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**PENNSYLVANIAN MARINE BIVALVIA
AND ROSTROCONCHIA OF OHIO**

by

Richard D. Hoare

Myron T. Sturgeon

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COLUMBUS

1979



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CONTENTS

	Page		Page
Chapter 1		Genus <i>Modiolus</i> Lamarck, 1799	32
Introduction	1	Genus <i>Promytilus</i> Newell, 1942	32
Location and extent of study area	1	Genus <i>Volsellina</i> Newell, 1942	32
Purpose and scope of investigation	1	Genus <i>Pteronites</i> M'Coy, 1844	33
Method of investigation	1	Genus <i>Myalina</i> de Koninck, 1842	33
Previous investigations	1	Genus <i>Septimyalina</i> Newell, 1942	34
Acknowledgments	2	Genus <i>Monopteria</i> Meek & Worthen, 1866	35
Chapter 2		Genus <i>Placopterina</i> Hoare, Sturgeon & Kindt, 1978	35
Stratigraphy	3	Genus <i>Leptodesma</i> Hall, 1883	35
Chapter 3		Genus <i>Dunbarella</i> Newell, 1937	36
Stratigraphic significance and paleoecology	11	Genus <i>Aviculopecten</i> M'Coy, 1851: emend. Newell, 1937	37
General	11	Genus <i>Acanthopecten</i> Girty, 1903	40
Pottsville Group	11	Genus <i>Annuliconcha</i> Newell, 1937	41
Allegheny Group	11	Genus <i>Clavicosta</i> Newell, 1937	41
Conemaugh Group	11	Genus <i>Fasciculiconcha</i> Newell, 1937	42
Interbasin comparisons	18	Genus <i>Limipecten</i> Girty, 1904	43
Life habits	18	Genus <i>Streblochondria</i> Newell, 1937	43
General	18	Genus <i>Streblopteria</i> M'Coy, 1851	44
Nuculoids	19	Genus <i>Chaenocardia</i> Meek & Worthen, 1869	45
Solemyoids	19	Genus <i>Euchondria</i> Meek, 1874	45
Arcoids	19	Genus <i>Pseudomonotis</i> von Beyrich, 1862	46
Mytilids	20	Genus <i>Posidonia</i> Bronn, 1828	48
Pinnids	20	Genus <i>Pernopecten</i> Winchell, 1865	48
Pteroids	20	Genus <i>Palaeolima</i> Hind, 1903	49
Monopterids	20	Genus <i>Schizodus</i> de Verneuil & Murchison, 1844	50
Pteriids	20	Genus <i>Permophorus</i> Chavan, 1954	52
Pectinids	21	Genus <i>?Pleurophorella</i> Girty, 1904	54
Trigonoids	22	Genus <i>Astartella</i> Hall, 1858	54
Veneroids	22	Genus <i>Cypricardina</i> Hall, 1859	56
Pholadomyoids	22	Genus <i>Edmondia</i> de Koninck, 1841	56
Rostroconchids	23	Genus <i>Cardiomorpha</i> de Koninck, 1841	58
Chapter 4		Genus <i>Prothyris</i> Meek, 1871	58
Systematic paleontology	24	Genus <i>Solenomorpha</i> Cockerell, 1903	59
Genus <i>Clinopistha</i> Meek & Worthen, 1870	24	Genus <i>Exochorhynchus</i> Meek & Hayden, 1864	59
Genus <i>Nuculopsis</i> Girty, 1911	24	Genus <i>Wilkingia</i> Wilson, 1959	59
Genus <i>Palaeoneilo</i> Hall & Whitfield, 1869	26	Genus <i>Sanguinolites</i> M'Coy, 1844	60
Genus <i>Paleyoldia</i> Lintz, 1958	26	Genus <i>Unklesbayella</i> Hoare, Sturgeon & Kindt, 1978	60
Genus <i>Phestia</i> Chernyshev, 1951	27	Genus <i>Pseudoconocardium</i> Zavodowsky, 1960	60
Genus <i>Solemya</i> Lamarck, 1818	29	References cited	62
Genus <i>Parallelodon</i> Meek & Worthen, 1866	30	Appendix—collecting localities	65
		Index	76

FIGURES

1. General distribution of collecting localities for Pennsylvanian marine bivalves and rostroconchs in eastern Ohio	2	4. Inferred life position of species of <i>Solemya</i>	19
2. Members present in a complete cyclothem in the Lower Pennsylvanian System in Ohio	4	5. Inferred life positions of species of <i>Parallelodon</i>	19
3. Inferred life positions of <i>Nuculopsis</i> ; <i>Palaeoneilo</i> ; <i>Paleyoldia</i> ; <i>Phestia</i>	19	6. Inferred life positions of <i>Modiolus</i> ; <i>Promytilus</i> ; <i>Volsellina</i>	19
		7. Lateral views of specimens of <i>Pteronites</i>	20
		8. Inferred life positions of <i>Septimyalina perattenu-</i>	

CONTENTS

	Page		Page
	20	21. Views of internal mold of <i>Phestia arata</i> (Hall) . . .	29
9. Inferred life positions of <i>Monopteria</i> ; <i>Leptodesma</i> ; <i>Placopterina</i>	21	22. Hinge line of left valve of <i>Parallelodon obsoletus</i> (Meek & Worthen)	30
10. Inferred life positions of <i>Aviculopecten</i> ; <i>Acanthopecten</i> ; <i>Streblochondria</i> ; <i>Pernopecten</i>	22	23. Interior view of left valve of <i>Aviculopecten columbianus</i> Hoare, Sturgeon & Kindt	40
11. Inferred life positions of <i>Posidonia</i> ; <i>Pseudomonotis</i>	22	24. Hinge line of left valve of <i>Chaenocardia ovata</i> Meek & Worthen	45
12. Inferred life positions of species of <i>Schizodus</i> . . .	22	25. Interior view of right valve of <i>Euchondria smithwickensis</i> ? Newell	46
13. Inferred life positions of <i>Cypricardinia</i> ; <i>Permophorus</i> ; <i>Astartella</i>	23	26. Hinge line of left valve of <i>Pseudomonotis millhorni</i> Hoare, Sturgeon & Kindt	47
14. Inferred life positions of <i>Wilkingia</i> ; <i>Edmondia</i> ; <i>Solenomorpha</i> ?; <i>Prothyris</i> ; <i>Cardiomorpha</i>	23	27. Hinge line of left valve and right valve of <i>Astartella concentrica</i> (Conrad)	54
15. Inferred life position of <i>Pseudoconocardium</i>	23	28. Interior views of left valve and right valve of <i>Astartella varica</i> McChesney	55
16. Views of internal mold of <i>Clinopistha laevis</i> Meek & Worthen	24	29. Hinge line of right valve and left valve of <i>Astartella newberryi</i> Meek	55
17. Views of internal mold of <i>Nuculopsis girtyi</i> Schenck	25	30. Hinge line of left valve and right valve of <i>Cypricardinia carbonaria</i> Meek	56
18. Views of internal mold of <i>Nuculopsis anodontoides</i> (Meek)	26	31. Hinge line of right valve of <i>Cardiomorpha missouriensis</i> Shumard	59
19. Views of internal mold of <i>Palaeoneilo oweni</i> (McChesney)	26	32. Hinge line of right valve and left valve of <i>Unklesbayella geinitzi</i> (Meek)	60
20. Views of internal mold of <i>Paleyoldia stevensoni</i> (Meek)	27		

