in the Sharon ore from which internal casts of single valves of only three individuals have been discovered. It differs from *A. taffiana* Girty principally in its smaller size and its more pointed anterior extremity, which in the latter species is blunt and somewhat truncated. It is closely similar to *A. kessleriana* (Mather), but may be distinguished by its less centrally located beaks and its more produced anterior end (the long pointed one), which give to the shell a decidedly more transversely-elongate form.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), r. The specific name is given in honor of Dr. J. A. Bownocker, State Geologist of Ohio.

Genus *Parallelodon* Meek

Four species of *Parallelodon* are among the collections of Pottsville fauna studied: *P. carbonarius*, *P. obsoletus*, *P. sangamonensis*, and *P. tenuistriatus*, all of which are abundant except *P. sangamonensis*. The genus extends from the Harrison ore at the base throughout the entire formation but occurs most abundantly in the Lower Mercer and McArthur members.

Parallelodon carbonarius (Cox)

1857 *Arca carbonaria*. Cox, Geol. Surv. Ky., Vol. 3, p. 567, Pl. 8, Fig. 5.
Coal Measures: Kentucky.

1887 *Macrodon carbonaria*. Herrick, Bull. Den. Univ., Vol. 2, p. 32, Pl. 4, Figs. 21, 14.

Coal Measures: Flint Ridge, Ohio.

This species is particularly abundant in the Lower Mercer limestone although it has been found as low as the Boggs; it is common also in the higher members. It is characterized by surface sculpture of prominent, regular, radiating plications which become considerably larger and stronger on the flattened posterior portion below the hinge line. The dimensions of a specimen of representative size from the Boggs member are: length 20 mm., height from beak to opposite margin 9 mm.

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), c. Common and widely distributed in members above the Boggs.

Parallelodon obsoletus (Meek)

1871 *Macrodon obsoletus*. Meek, Rep. Regents Univ. W. Va.

Lower Coal Measures: Monongahela County, West Virginia.

1875 *Macrodon obsoletus*. Meek, Pal. Ohio, Vol. II, p. 334, Pl. 19, Fig. 9.

Coal Measures: Newark, Ohio.

This species of *Parallelodon* appears in the Lowellville limestone but is most characteristic and abundant in the Lower Mercer limestone. It is distinguished from the other species of *Parallelodon* occurring in this State by the apparent absence of all surface markings. The obscure, fine, radiating lines of the posterior-dorsal region, referred to by Meek¹ do not appear on the specimens examined. The individuals from the Lowellville limestone are all imperfectly preserved, so that their identification is not accompanied by a great degree of certainty. A specimen of average size from the Lower Mercer limestone measures: length 27.5 mm., maximum height 11.5 mm., convexity of right valve 5.5 mm.

Horizon and locality.—Lowellville limestone: Hopewell P.O., Muskingum County (Locality 19), r. Common in the Lower Mercer limestone.

Parallelodon tenuistriatus (Meek and Worthen)

1866 *Arca striata*. Geinitz, Carb. und Dyas in Nebraska, p. 20, tab. 1, Fig. 32. (Not *Mytilites striatus* Schloth, 1817), Nebraska City, Nebraska.

1867 *Macrodon tenuistriata*. Meek and Worthen, Proceed. Chicago Acad. Sci., Vol. 1, p. 17.

Upper Coal Measures: Springfield, Illinois.

Parallelodon tenuistriatus is a common fossil throughout the Pottsville formation of this State, but occurs in especial abundance in the Harrison ore and the Lower Mercer and McArthur limestones. The forms from the Harrison ore and McArthur limestone are unusually small and diminutive, while in the Lower Mercer and other

¹Meek, F. B., Pal. Ohio, Vol. II, p. 334, 1875.

horizons a much larger size is attained as may be seen by the following measurements:

<i>Specimen of average size</i>	<i>Harrison</i>	<i>Lower Mercer</i>
Length	14.5 mm.	29 mm.
Height	6 mm.	13.6 mm.
Thickness	3 mm.	6 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), a. Boggs limestone: Blunt Run, Muskingum County (Locality 27), r. Abundant in Lower Mercer, McArthur and other members.

Parallelodon sangamonensis (Worthen)

1890 *Macrodon sangamonensis*. Worthen, Geol. Surv. Ill., Vol. 8, p. 123, Pl. 21, Figs. 3, 3a.
Coal Measures: Sangamon County, Illinois.

This form is rare in the Pottsville formation of Ohio, and when found is only about one-half the size of the Illinois specimens, an average-sized individual measuring: length 24 mm., height from beak to ventral margin 13 mm. Extending from the beak to the posterior margin are generally six strong, rounded ribs; the remainder of the shell is smooth or marked by very faint, fine, radiating lines. The general contour resembles Worthen's species so closely that the identification is made with considerable confidence.

Horizon and locality.—Lowellville limestone: Lowellville, Mahoning County (Locality 22), r. Also found in the Lower Mercer limestone.

Genus *Aviculopinna* Meek

Aviculopinna americana Meek

1866 *Aviculopinna pinnaeformis*. Geinitz, Carb. und Dyas in Nebr., p. 31, tab. 2, Fig. 13, (Not *Solen pinnaeformis* Geinitz, 1848).
Nebraska City, Nebraska.

1867 *Aviculopinna americana*. Meek, Am. Jour. Sci., 2nd Ser., Vol. 44, p. 282.

1872 *Aviculopinna americana*. Meek, U. S. Geol. Surv. Nebr., p. 197, Pl. 9, Figs. 12a-d.
Upper Coal Measures: Nebraska City, Nebraska; Iowa.

Description.—Internal casts belonging to the above species are not uncommon in the Boggs member of Muskingum County; the species also occurs more rarely in the Lower Mercer limestone along Flint Ridge. On the average these specimens are quite comparable in size and contour to the one figured by Meek from the Lower Coal Measures of this State.¹ However, some of the forms from the Boggs limestone are much larger, the largest individual among the collection studied measuring, if restored, about 3.25 inches (or 82 mm.). As nearly as can be judged from the crushed condition of the shells, the convexity was originally great and the valves were flattened just

¹Meek, F. B., Pal. Ohio, Vol. II, p. 337, pl. 20, Fig. 2, 1875.

below the cardinal margin. The beak is minute and not quite terminal, with the anterior margin extending beyond it in a small, pointed lobe; a well-defined marginal ridge marks the straight cardinal margin. The surface is smooth except for a few thin, elevated lines parallel to the ventral and posterior margins.