TABLES

1. Lower Conemaugh, Allegheny, and Pottsville stratigraphic section	5	12. Measurements of species of <i>Dunbarella</i>	36
2. Stratigraphic distribution of the Pennsylvanian marine bivalves and rostroconchs in Ohio	12	13. Measurements of species of <i>Aviculopecten</i>	38
3. Comparison of the stratigraphic ranges of the Pectinacea and Mytilacea in the Appalachian, Eastern Interior, and Western Interior Basins . . .	18	14. Measurements of species of <i>Acanthopecten</i>	40
4. Measurements of species of <i>Nuculopsis</i>	25	15. Measurements of species of <i>Fasciculiconcha</i>	42
5. Measurements of <i>Palaeoneilo oweni</i> and <i>Paleyoldia stevensoni</i>	27	16. Measurements of species of <i>Streblochondria</i>	44
6. Measurements of species of <i>Phestia</i>	28	17. Measurements of <i>Streblopteria oklahomensis</i>	45
7. Measurements of species of <i>Solemya</i>	29	18. Measurements of <i>Chaenocardia ovata</i>	45
8. Measurements of species of <i>Parallelodon</i>	30	19. Measurements of species of <i>Euchondria</i>	46
9. Measurements of species of <i>Promytilus</i> and <i>Volsellina</i>	32	20. Measurements of species of <i>Pseudomonotis</i>	47
10. Measurements of species of <i>Myalina</i> and <i>Septimyalina</i>	34	21. Measurements of <i>Posidonia fracta</i>	48
11. Measurements of species of <i>Leptodesma</i>	35	22. Measurements of species of <i>Pernopecten</i>	49
		23. Measurements of species of <i>Palaeolima</i>	50
		24. Measurements of species of <i>Schizodus</i>	50
		25. Measurements of species of <i>Permophorus</i> and <i>?Pleurophorella</i>	52
		26. Measurements of species of <i>Astartella</i>	54
		27. Measurements of <i>Cypricardinia carbonaria</i>	56
		28. Measurements of species of <i>Edmondia</i>	57

CONTENTS

PLATES

	Following page
1. <i>Clinopistha</i> , <i>Nuculopsis</i> , <i>Paleyoldia</i> , and <i>Palaeoneilo</i>	77
2. <i>Phestia</i> , <i>Solemya</i> , and <i>Parallelodon</i>	77
3. <i>Parallelodon</i> , <i>Modiolus</i> , <i>Promytilus</i> , and <i>Volsellina</i>	77
4. <i>Pteronites</i> and <i>Myalina</i>	77
5. <i>Myalina</i> and <i>Septimyalina</i>	77
6. ? <i>Monopteria</i> , <i>Placopterina</i> , <i>Leptodesma</i> , and <i>Dunbarella</i>	77
7. <i>Aviculopecten</i>	77
8. <i>Aviculopecten</i> , <i>Acanthopecten</i> , <i>Clavicosta</i> , and <i>Annuliconcha</i>	77
9. <i>Fasciculiconcha</i> , <i>Limipecten</i> , and <i>Streblochondria</i>	77
10. <i>Streblochondria</i> , <i>Streblopteria</i> , <i>Chaenocardia</i> , <i>Euchondria</i> , and <i>Pseudo-</i> <i>monotis</i>	77
11. <i>Pseudomonotis</i> , <i>Posidonia</i> , <i>Pernopecten</i> , and <i>Palaeolima</i>	77
12. <i>Palaeolima</i> and <i>Schizodus</i>	77
13. <i>Schizodus</i> and <i>Permophorus</i>	77
14. <i>Permophorus</i> , ? <i>Pleurophorella</i> , and <i>Astartella</i>	77
15. <i>Astartella</i> , <i>Edmondia</i> , and <i>Cypricardinia</i>	77
16. <i>Edmondia</i> , <i>Cardiomorpha</i> , <i>Prothyris</i> , <i>Exochorhynchus</i> , <i>Solenomorpha</i> ?, <i>Sanguinolites</i> , and <i>Wilkingia</i>	77
17. <i>Pseudoconocardium</i> and <i>Pteronites</i>	77
18. <i>Pseudoconocardium</i> , <i>Parallelodon</i> , <i>Permophorus</i> , and <i>Unklesbayella</i> ...	77

Chapter 1

INTRODUCTION

LOCATION AND EXTENT OF STUDY AREA

The present study concerns the marine bivalves, until recently called pelecypods or lamellibranchs, and rostroconchs which are present in the marine units of the Pennsylvanian System in Ohio. The marine units are exposed in the eastern part of the state in an area extending from Lawrence County in the south to Lake County in the north (fig. 1). This area includes parts or all of 33 counties and covers an area of more than 11,000 square miles.

With the exception of one sample from West Virginia, collections from neighboring states were not made. Differences in environments are indicated in the marine units, and differences in faunal composition and distribution may be expected in areas outside of Ohio within the Appalachian Basin. The Pennsylvanian rocks in Ohio lie on the western margin of the Pennsylvanian System rocks and form part of the Appalachian Plateaus of the central Appalachian Mountains.

PURPOSE AND SCOPE OF INVESTIGATION

The major purpose of this investigation is to determine the stratigraphic distributions of marine bivalve and rostroconch faunas. It is hoped that this information will provide a broader base for the correlation of stratigraphic units in the Pennsylvanian System in Ohio; such knowledge will, in turn, aid in the research and development of the economic resources contained in these strata.

Secondarily, an attempt is made to interpret the paleoecologic relationships of many of the species present. This portion of the study is based upon the relationship between shell form and life habits of bivalves, on lithology, and to some extent on mode of occurrence.

Further, it is hoped that this information will help to complete our knowledge of the evolution of marine bivalves and rostroconchs and of their geographic occurrences. Continued collecting and study will supplement the information given here, and a more complete paleoecological picture will be possible after a number of other fossil groups are studied.

METHOD OF INVESTIGATION

Pennsylvanian invertebrate fossils which have been collected over the past 35 years and stored at Ohio University form the major basis for this investigation. These collections contain over 9,500 specimens of marine bivalves and rostroconchs from 258 localities in the Pottsville, Allegheny, and Conemaugh Groups of the Pennsylvanian System in Ohio (appendix). In numerous cases more than one collection was made from a particular locality.

For comparative purposes type specimens and other

specimens have been borrowed from a number of institutions and individuals. Specimens collected previously in Ohio were used where they were available. A large number of specimens in the collection are so poorly preserved that specific, and in some cases generic, identification was impossible.

Stratigraphic distributions of the forms present were compiled mainly on the basis of the specimens in the collections under study for this report. Occurrences reported by previous investigators are included in table 2. In many cases the specimens from these studies are no longer available, and it was impossible to confirm identifications. Differences in systematic nomenclature between present and previous usage have been reconciled where possible.

All illustrated specimens have been placed in the repository of Orton Museum at The Ohio State University. These specimens are designated by OSU numbers. The bulk of the collections will be housed at Ohio University, with a representative collection stored at Bowling Green State University.

The relative abundance of occurrence of specimens is: rare—4 or fewer; common—5-14; abundant—15 or more. Systematic designations above generic rank have been omitted. Recent classifications as given by Newell (1965), Newell (*in* Moore, 1969), and Pojeta and others (1972) may be consulted for taxonomic designations above the generic level.

PREVIOUS INVESTIGATIONS

There has not been a comprehensive study made concerning the Pennsylvanian bivalves in Ohio or in the Appalachian Basin. Most of the earlier reports deal with relatively few forms or with those forms present in specific units or groups.

The earliest known report is that of Morton (1836), who described a few species in an appendix to Hildreth's report on the bituminous coal deposits in the Ohio Valley. Stevens (1858) described four species from the Brush Creek unit; these species were later restudied by Murphy (1967). Several species described by Meek (1875) were collected mainly from the Lower Coal Measures near Newark, Licking County, and Putnam Hill, Muskingum County. Whitfield (1893) described one species from the Lower Coal Measures in Hocking County. In 1887 Herrick included descriptions and illustrations of 51 species in his discussion of the geology of Licking County.

Mark (1910) made the first systematic study in her report on the Mercer limestone. Later (1912), she studied the faunas of the Conemaugh Group, giving a comprehensive listing of the faunas present and describing 16 species. Morningstar (1922), in her study of the Pottsville faunas, described and illustrated most forms present in the Pottsville

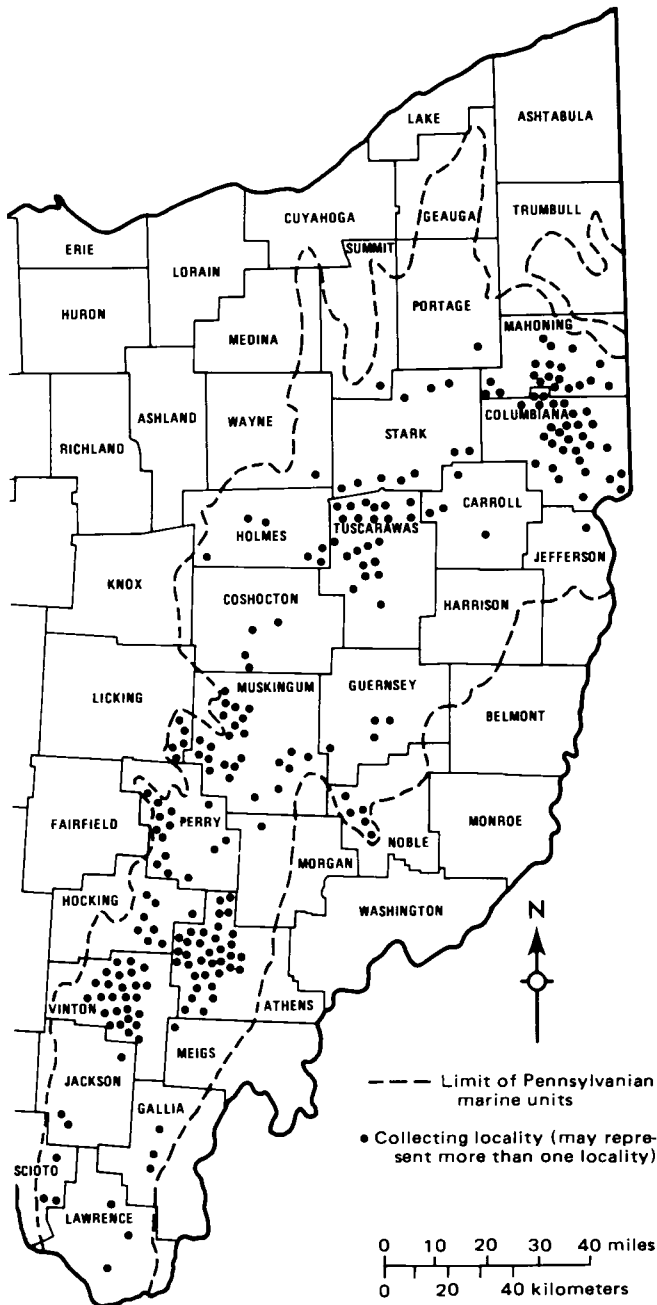


FIGURE 1.—General distribution of collecting localities for Pennsylvanian marine bivalves and rostroconchs in eastern Ohio.

and lower Allegheny Groups; 75 species and varieties of bivalves were included. In the 1930's Sturgeon (1933, 1936) began his studies of the stratigraphy and faunas of the Allegheny Group. Although not concentrated on the bi-

valves, the collections accumulated since this time form the primary basis for the present study. Laird (1937) presented a list of the faunas present in the Portersville unit in Muskingum County. Taber (1951) described the faunas of the Vanport unit in Ohio. Murphy (1965, 1966, 1967) discussed several forms, primarily from the upper Allegheny and Conemaugh Groups. Driscoll (1966), in his study of nuculids from the mid-continental United States, used and described some forms from the Pennsylvanian of Ohio. Updegraff (1967) described the bivalves of the Brush Creek unit. Hoare and Sturgeon (1975) described the stratigraphic distribution of the Pennsylvanian nuculoid bivalves in Ohio and Hoare, Sturgeon, and Kindt (1978) described new genera and species of bivalves and occurrences of *Pseudonocardium* from the Pennsylvanian of Ohio.

In addition to the reports dealing with the occurrences of various Pennsylvanian bivalves in Ohio, there are several authors whose publications contain references to these organisms in rocks of the same age elsewhere in the Appalachian Basin. Among these are E. T. Cox (1857); Raymond (1910), who discussed and illustrated some of the Allegheny and Conemaugh faunas of western Pennsylvania; Price (1914, 1916a, b, 1920), who discussed the Pennsylvanian geology of West Virginia and listed and described some of the invertebrate faunas; W. C. Morse (1931), who described the Pennsylvanian invertebrates of Kentucky; Lintz (1958), who listed and described the invertebrate faunas of the Ames and Brush Creek units of Maryland; and Williams (1960), who discussed the marine and freshwater fossiliferous units of the Pottsville and Allegheny Groups in western Pennsylvania, listed the faunas present, and illustrated some of them. Other publications describing the geology of the Appalachian Basin outside Ohio include lists of invertebrates present in the Pennsylvanian units.

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Chapter 2

STRATIGRAPHY

Brackish-water and marine fossils are known in approximately 25 members of the lowest three stratigraphic groups (Pottsville, Allegheny, and Conemaugh) of the Pennsylvanian System in Ohio (table 1). None are definitely known in the upper part of the Conemaugh Group or in the overlying Monongahela Group. Cross and Schemel (1956, p. 38) have, however, reported brackish-water fossils in Monongahela strata of West Virginia.

The members bearing brackish-water and marine fossils are quite diversified in lithology. They range from calcareous limestones to shaly, flinty, and/or ferruginous limestones; from flints to calcareous, shaly, and/or ferruginous flints; from black carbonaceous shales to gray, calcareous, and clayey and/or silty shales; and include even clay ironstones.

These fossiliferous beds are normally only a few inches to several feet thick, but several limestones are 15 to 20 or more feet thick and in places fossiliferous shales are 30 or more feet in thickness. The fossiliferous beds are distributed at more or less regular intervals through more than 700 feet of strata. Figures derived mostly from the generalized geologic section of Ohio rocks (Stout, 1930, 1943, 1947) indicate that brackish-water and marine fossiliferous members have a total thickness of 63 feet and an average individual thickness of 30 inches and that the coals over which those members normally lie average roughly 20 feet apart. These data reveal also that brackish-water and marine beds comprise approximately 9 percent of the total thickness, and published reports disclose that the greater amount of this thickness is marine. It should be remembered that the above figures are only averages, and that in the field actual thicknesses may differ considerably for different portions of the section and at different geographic localities for the same parts of the section. Furthermore, thickness figures for most brackish-water and marine members are undoubtedly too small. At many localities a considerable thickness of fossiliferous shale overlies the limestone unit, and these fossiliferous shales have been overlooked in many places. Hence many recorded stratigraphic sections do not show the complete thickness of the shales. It is likely that most fossil collections have been made from the limestones and from the more conspicuously fossiliferous shales adjacent to the limestones.