Remarks.—This species is rare in the Pennsylvanian rocks of Ohio, and there is no record of its occurrence at any horizon as commonly as it does in the Boggs member. The type specimen was obtained from the Upper Coal Measures of Nebraska, at which horizon it also occurs in Iowa and Missouri. Meek, however, described and figured the same species from the Lower Coal Measures of Ohio, but he does not state the exact horizon and locality from which the figured specimen came. Herrick also figures a form from Flint Ridge in Licking and Muskingum counties (Lower Mercer) which he provisionally refers to this species.¹

Horizon and locality.—Boggs limestone, near Hopewell P.O., Muskingum County (Locality 26), c. Lower Mercer.

Genus *Myalina* DeKoninck

Myalina pernaformis Cox

Pl. V, Figs. 3, 4.

1857 *Myalina pernaformis*. Cox, Geol. Rept. Ky., Vol. 3, p. 569, Pl. 8, Fig. 8.
Coal Measures: Providence, Hopkins County, Kentucky.

Description.—This form is not rare in the Pottsville rocks of Ohio, but is particularly common and characteristic of the Boggs and Black Flint members. In size it varies within wide limits from very large specimens to immature ones which are about one-half the size of that figured by Cox. The following measurements of individuals selected from the Boggs and Black Flint members will illustrate this variation in size. In the latter member the species attains an unusually large size.

	<i>Boggs</i>	<i>Black Flint</i>		
Length of greatest diameter, from beak to posterior-inferior margin	22 mm.	48 mm.	60 mm.	69 mm.
Width, normal to umbonal ridge	10 mm.	21 mm.	30.5mm.	35.5 mm.
Length of hinge line	12 mm.	21 mm.	28 + mm.	44 mm.
Convexity of left valve	3 mm.	6 mm.	10 mm.	crushed

Anterior margin straight, forming an angle of 60 to 65 degrees with the hinge line, subparallel to posterior margin; posterior margin slightly convex in outline, rounding broadly into the front below the middle of the shell. Sometimes the posterior end of the hinge line is somewhat produced with the posterior-lateral margin directly below slightly constricted, so that the posterior-superior angle forms

¹Herrick, C. L., Bull. Den. Univ., p. 38, pl. 1, Fig. 20, 1887.

a small wing-like extension; sometimes the posterior margin meets the hinge line at right angles, while more commonly the hinge line is shorter and the posterior-superior angle is truncated and slightly rounded. The surface is marked by strong, regular, concentric lines of growth.

Remarks.—The form resembles that of *M. kansasensis* Shumard, but lacks the fluted lamellae of that species. It differs from *M. recurvirostris* Meek and Worthen in its more oblique form and in lacking the prominent, strongly recurved beak which characterizes the latter species.

Horizon and locality.—Boggs limestone in Muskingum County: near Hopewell P.O. (Locality 26), c; Blunt Run (Locality 27), c; Rock Cut (Locality 28), c. Present in higher horizons of the Pottsville formation in Ohio.

Myalina pernaformis Cox var.

Pl. V, Figs. 5, 6.

Description.—Two small specimens of *Myalina* from the Harrison ore of Jackson County have been classed as varieties of *Myalina pernaformis*. The axis is somewhat more oblique and the size much less than that of mature specimens of *M. pernaformis* from the higher Pottsville horizons. The angle between the cardinal and anterior margins measures about 52 degrees. It can be compared to *M. cuneiformis* Gurley, but that form is still more oblique and more triangular in outline.

Dimensions.—Length of greatest diameter from beak to posterior-inferior margin 31 mm., width normal to umbonal ridge 16 mm., thickness of left valve 7 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), r.

Genus *Posidonia* Bronn

Posidonia girtyi n.sp.

Pl. V, Figs. 1, 2.

Description.—Shell large, ovate, compressed; beaks prominent, almost anterior, slightly elevated and incurved over hinge line; greatest convexity in umbonal region, posterior and ventral portions flattened; hinge line straight, about three-fifths the length of the shell below; anterior margin almost straight, with small anterior auricle; ventral and posterior margins continuously rounded, truncated above and meeting the hinge line at an obtuse angle; posterior auricle flattened, much larger than anterior auricle. Surface marked by numerous, strong, regular, concentric wrinkles, separated by broad, rounded furrows.

Dimensions.—The measurements of two cotypes are:

Length 40 mm. 32 mm.

Height.....	45 mm.	38 mm.
Length of hinge line.....	? mm.	18 mm
Convexity.....	3.5 mm.	3 mm.

Remarks.—This species of *Posidonia* has been found at only two localities, and although it is fairly abundant, no perfect specimens have been obtained, possibly on account of the thin, fragile character of the shell; the small depressed anterior auricle is very seldom preserved. The species is characterized by its almost erect form, by its small anterior ear, and by its strong regular concentric wrinkles. There is no American species with which it can be compared except *P. pertenuis* Beede; although similar to the latter species in contour, the Ohio form can be distinguished by its much stronger, more numerous, and more regular concentric wrinkles. It is the opinion of the writer that the short auricle of both species is anterior, while the longer is posterior.¹

Horizon and locality.—Lowellville horizon ? : black shale near Holbein, Muskingum County (Locality 20), c. Lower Mercer, Rock Hollow, Vinton County, a. Named in honor of the distinguished paleontologist, Mr. George H. Girty, of the United States Geological Survey.

Genus *Naiadites* Dawson
Naiadites elongata Dawson
 Pl. IV, Figs. 22, 23, 24.

1860 *Naiadites elongata*. Dawson, Supp. Acad. Geol., p. 43.
 Coal Measures: Nova Scotia.

1868 *Naiadites elongata*. Dawson, Acad. Geol., p. 204, Fig. 43.
 Middle Coal Measures: Joggins and Sidney, Nova Scotia.

Description.—This fresh or brackish water Pelecypod is characterized by its elongate, oblique form, its small inconspicuous beak, its short hinge line, and its fine, regular, concentric surface markings. Its great variability of form is conspicuous, and it is possible that more than one species may here be included under the name *N. elongata*. However, it is generally found greatly crushed and distorted by pressure so that a considerable variation in form is to be expected. It occurs abundantly in the lower horizons of the Pottsville formation, especially in the fissile shale and black band ore on the Bear Run coal horizon in which it is the only fossil found with the exception of plants and fish scales. A form of *Naiadites* which has provisionally referred to the same species occurs very sparingly in the shales associated with the Quakertown or No. 2 coal. The Quakertown specimens differ considerably in contour from those of the Bear Run horizon, but again a possible explanation for these differences is distortion due to pressure. Forms similar to those of the Bear Run member

¹Beede, J. W., Geol. Surv. Kansas, Vol. VI, p. 136, pl. XIX, Fig. 5, 1900. Dr. Beede, in his description of this species, makes the longer auricle anterior in position.

have also been found abundantly on the Sharon horizon, in the black shales overlying the coal and in the ore,—and also at one locality in the Boggs member. Average sized individuals from the various horizons in which they occur have the following measurements:

	Sharon	Quakertown	Bear Run	Boggs	
Length	15 mm.	9 mm.	15.5 mm.	16.2 mm.	18.5 mm.
Height	8.5 mm.	5.5 mm.	9.5 mm.	9.7 mm.	9.5 mm.
Thickness . . . . .	..	3.8 mm.	..	..	..

The members of this genus, as they are found in Ohio, occur either wholly by themselves, or associated with plant remains and fish scales. However, a few poorly preserved specimens of a large obscure species of *Naidites* are found with large numbers of *Lingula carbonaria* on the Anthony coal horizon. Often *N. elongata* is so abundant that a freshly broken surface of shale presents a mass of crushed and macerated individuals.

Horizon and locality.—Sharon horizon: Harry Odle mine, Scioto County (Locality 4), r; John Alexander mine, Scioto County (Locality 3), c. Quakertown or No. 2 Coal horizon: Grace mine, Twin-Ada mine, and Wilson mine, Muskingum County (Localities 11, 10, 9), r. Bear Run horizon: abundant in Scioto, Jackson, and Vinton counties in all localities from which collections were made (Localities 13, 14, 15, 16, 17, 18). Boggs member: Bloom Township, Scioto County (Locality 23), a.

Naiadites ohionese n.sp.

Pl. IV, Figs. 25, 26, 27.

Description.—Shell small, obliquely elongate, gibbous, the greatest thickness being a little anterior to the middle, right valve a little more compressed than the left, shell gaping along ventral and posterior margins; hinge line almost or entirely as long as the greatest length of the shell; beaks minute, anterior but not quite terminal, incurved, slightly elevated above the hinge line; anterior lobe small, prominent, gibbous, projecting a little beyond the beak, rounding into the ventral or inferior margin; ventral margin concave in middle, bluntly rounded posteriorly; posterior portion of shell forming the greatest height of the shell, margin straight or very slightly rounded, meeting the hinge line at an angle which is either a little greater than or equal to a right angle; a prominent, gibbous umbonal ridge extending obliquely backward from the beak to the posterior-inferior angle, broadening posteriorly, but preserving its distinctive character throughout its extent; a deep, oblique sinus anterior to the ridge, separating the anterior lobe from the remainder of the shell; region below hinge line depressed. Surface marked by fine, regular, concentric lines of growth.

Dimensions.—A cotype measures: Maximum length 12 mm., maximum height near posterior margin 8 mm., length of hinge line 9.5 mm., convexity 6.5 mm.

Remarks.—This species of *Naiadites* has been found at one locality in Scioto County where it is not only extremely abundant, but the specimens are often in a remarkable state of preservation,—a condition very unusual for the representatives of the genus. The general condition of occurrence of *Naiadites* in the Pottsville rocks of Ohio is crushed, distorted, or macerated. The species under discussion occurs in nodules of iron ore and is associated with *N. elongata*, but no other fossils are present. *N. elongata* differs in having a shorter hinge line which is equal to less than one-half the length of the shell; also in its rounded posterior margins and its less prominent umbonal ridge. *N. ohioense*, however, is very variable and differences exist in the size and prominences of the anterior lobe, the length of the hinge line, and the outline of the posterior portion. Whether these points of difference are due to slight distortion or natural variation among individuals, or whether more than one species is really present, is a matter of question. But on account of the variable nature of the genus itself, such differences are to be expected and are therefore particularly difficult to evaluate. After a careful study of the material at hand, it seems best to the writer to group under one species these forms with the long hinge line as there seems no tangible basis for further subdivision.

Horizon and locality.—Sharon ore: occurs in nodules of iron ore in the John Alexander mine, Scioto County (Locality 3), aa.

Naiadites sp.

Several crushed, poorly preserved specimens of a very large species of *Naiadites* were found associated with large numbers of *Lingula carbonaria* in the black shales of the Anthony coal horizon. They are, however, too poor for identification.

Horizon and locality.—Anthony coal horizon: Wm. E. Dee mine, Scioto County (Locality 7), r.

Genus *Schizodus* King

Schizodus amplus Meek and Worthen

1870 *Schizodus amplus*. Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 41.

Coal Measures: Seaville, Fulton County, Illinois.

1873 *Schizodus amplus*. Meek and Worthen, Geol. Surv. Ill., Vol. 5, p. 579, Pl. 27, Fig. 6.

Coal Measures: Seaville, Fulton County, Illinois.

Description.—An excellent cast of the left valve of *Schizodus amplus* is among the collections of Boggs fossils at hand. The species is characterized by its large size, quadrangular form, anteriorly placed beak, and long, straight cardinal margin posterior to the beak. In the specimen studied the pallial line, the large adductor scar, and the anterior pedal muscular impression are distinctly marked. Other less perfect specimens were obtained from the Lower Mercer limestone.

Dimensions.—A specimen from the Boggs limestone measures: length about 70 mm., height 56.5 mm., thickness of left valve 14 mm. (somewhat crushed).

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), r. Also present in the Lower Mercer limestone, r.