It was long ago recognized that in many areas Pennsylvanian strata were repeated vertically in a definite sequence. J. M. Weller (1930, p. 102) proposed the term cyclothem for a single succession, and many geologists have since used that term. Sturgeon and others (1958, p. 39-42), summarized some features and problems of the cyclothem concept, and parts of that summary follow:

Pennsylvanian and Permian strata at many localities were deposited under a more or less regular succession of varying

environmental conditions that was repeated many times during those periods. As a result certain definite succession of strata represents one succession of changing sedimentary conditions, and each sequence of strata matching one depositional cycle is now called a cyclothem

Cyclothem differ somewhat from one region to another and in different parts of the stratigraphic section in the same region. An ideal or typical cyclothem in Kansas is somewhat different from one in Illinois, which in turn differs in detail from one in Pennsylvania. Stout (1931, p. 197-202) pointed out that in Ohio cyclothem of the lower Pennsylvanian (Pottsville and lower Allegheny) vary from those in the middle Pennsylvanian (upper Allegheny and lower and middle Conemaugh), and that cycles of the upper Pennsylvanian (upper Conemaugh and Monongahela) and Permian (Dunkard) are more or less alike but differ from [typical upper Pennsylvanian and Permian cyclothem described by Cross and others (1950, p. 99-100)]. Hence, any ideal cyclothem must be selected arbitrarily and pertain to a selected locality or part of the stratigraphic column and, for the lower Pennsylvanian in Ohio, is usually considered to include the [members shown in figure 2].

. . . In Ohio the more complete cyclothem of the upper Allegheny and lower and middle Conemaugh series approach an ideal cyclothem in completeness. Cyclothem below the Middle Kittanning cyclothem lack fresh water limestones and those above the Skelley limestone lack marine members with the exception of thin inconspicuous brackish limestones and shales

Cyclothem that occur in the upper Conemaugh, Monongahela, and Dunkard series of Athens County are characterized locally, in part, by a facies of red and variegated shales and mudstones (Arkle, 1953, p. 2-8) (collectively called redbeds in this report), either bedded or massive; by thick nodular, bedded, or massive limestones, often earthy or marly; by sandstones locally reduced in coarseness and thickness; and by very thin coals and underclays. In fact, the underclays are at many localities less than an inch thick, and the coals may be represented by a mere sooty or carbonaceous film on top of the underclay. Discovery and recognition of these thin coals and underclays in field work is not as difficult as one might anticipate since the red shales and mudstones below those horizons are massive and break irregularly with a starch-like fracture, and those above are bedded and fissile and can be split parallel to bedding into flakes or sheets. Fossil clams, clam-like estherids (shelled crustaceans), and plants also occur, but not universally, in the bedded rocks just over the coal horizons (Arkle, 1953, p. 4). No dark limestones containing brackish water fossils have been recognized in Athens County.

Lateral or facies change in cyclothem from one region to another and the vertical differences among cyclothem in the same region offer numerous challenges in correlation of strata and for interpretation of origin. Thickness and degree of completeness of different cyclothem vary widely; for example, the Bolivar cyclothem is incomplete and thin, while the underlying Lower Freeport cyclothem is nearly complete and much thicker. Member beds fluctuate in thickness even to the extent of pinching out completely, or vary in character from one rock type to another in short horizontal distances. Hence a cyclothem, when traced laterally, can show thickening or thinning of individual members or in its entire thickness, gain or lose members, change widely in its lithologic characteristics, appear or disappear, or exhibit features that render

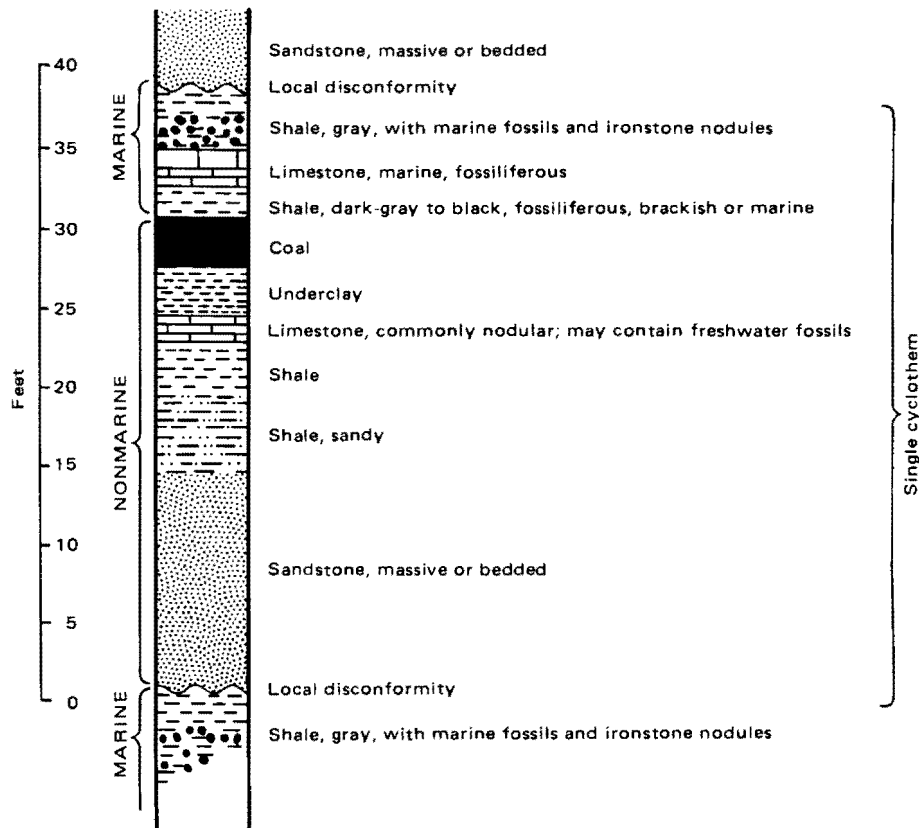


FIGURE 2.—Members present in a complete cyclothem in the Lower Pennsylvanian System in Ohio (from Sturgeon and others, 1958).

correlation difficult. On the other hand, the lateral extent of certain members and their features, such as the nodular and shaly lithology (physical characteristics) of the Portersville limestone or the persistent partings in the Middle Kittanning (No. 6) coal can be surprisingly widespread. In spite of all inconsistencies it is possible to trace and to correlate members and cyclothem across geographic areas ranging from townships or less to states or larger in size

Flint (1951) and Merrill (1950) have named Ohio cyclothem, with both uniformly and differently named members, from their coal members, and that method is used in this report

A typical cyclothem is partly marine and partly nonmarine, and the cyclothem boundary can most logically be placed between marine and nonmarine beds — at the top of the coal or at the base of the sandstone. Although by no means perfect, the boundary at the coal's roof has several cogent points in its favor, and were it not for long established and often illogical use of member names, that limit for cyclothem would have been employed in this report. The top of the coal, or in the absence of the coal the top of the underclay, is one of the more easily found and recognized planes of separation in an entire cyclothem. Coal and/or underclay or any overlying marine member are more persistent in regional extent and therefore are most useful for purposes of correlation. In cyclothem containing marine members this plane

marks the separation of the underlying nonmarine rocks from the overlying marine rocks more certainly than the boundary above or below where marine rocks are succeeded upward by nonmarine ones. Furthermore, coal, underclay, and marine limestones are valuable mineral resources and hence are desirable units for mapping purposes in preparation of geologic, economic, and structural maps.