Schizodus affinis Herrick

1887 *Schizodus affinis*. Herrick, Bull. Den. Univ., Vol. 2, p. 41, Pl. 4, Figs. 22, 22a.
Coal Measures: Flint Ridge, Ohio.

Schizodus affinis is a common fossil of wide stratigraphic range in the Pottsville rocks of this State; it is found from the Harrison ore at the base to McArthur member near the top. The species exhibits considerable variation in size. A individual of average size from the Harrison ore measures: length 17.5 mm., height 14.2 mm., thickness of left valve 4.8 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), r. Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), c; Rock Cut, Muskingum County (Locality 28) c. Also common in the Lower Mercer and McArthur limestones.

Schizodus curtus Meek and Worthen

1866 *Schizodus curtus*. Meek and Worthen, Proc. Chicago Acad. Sci., Vol. 1, p. 18.
1887 *Schizodus curtus*. Herrick, Bull. Den. Univ., Vol. 12, pp. 42, 145, Pl. 14, Fig. 20.
Coal Measures: Flint Ridge, Ohio.

This small species of *Schizodus* appears in the Boggs member, but is of relatively rare occurrence except in the Lower Mercer and McArthur limestones.

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), r; Blunt Run, Muskingum County (Locality 27), r. Present in fossiliferous horizons above the Boggs member.

Schizodus subcircularis Herrick

1887 *Schizodus subcircularis*. Herrick, Bull. Den. Univ., Vol. 2, p. 41, Pl. 4, Fig. 24; p. 145, Pl. 14, Fig. 18.
Coal Measures: Flint Ridge, Ohio.

A single, well preserved individual of *Schizodus* from the Harrison ore has been referred to this species, the form of which is slightly more elongate than Herrick's figured specimens indicate. However, allowances must be made for the variable character of the *Schizodus* group and for some distortion resulting from compression. The collections studied contain excellent examples from the Lower Mercer and McArthur members which retain the almost circular form which characterizes the species. The beaks in these specimens are almost

median in position. A specimen from the Harrison ore measures: length 14.5 mm., height 14 mm., convexity of left valve 4.5 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), r. Common in Lower Mercer and McArthur limestones.

Schizodus wheeleri Swallow

1858 *Schizodus obscurus*. Swallow, Trans. St. Louis Acad. Sci., Vol. 1, p. 193.
(Not *Aximus obscurus* Sowerby, 1823.)

Lower Permian, Kansas.

1872 *Schizodus wheeleri*. Meek, U. S. Geol. Surv. Nebr., p. 209, Pl. 10, Figs. la-f.
Upper Coal Measures: Missouri, Nebraska, Iowa.

This species is common in the middle and upper Pottsville rocks of Ohio, but has not been found below the Boggs horizon. Specimens are generally in a good state of preservation so that their identification is made with a considerable degree of confidence.

Horizon and locality.—Boggs member: near Hopewell P.O., Muskingum County (Locality 26), c. Common in middle and upper Pottsville.

Genus *Aviculopecten* McCoy

Aviculopecten coxanus Meek and Worthen

1860 *Aviculopecten coxanus*. Meek and Worthen, Proc. Acad. Nat. Sci. Phil. p. 453.
Coal Measures: Adams County, Illinois.

Common throughout the Pottsville formation of Ohio, but abundant in the Lower Mercer limestone. The radiating ribs, which alternate in size, are on the whole finer with wider interspaces than indicated on Herrick's figured specimen from the Lower Mercer limestone of Flint Ridge.¹ The form is slightly oblique with large ears which are also marked by radiating ribs. The entire surface is covered with fine, closely arranged, concentric lines.

Dimensions.—A large specimen from the Sharon ore measures: length 13.5 mm., length of hinge line 10 mm., maximum width below hinge line 13 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), r. Sharon ore: Lick Run, Scioto County (Locality 2), c. Lowellville limestone: Poverty Run, Muskingum County (Locality 19), c. Boggs limestone: Blunt Run, Muskingum County (Locality 27), c. Abundant in the Lower Mercer and upper Pottsville.

Aviculopecten pellucidus Meek and Worthen

1860 *Aviculopecten pellucidus*. Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 455.

Coal Measures: Adams County, Illinois.

1866 *Aviculopecten pellucidus*. Meek and Worthen, Geol. Surv. Ill., Vol. 2, p. 327, Pl. 26, Figs. 5a, b.

Lower Coal Measures: Adams County, Illinois.

Description.—A single specimen of this small, delicately sculptured *Aviculopecten* was found in the black shale associated with the

¹Herrick, C. L., Bull. Den. Univ., Vol. II, pl. 1, Fig. 17, 1887.

Lowellville limestone. Its surface is ornamented by slender ribs, a little more than their own diameter apart, which are crossed by rather strong, more closely arranged concentric lines. Where the radiating and concentric markings cross each other, little nodes or scales are formed. The ornamentation of the ears is similar to that of the body of the shell.

Dimensions.—Height 6.5 mm., length about 6 mm.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), r.

Genus *Deltopecten* Etheridge

Deltopecten scalaris (Herrick)

Pl. V, Figs. 7, 8.

1887 *Aviculopecten scalaris*. Herrick, Bull. Den. Univ., Vol. 2, p. 26, Pl. 1, Fig. 8.
Coal Measures: Flint Ridge, Ohio.

Description.—Shell of medium size, almost equivalve, moderately convex, length and width about equal, maximum length below middle of shell; hinge straight or nearly so, equal to about three-fourths the maximum width of the shell below; cardinal area broad with large, triangular ligamental pit beneath the beaks. Ventral and anterior margins broadly rounded, posterior margin slightly produced below the middle of the shell; ears subequal, sharply defined on either side of the beaks by a sinus which is deeper on the anterior ear than on the posterior; anterior ear slightly convex in outline, posterior ear mucronate at hinge line, strongly concave in outline. Surface marked by fascicles of strongly elevated ribs, three to five in each bundle (generally four) which increase by bifurcation; ears also marked by strong radiating ribs; entire surface including the ears crossed by fine, regular, closely arranged, concentric lines, which form minute scales where they cross the radiating ribs.

Dimensions.—An individual of average size measures: length 34 mm., height 33 mm., length of hinge line 22.5 mm; convexity of left valve 5 mm.

Remarks.—*Aviculopecten fasciculatus* Keyes and *A. providencesis* Cox are Pennsylvanian species which also have the fasciculate grouping of the ribs and to which the Ohio Pottsville form can be compared. The former is a much larger species,—almost three times as large,—and comes from a much higher horizon in the Pennsylvanian system. *A. providencesis* is likewise a much larger form. If these species could be reduced to the size of *D. scalaris*, the ribs would probably be larger and less numerous.

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), c. Lower Mercer and higher Pottsville horizons, c.

Deltopecten occidentalis (Shumard)

1855 *Pecten occidentalis*. Shumard, Geol. Rep. Mo., p. 207, Pl. C, Fig. 18.
Coal Measures: Near Plattsburg, Clinton County, Missouri.

Description.—This common and widely distributed Pennsylvanian pelecypod appears in this State in the Boggs limestone and continues as a common fossil throughout the remainder of the Pottsville formation. It is recognized by its subequal ears and its rounded radiating ribs of unequal size which die out at various intervals between the beak and margins with only a comparatively few reaching the beak. The Ohio specimens are apparently smaller than is generally the case; an individual of average size from the Boggs limestone measures: length 20 mm., width 18 mm., length of hinge line 15 mm.

Horizon and locality.—Boggs limestone: Blunt Run, Muskingum County (Locality 27), r; common throughout the middle and upper members of the Pottsville formation.

Genus *Acanthopecten* Girty

Acanthopecten carboniferous (Stevens)

1858 *Pecten carboniferous*. Stevens, Am. Jour. Sci. and Arts, Vol. XXV, p. 261.
Coal Measures: Crooked Creek, Marion County, Illinois.

Description.—This is an abundant and widely distributed fossil in the Pottsville rocks above and including the Boggs member, but it has not been discovered below the latter formation. It is readily distinguished by its large ears, and by its distinctive surface markings of 15 to 18 large, regular plications which are marked at regular, somewhat distant intervals by spine-like projections where concentric lines cross the plications. The size is comparatively constant: an individual of average size measures: height 16 mm; length of hinge line 13 mm., greatest width below hinge line 18 mm. A specimen of unusual size from the Lower Mercer limestone has the following measurements: height 27 mm., length of hinge line 23 m±m., greatest width below hinge line 29 mm.

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), c. Abundant and generally distributed in the Lower Mercer and higher horizons.

Genus *Crenipecten* Hall

Crenipecten foerstii Herrick

1887 *Crenipecten foerstii*. Herrick, Bull. Den. Univ., Vol. 2, p. 28, Pl. 3, Figs. 9, 9a.
Coal Measures: Flint Ridge, Ohio.

Herrick's description: "Shell below the ears subcircular, but moderately convex, equivalve. Right valve with anterior ear produced, rounded in front, separated from the valve by a deeply impressed, concave auricular sinus; posterior ear nearly rectangular, slightly concave in posterior outline, separated from the valve by an im-

pressed line; hinge line one half the height of the valves. Left valve of same form, but the ears less distinctly separated; hinge line less than one half the height, anterior ear with concave front outline. The beaks are acute and moderately prominent. Surface marked by numerous close, minute, concentric lines, and numerous irregular, concentric wrinkles which give a peculiar appearance to the shell, not shared by other species. These wrinkles are less marked on young shells. There are also, in most cases, indications of radiating lines, which in the larger shells are strong striae or ribs, at a distance from each other."

Remarks.—This species appears in the Boggs limestone where it is rare, but in the Lower Mercer horizon it constitutes a very abundant and characteristic fossil, especially in the Flint Ridge region. Herrick states that next to *Entolium aviculatum* Swallow it is the most common bivalve at Flint Ridge, which statement in the experience of the writer is true. A specimen a little above average size measures: length 20 mm., height 20.5 mm., length of hinge line of right valve 11 mm.

Horizon and locality.—Boggs limestone: Blunt Run, Muskingum County (Locality 27), r. Abundant and wide-spread in the Lower Mercer limestone.

Genus *Euchondria* Meek

Euchondria neglecta (Geinitz)

1866 *Pecten neglectus*. Geinitz, Carb and Dyas in Nebr., p. 33, tab. 2, Fig. 17.
Nebraska City, Nebraska.

1872 *Aviculopecten neglectus*. Meek, U. S. Geol. Surv. Nebr., p. 193, Pl. 9, Figs. 1a, b.
Upper Coal Measures: Nebraska City, Nebraska.
Coal Measures: Illinois.

Meek's description: "Shell very small, broad subovate exclusive of ears, even thin, rather compressed; sides and base more or less regularly rounded; cardinal margin shorter than breadth of valves. Left valve (according to Professor Geinitz figure) with ears nearly equal, the anterior one separated from the margin below by a broad, very shallow sinus, and forming less than a right angle at its extremity; posterior ear extending farther down the margin than the other, very faintly sinuous behind, and forming an angle of about 100° at the extremity. Right valve with anterior ear narrow and rather acutely angular, defined by a deep, narrow sinus, extending back about half its length; posterior of about the same length, but of greater vertical breadth than the other, rather pointed at the extremity and defined by a moderately deep, broadly rounded sinus, and a subangular umbonal slope. Surface of the body part of both valves apparently only marked by fine concentric striae; ears with a few radiating costae, crossed by fine striae and a few coarser marks of growth.

Height and breadth each, 0.26 inch; length of hinge, 0.21 inch."

Remarks.—A single, well preserved specimen was found in the Lowellville limestone, but the species occurs rather commonly in the Lower Mercer and McArthur members. The Ohio specimens are on the average larger than those figured by Meek but in other respects the forms are identical. The measurements of the specimen from the Lowellville limestone which is among the largest found, are: length 9.7 mm., height 9.5 mm., length of hinge line 7 mm. One from the Lower Mercer limestone measures: length and height 5 mm., length of hinge line 4.2 mm.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), r. Common in the Lower Mercer and McArthur limestones.