Table 1 is modified from that part of Stout's generalized stratigraphic section for Ohio between the Harrison ironstone at the base of the Pennsylvanian System and the Skelley limestone high in the Conemaugh Group. These two members mark the lower and upper limits of known brackish-water and marine fossils in the Pennsylvanian strata of Ohio. Additions and changes to Stout's section include new and revised stratigraphic names, including names for four additional marine members, boundaries as well as names for all cyclothem, and minor changes in lithologic descriptions published since Stout's work. This table is not intended to be a final revision of this part of the Pennsylvanian section exposed in Ohio.

STRATIGRAPHY

TABLE 1.—Lower Conemaugh, Allegheny, and Pottsville stratigraphic section¹

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Conemaugh	Duquesne	Skelley	Limestone, fossiliferous, marine, local; bedded and similar to Ames limestone or nodular and ferruginous in shale		4	20	7
		Duquesne	Coal, shaly, thin, local		1		
			Underclay, local	1	6		
			Limestone, nodular, freshwater	1	8		
			Redbed, calcareous, local	6	0		
	Lower Grafton	Shale and/or sandstone	11	0			
	Gaysport	Gaysport	Limestone, nodular or bedded, sandy, fossiliferous, marine	1	0	17	0
			Shale and/or sandstone; locally fossiliferous marine shale	16	0		
	Ames	Ames	Limestone, light-gray, semicrystalline, bedded, massive, fossiliferous, marine, persistent; in many places greenish or pinkish	1	6	16	9
			Coal, shaly, thin, local		3		
			Underclay and clay shale, persistent; composition differing from place to place	1	0		
			Shale and/or sandstone, persistent	14	0		
	Harlem	Harlem	Coal, shaly, persistent	1	0	30	6
			Underclay, siliceous	2	0		
		Rock Riffle	Limestone, nodular, freshwater, local	4	6		
		Round Knob	Redbed, varicolored, calcareous	12	0		
		Saltsburg	Shale and/or sandstone	11	0		
	Upper Bakerstown	Upper Bakerstown	Coal, local	1	0	26	0
			Underclay and clay shale	4	0		
		Ewing	Limestone, gray to bluish-gray, ferruginous, nodular, nonmarine	1	0		
		Cow Run	Shale and/or sandstone; sandstone locally massive	20	0		
	Anderson	Portersville	Shale and limestone, gray to black, fossiliferous, marine; soft to ferruginous shale with dark nodular limestone	2	0	27	2
		Anderson	Coal, thin, persistent	1	8		
			Underclay, calcareous, ferruginous, shaly, persistent	3	0		
		Bloomfield	Limestone, gray, nodular, fossiliferous, nonmarine, local	1	6		
		Bakerstown	Shale and/or sandstone; sandstone locally massive	19	0		

PENNSYLVANIAN MARINE BIVALVIA AND ROSTROCONCHIA OF OHIO

TABLE 1.—Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued

Group	Cyclothem	Unit	Description	Thickness				
				Unit		Cycle		
				Ft	In	Ft	In	
Conemaugh	Wilgus	Cambridge	Limestone, fossiliferous, marine, persistent; widely varied in color, composition, and lithology	4	0	32	8	
		Wilgus	Wilgus	Coal, nonpersistent; locally mineable in southern Ohio	2			0
				Underclay, shaly, local	3			8
		Buffalo	Shale and/or sandstone; sandstone locally massive	23	0			
	Brush Creek	Brush Creek		Limestone and shale, fossiliferous, marine, persistent; north of Muskingum County, mostly black sandy shale with nodules and lenses of dark limestone; locally southward as two beds of cherty and ferruginous limestone	20	0	40	4
				Coal, thin, local		4		
				Underclay and clay shale, varicolored	10	0		
				Shale and/or sandstone	10	0		
	Mason	Mason		Shale, dark, fossiliferous, marine, local	5	0	30	0
				Coal, local		6		
				Underclay, local	2	6		
		Upper Mahoning		Redbed, varicolored, local	12	0		
				Shale and/or sandstone; sandstone locally massive	10	0		
	Mahoning	Mahoning	Coal, mostly thin; locally mineable in northeastern Ohio	1	0	42	0	
		Thornton	Underclay, nonpersistent	5	0			
		Lower Mahoning		Limestone, gray to bluish-gray, ferruginous, fossiliferous, nonmarine, nonpersistent; nodular and embedded in clay	2			0
				Redbed, varicolored, local	9			0
				Shale and/or sandstone; sandstone locally massive	25			0
	Allegheny	Upper Freeport		Shale, black, carbonaceous, fossiliferous, brackish-water, local		4	29	4
Upper Freeport				Coal No. 7, nonpersistent, locally thick and mineable	3	0		
				Underclay and shale	7	0		
				Limestone and marly shale, fossiliferous, nonmarine, local	2	0		
				Shale and/or sandstone; with ferruginous zones	17	0		
Bolivar		Bolivar		Coal, thin, local		3	18	6
				Underclay, flint and plastic, rather persistent	5	0		
		Shawnee	Limestone, bedded or nodular, locally ferruginous, fossiliferous, nonmarine, local	1	3			
		Bolivar	Shale and/or sandstone	12	0			

STRATIGRAPHY

TABLE 1.—Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Allegheny	Lower Freeport	Dorr Run	Shale, dark-gray to black, carbonaceous, fossiliferous, marine, local	1	9	31	3
		Lower Freeport	Coal No. 6A, patchy, locally thick and mineable	1	0		
			Underclay	2	6		
			Limestone, nodular, fossiliferous, nonmarine, local	1	0		
			Shale and/or sandstone; sandstone locally thick	25	0		
	Upper Kittanning	Upper Kittanning	Coal, present in only a few places	1	0	11	10
			Underclay, local		10		
			Shale and/or sandstone	10	0		
	Middle Kittanning	Washingtonville	Shale, gray to black, carbonaceous, fossiliferous, marine, rather persistent; in east-central and northeastern Ohio only	4	0	22	0
		Middle Kittanning	Coal No. 6, mineable, persistent	4	0		
			Underclay, siliceous, persistent	3	6		
		Leetonia	Limestone, bedded or nodular, fossiliferous, nonmarine, local		6		
		Middle Kittanning	Shale and/or sandstone	10	0		
	Strasburg	Tuscarawas	Shale, dark-gray, fossiliferous, marine, local	1	6	9	0
		Strasburg	Coal, thin, local		6		
		Oak Hill	Underclay, flint and plastic, rather persistent	4	0		
		Strasburg	Shale and/or sandstone	3	0		
	Lower Kittanning	Columbiana	Shale and nodular limestone, gray, fossiliferous, marine, rather persistent; in east-central and northeastern Ohio only	4	0	14	4
		Lower Kittanning	Coal No. 5, mineable, persistent	2	4		
			Underclay, persistent	5	0		
			Shale and/or sandstone, nonpersistent	3	0		
	Lawrence	Lawrence	Coal, shaly, local		4	14	6
			Underclay, flint and plastic, persistent	6	0		
			Shale and/or sandstone	8	2		
	Scrubgrass	Ferriferous	Ironstone, clay ironstone, and limonite, fossiliferous, marine, local		8	12	2
		Vanport	Limestone, flint, and shale, fossiliferous, marine	6	0		
		Scrubgrass	Coal, present in only a few places		6		
			Shale and/or sandstone	5	0		
Clarion	Clarion	Coal No. 4A, patchy, locally mineable	4	0	19	6	
		Underclay, flint and plastic	5	0			
	Canary	Ironstone, nodular; in southern Ohio only, local		6			
	Clarion	Shale and/or sandstone; sandstone locally massive	10	0			

PENNSYLVANIAN MARINE BIVALVIA AND ROSTROCONCHIA OF OHIO

TABLE 1.—Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued

Group	Cyclothem	Unit	Description	Thickness						
				Unit		Cycle				
				Ft	In	Ft	In			
Allegheny	Winters	Winters	Coal; in Jackson and Vinton Counties, local	1	0	5	0			
			Underclay, generally absent	4	0					
	Ogan	Zaleski	Zaleski	Flint and limestone, dark-gray to black, locally shaly or ferruginous, fossiliferous, marine; in Jackson and Vinton Counties, local	1	0	29	0		
				Ogan	Ogan	Coal; in Jackson and Vinton Counties, local			1	0
		Underclay; in Jackson and Vinton Counties, local	2			0				
		Shale and/or sandstone	25	0						
	Brookville	Putnam Hill	Putnam Hill	Limestone and shale, gray, quite persistent; in southern and northeastern Ohio only	4	0	22	0		
				Brookville	Brookville	Coal No. 4, persistent			4	0
		Underclay, plastic, persistent	4			0				
		Homewood	Homewood	Shale and/or sandstone; sandstone locally massive	10	0				
Pottsville	Tionesta	Tionesta	Coal, thin, local	1	0	30	0			
			Underclay, plastic, persistent	5	0					
			Shale and/or sandstone; sandstone locally massive	24	0					
	Bedford	Big Red Block	Big Red Block	Ironstone, blocky clay ironstone, and/or limonite, sparingly fossiliferous, marine, local		4	13	0		
				Upper Mercer	Upper Mercer	Limestone and/or flint and shale, dark-bluish-gray to black, fossiliferous, marine			1	8
		Bedford	Bedford			Coal, patchy			1	0
						Underclay, siliceous			3	0
		Shale and/or sandstone	7	0						
	?	Sand Block	Sand Block	Ironstone, blocky or nodular, locally fossiliferous, marine; siliceous clay ironstone or limonite; in southern Ohio only, local		6	4	0		
				Shale and/or sandstone	3	6				
Upper Mercer	Upper Mercer	Upper Mercer	Coal No. 3A, local	1	0	15	0			
			Underclay, siliceous, plastic	3	0					
			Shale and/or sandstone	11	0					
Middle Mercer	Little Red Block	Little Red Block	Ironstone, nodular clay ironstone, and limonite, sparingly fossiliferous; in southern Ohio only, local		3	13	0			
			?	?	Shale, siliceous			1	9	
	Lower Mercer	Lower Mercer	Lower Mercer	Limestone and shale; dark-bluish-gray to black limestone and shaly limestone, locally ferruginous or siliceous; similarly colored shale, very fossiliferous, marine, very persistent	2			0		
				Middle Mercer	Middle Mercer			Coal, thin, persistent		6
	Underclay, siliceous, plastic	3	6							
	Shale and/or sandstone	5	0							

PENNSYLVANIAN MARINE BIVALVIA AND ROSTROCONCHIA OF OHIO

TABLE 1.—*Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued*

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Pottsville	Sharon	Sharon	Ironstone and shale, buff to brown, siliceous, fossiliferous, marine; soft ironstone or dark-gray shale		3	25	0
			Shale, siliceous	4	9		
			Coal, patchy, locally mineable	3	0		
			Underclay, siliceous	2	0		
			Shale, siliceous, nonpersistent	5	0		
			Conglomerate and/or sandstone, local; locally 100 ft or more thick	10	0		
Harrison	Harrison	Ironstone, buff to red, limonitic, siliceous, coarse, fossiliferous, marine, local		6		6	

¹The stratigraphic nomenclature in this table does not necessarily agree with current usage of the Division of Geological Survey.

Chapter 3

STRATIGRAPHIC SIGNIFICANCE AND PALEOECOLOGY

GENERAL

The marine units in the Pennsylvanian System in Ohio contain an abundance of bivalves and rare rostroconchs; there are over 9,500 specimens in our collections. The thick sequences of nonmarine sediments between the relatively thin marine units and the marginal marine nature of some of these units have limited the variety of marine bivalves present. Many of the bivalve forms present range widely through the stratigraphic section. A number of forms appear to be restricted stratigraphically as noted below. The stratigraphic distributions are based primarily upon the present study; in some cases, where the taxonomic and stratigraphic designations are known to be valid, the work of other authors has been included. Table 2 illustrates the stratigraphic distribution of all bivalves in the Ohio Pennsylvanian. The nonmarine units are not included in the stratigraphic sequence in table 2 nor are the units to scale. The ranges marked by dashed lines are uncheckable occurrences reported by other authors.

POTTSVILLE GROUP

The following forms appear to be restricted to the Pottsville Group:

Phestia bellistriata prolongata (Morningstar)
Modiolus (M.) radiatus Hoare, Sturgeon & Kindt
Septimyalina orthonota? (Mather)
?Monopteria subalata Beede & Rogers
Placopterina ohioensis Hoare, Sturgeon & Kindt
Aviculopecten coxanus Meek & Worthen
Fasciculiconcha scalaris (Herrick)
Pseudomonotis carbonaria (Meek & Worthen)
Schizodus acuminatus Hoare, Sturgeon & Kindt
Permophorus spinulosa (Morningstar)
?Pleurophorella sesquiplicata Price
Edmondia meekiana (Herrick)

The following forms are found primarily in the Pottsville Group but range into the Putnam Hill and Vanport units in the lowest portion of the Allegheny Group:

Promytilus pottsvillensis Hoare, Sturgeon & Kindt
Leptodesma (L.) ohioense (Herrick)
Aviculopecten halensis? Mather
Aviculopecten germanus Miller & Faber
Aviculopecten sorer Herrick
Aviculopecten appalachianus Hoare, Sturgeon & Kindt
Fasciculiconcha providencensis (Cox)
Streblochondria hertzeri (Meek)
Schizodus cuneatus Meek

Schizodus amplus Meek & Worthen
Pseudoconocardium parrishi (Worthen)

ALLEGHENY GROUP

The following forms appear to be restricted to the Allegheny Group:

Volsellina subelliptica (Meek)
Aviculopecten columbianus Hoare, Sturgeon & Kindt
Acanthopecten bellosum Hoare, Sturgeon & Kindt
Chaenocardia ovata Meek & Worthen
Euchondria smithwickensis? Newell
Pseudomonotis precursor Mather
Pseudomonotis millhorni Hoare, Sturgeon & Kindt
Cardiomorpha missouriensis Shumard
Pseudoconocardium missouriensis (Girty)
Parallelodon delicatus (Meek & Worthen)