Genus *Pleurophorus* King

Pleurophorus tropidophorus Meek

1875 *Pleurophorus tropidophorus*. Meek, Pal. Ohio, Vol. 2, p. 338, Pl. 19, Figs. 10 a, b.

Coal Measures: Newark, Ohio.

Meek's description: "Shell transversely oblong, much compressed, with length a little greater than twice the height; posterior margin flattened and bifurcated, the lower truncation being nearly vertical, and the upper sloping obliquely downward and backward from the hinder end of the hinge; cardinal margin straight, equaling about two-thirds the length of the valves; anterior rounded below and sloping abruptly forward from the beaks above; basal margin long, parallel to the hinge, nearly straight for most of its length, or faintly sinuous near the middle, rounding up anteriorly, and forming a more or less defined angle at its connection with the lower part of the posterior margin behind; posterior umbonal slope distinctly angular from the beaks to the angular posterior basal extremity, while a second carina passes obliquely backwards and downwards along the middle of the posterior dorsal space above the umbonal ridge of each valve; beaks depressed to the line of the cardinal margin, very little projecting, and placed one-fifth to one-fourth the length of the valves from the anterior margin. Surface marked by distinct concentric lines of growth, that become strongly defined on the flanks and anterior parts of the valve, but are less distinct on the space above and behind the umbonal angles."

Dimensions.—A specimen of typical size from the cannel coal mine on Flint Ridge, Licking County, measures: length 29.5 mm., maximum height posterior to the beak 15 mm., convexity of a single valve 4 mm.

Remarks.—This species is rare below the Lower Mercer limestone but is fairly common and widely distributed in the latter and higher members, especially the McArthur limestone. The species shows very little variation from place to place, and differs from Meek's figured specimen only in having the beak slightly more depressed.

In his study of the fauna of Flint Ridge, Herrick¹ mentions that possibly two related species differing chiefly in size may exist; in the writer's opinion if the characters exhibited in his figure prove constant in a number of specimens, a different species rather than an abnormal development of *P.tropidophorus* is represented. This form differs not only in its larger size, but in its less angular posterior outline and its convex ventral margin. Collections were made at a number of localities along Flint Ridge, but no specimens comparable to Herrick's were discovered.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), r. Common in the Lower Mercer and upper Pottsville members.

Pleurophorus oblongus Meek

1866 *Clidophorus pallasi*. Geinitz, Carb. und Dyas in Nebr., p. 23, tab. 2, Fig. 4.
(Not *Modiola pallasi* de Vern., 1845.)

Nebraska City and Wyoming, Nebraska.

1872 *Pleurophorus oblongus*. Meek, U. S. Geol. Surv. Nebr., p. 212, Pl. 10, Figs. 4a-c.
Upper Coal Measures: Nebraska City, Nebraska.

Represented in the lower Pottsville formation by the internal cast of a single specimen from the Sharon ore, which, however, is in an almost perfect state of preservation so that the identification is made with a considerable degree of confidence. This specimen is somewhat smaller than indicated by Meek's description and figures; its dimensions are: length 8 mm., length of hinge line 6 mm., maximum height near posterior end 4.5 mm., thickness of right valve 1.2 mm.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), r. Also present in the Lower Mercer limestone.

Genus Astartella Hall

Astartella concentrica (Conrad)?

1842 *Nuculites concentricus*. Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st Ser., Vol. 8, Pt. 2, p. 248.

Coal Measures: Pennsylvania.

1913 *Astartella concentrica*. Girty, U. S. Geol. Surv., Bull. 544, p. 142, Pl. XVIII, Figs. 2-9.

Wewoka formation: Oklahoma.

Several small, imperfect specimens belonging to the genus *Astartella* have been referred to this species. The poorly-preserved condition of the material, however, renders the identification doubtful.

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19), r. Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), r.

Astartella sp.

A small, crushed pelecypod, probably belonging to the genus *Astartella*, occurs in great abundance at two localities,—one in the

¹Herrick, C. L., Bull. Den. Univ., Vol. II, p. 35, 1887.

Lowellville limestone ? and the other in the Lower Mercer, distant from each other, yet faunally very similar and unique. The somewhat square posterior outline, long cardinal margin, prominent beaks, and fine, regular, concentric lines characterize the form. It is, however, too poorly preserved to be identified specifically. The measurements of a specimen of average size are: length 9.5 mm., height 6.5 mm., length of cardinal margin 6 mm.

Horizon and locality.—Lowellville member ?: Near Holbein, Muskingum County (Locality 20), a. Lower Mercer limestone: Rock Hollow, Vinton County, a.

PHYLUM MOLLUSCA

Class Gastropoda

Family Bellerophontidae McCoy

No fossils are more abundant in the Harrison and Sharon ores than the *Bellerophon*-like shells which can be obtained in an almost perfect condition. They are diminutive in size and occur as internal casts, so that in most cases even the generic position is undeterminable. In only a few instances, however, is surface sculpture shown sufficiently well to disclose the generic and specific relations.

Genus *Bellerophon* Montfort

Bellerophon crassus Meek and Worthen?

1860 *Bellerophon crassus*. Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 458.
Lower Coal Measures: Pittsburg, St. Clair County, Illinois.

Several of the numerous small *Bellerophon*-like forms from the Harrison and Sharon ores show a narrow slit band with faint lines of growth, and have been referred provisionally to *B. crassus*. The species has not been found on any other Pottsville horizon below the Lower Mercer limestone.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), a. Sharon ore: Lick Run, Scioto County (Locality 2), a.

Genus *Euphemus* McCoy

Euphemus carbonarius (Cox)

1855 *Bellerophon urii*. Norwood and Pratten, Jour. Acad. Nat. Sci. Phil., 2nd Ser., Vol. 3, p. 75, Pl. 9, Figs. 65 (Not *B. urii* Fleming, 1828.)
Coal Measures: Galatia and Grayville, Illinois; 5 miles below New Harmony, Indiana.

1857 *Bellerophon carbonarius*. Cox, Geol. Surv. Ky., Vol. 3, p. 562.
Coal Measures: Indiana.