CONEMAUGH GROUP

The following forms appear to be restricted to the Conemaugh Group:

Parallelodon tenuistriatus (Meek & Worthen)
Parallelodon sangamonensis? (Worthen)
Pteronites americana (Meek)
Pteronites peracuta (Shumard)
Myalina (O.) subquadrata? Shumard
Myalina (M.) meeki? Dunbar
Leptodesma (L.) sulcata? (Geinitz)
Leptodesma (L.) longa (Geinitz)
Aviculopecten occidentalis (Shumard)
Aviculopecten arctisulcatus Newell
Aviculopecten bascilicus? Newell
Acanthopecten meeki Newell
Limipecten sp.
Streblopteria oklahomensis Newell
Pernopecten prosseri (Mark)
Schizodus wheeleri (Swallow)
Permophorus costatiformis (Meek & Worthen)
Edmondia anodontoides (Meek)
Edmondia aspinwallensis? Meek
Edmondia nodulifera Hoare, Sturgeon & Kindt
Permophorus occidentalis (Meek & Hayden)

The following are found mainly in the Conemaugh Group but range down into the upper Allegheny Group:

Streblochondria stantonensis Newell
Palaeolima triplistriata (Stevens)
Euchondria ohioensis (Mark)

TABLE 2.—Stratigraphic distribution of the

Group	Marine units	Species									
Washington	Washington shale										
	(no definite marine units)										
Monongahela	Skelley limestone and shale										
	Gaysport limestone and shale										
	Ames limestone and shale										
	Portersville shale and limestone										
	Cambridge limestone and shale										
	Upper Brush Creek limestone and shale										
	Lower Brush Creek limestone and shale										
Conemaugh	Mason shale										
	(unnamed shale)										
	Dorr Run shale										
	Washingtonville shale										
	Tuscarawas shale										
Allegheny	Columbiana shale and limestone										
	Vanport limestone, flint, and shale										
	Zaleski flint, limestone, and shale										
	Putnam Hill limestone and shale										
Pottsville	Upper Mercer flint, limestone, and shale										
	Sand Block ironstone										
	Lower Mercer ironstone										
	Lower Mercer limestone and shale										
	Boggs limestone, flint, and ironstone										
	Lowellville or Poverty Run limestone and shale										
	Bear Run shale										
	Quakertown shale										
	Anthony shale										
	Sharon ironstone										
Harrison ironstone											

— Range based upon extant specimens
 - - - Range previously reported but uncheckable

Pennsylvanian marine bivalves and rostrocorchids in Ohio¹

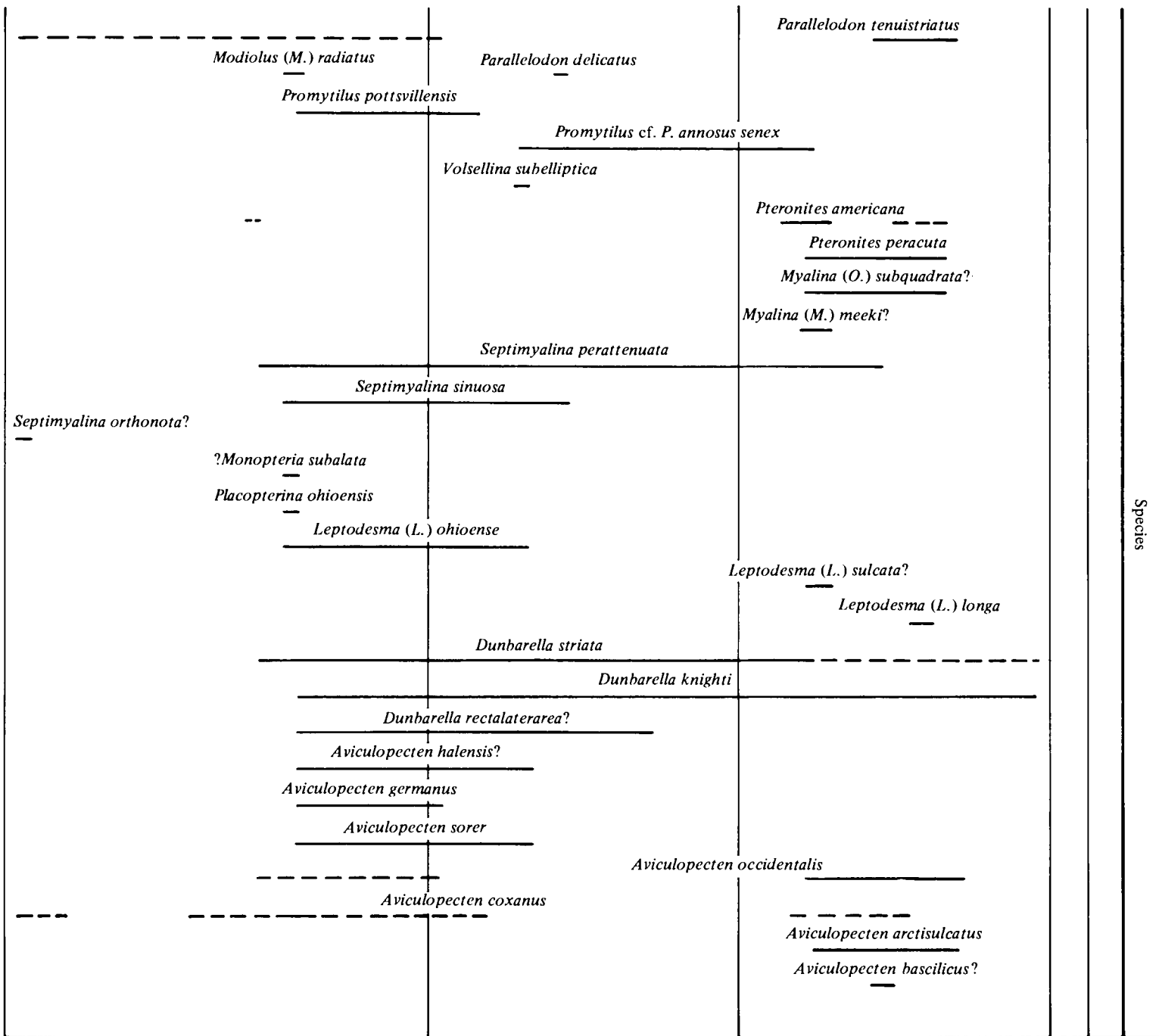


TABLE 2.—Stratigraphic distribution of the

Group	Marine units	Species									
Washington	Washington shale										
	(no definite marine units)										
Monongahela	Skelley limestone and shale										
	Gaysport limestone and shale										
	Ames limestone and shale										
	Portersville shale and limestone										
	Cambridge limestone and shale										
	Upper Brush Creek limestone and shale										
	Lower Brush Creek limestone and shale										
Conemaugh	Mason shale										
	(unnamed shale)										
	Dorr Run shale										
	Washingtonville shale										
Allegheny	Tuscarawas shale										
	Columbiana shale and limestone										
	Vanport limestone, flint, and shale										
	Zaleski flint, limestone, and shale										
	Putnam Hill limestone and shale										
Pottsville	Upper Mercer flint, limestone, and shale										
	Sand Block ironstone										
	Lower Mercer ironstone										
	Lower Mercer limestone and shale										
	Boggs limestone, flint, and ironstone										
	Lowellville or Poverty Run limestone and shale										
	Bear Run shale										
	Quakertown shale										
	Anthony shale										
	Sharon ironstone										
	Harrison ironstone										