Among the numerous *Bellerophon*-like forms from the Harrison and Sharon ores, several individuals retain indications of numerous strong, revolving lines and have been identified as *E. carbonarius*, at least according to the generally usage of the term which may include several distinct species. It is also found rarely in the Boggs, but is

common in the Lower Mercer and higher Pottsville horizons where it attains a much larger size than in the basal members.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), a. Sharon ore: Lick Run, Scioto County (Locality 2), a. Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), r.

Family Pleurotomariidae D'Orbigny

Representatives of this family are extremely abundant in the Harrison and Sharon ores, and at least four forms, possibly more, are thought to be present. They occur, like the entire assemblage from these horizons, as internal casts, which show the form but give little clue as to the external sculpture. These Pleurotomaria-like forms, which are all small, may prove to be new species, although no definite conclusions can be reached concerning them, unless the examination of more material in the future may reveal something concerning the external markings of the group. In only one species, which is described below, is the surface sculpture preserved in external molds.

Genus Pleurotomaria Shumard

Pleurotomaria ornatiformis n. sp.

Pl. V, Figs. 9, 10, 11, 12, 13.

Description.—Shell small, height a little less than width; volutions moderately convex, angular, and shouldered, marked centrally by a relatively broad, flat zone bounded by two prominent revolving carinae; slit-band situated on the central zone between two smaller revolving carinae; region between the shoulder and the central flattened area slightly concave, marked by three or four revolving carinae; region below the slit-band on the last volution convex, marked by numerous closely arranged carinae; surface also marked by fine, transverse, thread-like lines which turn backward above and forward below the slit band. Aperature unknown.

Dimensions.—As these specimens occur as impressions, most of them very fragmental, exact measurements cannot be given. However, judging from the material studied, the dimensions of a typical individual are approximately: height 7 mm., height of last volution 4.5 mm., width of last volution 9 mm.

Remarks.—This species at first appears identical with *P. gurleyi* Meek and Worthen, but may be distinguished by the difference in the position of the slit-band. In *P. gurleyi* it is situated upon or just above the mesial angle, while in the species under discussion it is on the flat, vertical zone between the carinae. The form is common in both the Harrison and Sharon ores.

Horizon and locality.—Harrison ore: Jackson county (Locality 1), c. Sharon ore: Lick Run, Scioto County (Locality 2), c.

Pleurotomaria sp.

Internal casts of small gastropods, evidently of the genus *Pleurotomaria* are common in the Boggs limestone, but in the absence of all surface markings, specific identification is impossible.

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), c.

Genus *Schizostoma* Bronn

Schizostoma catilloides (Conrad)

1842 *Inachus catilloides*. Conrad, Acad. Nat. Sci. Phil. Jour., 1st Ser., Vol. 8, Pt. 2, p. 272, Pl. 15, Fig. 3.

Carboniferous: Inclined plane of the Allegheny Mountains, Pa.

Common and widely distributed throughout the Pottsville formation of Ohio. It is present in every member in which marine fauna occurs from the Harrison ore at the base to the Black Flint at the top.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), a. Sharon ore: Lick Run, Scioto County (Locality 2), c. Lowellville member: Poverty Run, Muskingum County (Locality 19), r. Boggs member: near Hopewell P.O., Muskingum County (Locality 26), c.

Genus *Naticopsis* McCoy

Naticopsis altonensis (McChesney)

1865 *Natica altonensis*. McChesney, Ill. New Spec. Foss., p. 6, Pl. 2, Figs. 14 a,b.
Coal Measures: Alton, Illinois.

1868 *Naticopsis altonensis*. McChesney, Trans. Chicago Acad. Sci., Vol. 1, p. 50, Pl. 2, Figs. 14 a-c.
Coal Measures: Alton, Illinois.

A few individuals belonging to this species are among the collections of Boggs fossils. They are characterized by the large lower volution which occupies the entire length of the shell, the high shoulder and prominent depression above the middle of the volution, together with the surface markings of fine, regular, transverse lines. The figured specimen which is somewhat crushed from above, is the most perfect individual obtained.

Horizon and locality.—Boggs limestone: near Hopewell P.O., Muskingum County (Locality 26), r.

Genus *Sphaerodoma* Keyes

Sphaerodoma humilis (Keyes) ?

1888 *Macrocheilus humilis*. Keyes, Proc. Acad. Nat. Sci. Phil., p. 239, Pl. 12, Fig. 1.
Lower Coal Measures: Des Moines, Iowa.

Internal casts of small, high-spired gastropods from the Harrison ore, with a fold on the columella and apparently no anterior canal on the outer lip, have been placed under the genus *Sphaerodoma*. Specifically they have been referred rather doubtfully to *S. humilis*,

which they resemble most closely in contour. Height 5.5 mm., height of last volution 3 mm., width of last volution 3 mm.

Horizon and locality.—Harrison ore: Jackson County (Locality 1), c.

Sphaerodoma primigenia (Conrad) ?

1835 *Styliifer primigenia*. Conrad, Trans. Geol. Sec. Penn., Vol. 1, p. 267, Pl. 12, Fig. 2.

A single internal cast of a small gastropod from the Sharon ore has been placed with the above species. As may be seen by the following measurements, the form from the Sharon ore is much smaller than even small specimens of *S. primigenia*. Height 12 mm., height of last volution 7 mm., width of last volution 10 mm.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), r.

PHYLUM MOLLUSCA

Class Cephalopoda

Genus *Orthoceras* Breynius

Orthoceras n.sp.

Description.—A small, gradually tapering *Orthoceras* from the Sharon ore represents in all probability a new species, but the material at hand is too poor for descriptive purposes. The siphuncle is conspicuously eccentric, and the septa which are strongly convex, are situated at any given point about one-fourth the diameter of the shell from each other.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), c.

Orthoceras n.sp.

Several crushed specimens of a large *Orthoceras* from the Lowellville and Lower Mercer members apparently belong to the same species which is undescribed. The material at hand, however, is too poor and fragmentary for description and figuring. The form appears to be gradually tapering, but other characters, such as the position of the siphuncle and the ratio of the height of the chambers to their diameter cannot be determined. The species can be most readily compared with *O. fanslerensis* Keyes and *O. colletti* Miller, but they can be distinguished from the Ohio form by the greater height of their chambers.

Horizon and locality.—Lowellville member ? : Holbein, Muskingum County (Locality 20) r. Lower Mercer: Little Mill Creek, Mahoning County, r.

Genus *Pseudorthoceras* Girty

Pseudorthoceras knoxense (McChesney)

1860 *Orthoceras knoxensis*. McChesney, Desc. New Spec. Foss., p. 69, (Date of imprint, 1859.)

Coal Measures: Knox County, Missouri.

1866 *Orthoceras cribrosum*. Geinitz, Carb. und Dyas in Nebr., p. 4, tab. 1, Fig. 5.
Dyas; Nebraska City, Nebraska.

(Most or all of the citations, given under *Orthoceras rushense* McChesney, possibly including McChesney's form.)

Common in the marine limestones of the Pottsville formation, but not found below the Lowellville member. Although small, representatives vary considerably in size; the form is gradually tapering and the siphuncle is central or almost central in position. The septa are moderately convex with about three equaling the diameter of the shell at any point. Variations occur in the latter condition, but the extent of variation cannot be determined as the shells are invariably found in a crushed condition. The peculiar, pitted surface on the Nebraska forms, described by Professor Geinitz as *O. cribrosum*, is not apparent on the Ohio specimens, but this difference is in no way significant as the pitted character was probably produced by minute parasites and therefore is not of specific importance.¹

Horizon and locality.—Lowellville member: Poverty Run, Muskingum County (Locality 19) c; near Symmes Ford, Muskingum County (Locality 21), c. Boggs member: near Hopewell P.O. and Rock Cut, Muskingum County (Localities 26 and 28), c.

Genus *Coloceras* Hyatt

Coloceras ? sp.

Represented by a small, imperfect specimen from the Sharon ore, the generic relationship of which is very doubtful.

Horizon and locality.—Sharon ore: Lick Run, Scioto County (Locality 2), r.

Genus *Temnocheilus* McCoy

Temnocheilus forbesianus (McChesney)

1860 *Nautilus forbesianus*. McChesney, Desc. New Pal. Foss., p. 63.

Coal Measures: Mercer County, Illinois.

1865 *Nautilus forbesianus*. McChesney, New Spec. Foss., Pl. 3, Figs. 4 a-b.

Represented in the collections studied by several fragments of the outer volution which preserve fairly well the characters of the outer surface. The form is found more commonly in the horizons above the Boggs.

Horizon and locality.—Boggs member: near Hopewell P.O., Muskingum County (Locality 26), r.

¹Geinitz, H. B., Die Carb. und Dyas in Nebr., p. 4, 1866.

PHYLUM ARTHROPODA

Class Crustacea

SUBCLASS TRILOBITA

Genus *Phillipsia* Portlock

Phillipsia trinucleata Herrick

1887 *Phillipsia trinucleata*. Herrick, Bull. Den. Univ., Vol. 2, p. 64, Pl. 1, Fig. 23; Pl. 2, Fig. 32; Pl. 3, Fig. 21.
Coal Measures: Flint Ridge, Ohio.

Several small pygidia from the Sharon member are here referred to *P. trinucleata*, but they differ in the absence of the minute granules on the surface which are present in Herrick's species. These, however, are so minute that they may easily have been destroyed. The form is relatively common in the Lower Mercer and higher horizons.

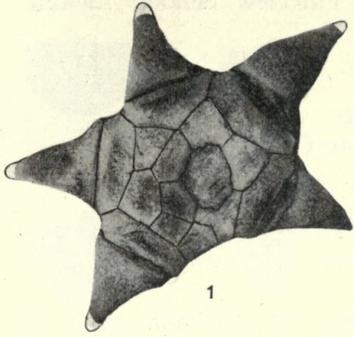
Horizon and locality.—Sharon member: Lick Run, Scioto County (Locality 2), r; east of Tattle Creek, Scioto County (Locality 6), c.

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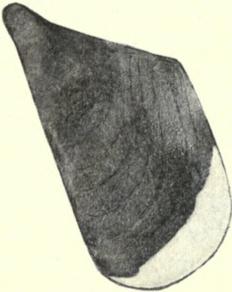
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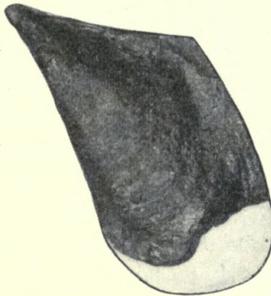
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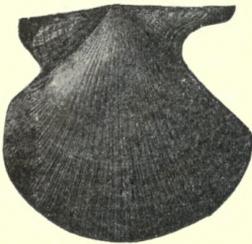
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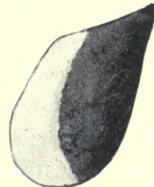
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VITA

I, Helen Morningstar, was born in Columbus, Ohio, on September 23, 1891. I attended the Columbus public schools and was graduated from East High School in June, 1909. In September, 1909, I entered the Ohio State University and graduated with the degree of Bachelor of Arts in June, 1913. In the same year I was elected to membership in the Phi Beta Kappa Society. During the years 1913 to 1915, I was a graduate assistant in the department of English at the Ohio State University, and in 1915 received the degree of Master of Arts, and was also elected a member of the Sigma Xi Society. The next two years, 1915 to 1917, I spent at Bryn Mawr College in the capacity of graduate Fellow and Scholar in Geology in study for the degree of Doctor of Philosophy, and in 1916 was awarded the President's European fellowship by the faculty of Bryn Mawr College. Work in the major subject, Paleontology, was carried on under the direction of Dr. Thomas C. Brown, while the associated minor, Petrology, was directed by Dr. Florence Bascom, and the independent minor, Biology, by Dr. David H. Tennent, to each of whom I wish to express my indebtedness for the kindly interest and aid given me throughout my course of study at Bryn Mawr College. Since 1917 I have been an instructor in the department of Geology at the Ohio State University.

My dissertation for the degree of Doctor of Philosophy entitled "The Fauna of the Pottsville Formation of Ohio below the Lower Mercer Limestone" was presented to the faculty of Bryn Mawr College on April 10, 1921. In the introduction acknowledgements have been made for the assistance which I have received during its preparation.

Makers
Syracuse, N. Y.
PAT. JAN 21, 1908