Aviculopecten columbianus
Aviculopecten appalachianus
Acanthopecten carboniferous
Acanthopecten meeki
Acanthopecten hellosum
Annuliconcha interlineata
Clavicosta echinata?
Fasciculiconcha scalaris
Fasciculiconcha providencensis
Clavicosta sp.
Limipecten sp.
Streblochondria stantonensis
Streblochondria hertzeri
Streblochondria tenuilineata
Streblopteria oklahomensis

STRATIGRAPHIC SIGNIFICANCE AND PALEOECOLOGY

Pennsylvanian marine bivalves and rostroconchs in Ohio—Continued

		Species	
	<i>Chaenocardia ovata</i>	<i>Euchondria ohioensis</i>	
		<i>Euchondria levicula</i>	
		<i>Euchondria smithwickensis?</i>	
	<i>Pseudomonotis carbonaria</i>		--
	<i>Pseudomonotis precursor</i>	<i>Pseudomonotis millhorni</i>	
		<i>Pseudomonotis</i> spp.	-----
	<i>Posidonia fracta</i>		-----
		<i>Pernopecten ohioensis</i>	-----
		<i>Pernopecten attenuatus</i>	
			<i>Pernopecten prosseri</i>
		<i>Palaeolima retifera</i>	
			<i>Palaeolima triplistriata</i>
	<i>Schizodus cuneatus</i>		-----
			<i>Schizodus wheeleri</i>
	<i>Schizodus amplus</i>		-----
	<i>Schizodus affinis</i>		-----
--	<i>Schizodus subcircularis</i>		
--	<i>Schizodus acuminatus</i>		
		<i>Permophorus tropidophorus</i>	-----
		<i>Permophorus immaturus</i>	
	<i>Permophorus spinulosa</i>		<i>Permophorus occidentalis</i>
		<i>Permophorus oblongus</i>	-----
		<i>Permophorus costatiformis</i>	
	? <i>Pleurophorella sesquiplicata</i>		
		<i>Astartella concentrica</i>	
		<i>Astartella varica</i>	

INTERBASIN COMPARISONS

Too little systematic stratigraphic work has been done on the bivalves to make any comprehensive study of stratigraphic species distribution from the Appalachian Basin westward to the Western Interior Basin. Table 3 is based primarily on the work of Newell (1937, 1942), Wanless (1958), Hoare (1961), and the present study. The table is restricted to a comparison of the Pectinacea and Mytilacea and shows some degree of similarity of ranges in many forms. There is no information concerning stratigraphic distribution above the Kewanee Group in the Eastern Interior Basin.

LIFE HABITS

General

The occurrence of marine bivalves and rostroconchs in the Pennsylvanian of Ohio is controlled by a number of environmental factors such as salinity, substrate, food, space, temperature, and the presence or absence of physical barriers which controlled bivalve migration into acceptable habitats. At this time the competition for space and food with the brachiopods was possibly among the more important controls of distribution. Bretsky (1969) has shown that the more stenotopic articulate brachiopods dominated offshore habitats, leaving nearshore areas to the bivalves, which were more tolerant of physical and chemical changes in their

environments. Rarely have we found any great mixing of brachiopod and bivalve assemblages except where broken, worn, and disarticulated shells give evidence of a thanatocoenose, or death assemblage. It is not uncommon to find a few of one group mixed in with the other, but the fauna is clearly dominated by either brachiopods or bivalves.

At many of the localities (appendix) from which numerous specimens of bivalves were collected brachiopods may also be abundant (Sturgeon and Hoare, 1968). The groups are not normally found associated on the same depositional plane at any one locality, but are separated and indicate different positions relative to the shoreline at a given time. Inarticulate brachiopods such as *Lingula*, which is a nearshore form, commonly may be found in association with numerous bivalves.

No attempt was made to perform detailed sediment analyses in association with bivalve occurrences. The general lithology in which a particular taxon occurs is given in the following discussion.

Relatively few occurrences of epibionts have been found in the collection under study. This may be a result of poor preservation of external shell material in many cases. A few bivalves have specimens of the foraminifer *Serpulopsis* attached to them, but this is not as common as on brachiopod specimens from the same beds (Sturgeon and Hoare, 1968). Specimens of *Pseudomonotis* and *Schizodus* have *Crania modesta*, an inarticulate brachiopod, attached to them. In *Pseudomonotis* the attachment is on the anterodorsal region of the left valve, and in *Schizodus* the

TABLE 3.—Comparison of the stratigraphic ranges of the Pectinacea and Mytilacea in the Appalachian, Eastern Interior, and Western Interior Basins

Species	Appalachian Basin	Eastern Interior Basin	Western Interior Basin
<i>Posidonia fracta</i>	Upper Pottsville-Upper Allegheny	Upper Kewanee	
<i>Aviculopecten coxanus</i>	Upper Pottsville	Lower Kewanee	
<i>A. germanus</i>	Upper Pottsville-Lower Allegheny	Upper Kewanee	
<i>A. arctisulcatus</i>	Conemaugh		Virgilian
<i>A. occidentalis</i>	Conemaugh		Missourian
<i>A. bascilicus?</i>	Lower Conemaugh		Virgilian
<i>A. halensis?</i>	Upper Pottsville-Lower Allegheny		Morrowan
<i>Fasciculiconcha knighti</i>	Upper Pottsville-Lower Conemaugh		Desmoinesian-Missourian
<i>F. providencensis</i>	Upper Pottsville-Lower Allegheny		Desmoinesian
<i>Acanthopecten meeki</i>	Conemaugh		Middle and Upper Missourian
<i>A. carboniferous</i>	Upper Pottsville-Upper Conemaugh	Kewanee	Desmoinesian-Upper Virgilian
<i>Annuliconcha interlineata</i>	Lower Allegheny	Upper Kewanee	Lower Desmoinesian-Virgilian
<i>Streblochondria hertzeri</i>	Upper Pottsville-Lower Allegheny	Kewanee	Desmoinesian
<i>S. stantonensis</i>	Upper Allegheny-Middle Conemaugh		Missourian
<i>S. tenuilineata</i>	Upper Pottsville-Lower Conemaugh	Kewanee	Lower Desmoinesian-Missourian
<i>Streblopteria oklahomensis</i>	Lower Conemaugh		Desmoinesian-Upper Missourian
<i>Euchondria levicula</i>	Upper Pottsville-Upper Conemaugh	Upper Kewanee	Desmoinesian-Missourian
<i>Pernopecten ohioensis</i>	Upper Pottsville-Upper Allegheny	Kewanee	Desmoinesian
<i>P. attenuatus</i>	Upper Pottsville-Middle Conemaugh	Kewanee	Lower Desmoinesian
<i>Dunbarella striata</i>	Upper Pottsville-Lower Conemaugh		Virgilian
<i>D. knighti</i>	Upper Pottsville-Upper Conemaugh	Kewanee	Desmoinesian
<i>D. rectalaterarea?</i>	Upper Pottsville-Upper Allegheny	Upper Kewanee	Desmoinesian
<i>Promytilus annosus senex</i>	Lower Allegheny-Lower Conemaugh		Missourian
<i>Volsellina subelliptica</i>	Lower Allegheny	Upper Kewanee	Lower Desmoinesian-Virgilian
<i>Myalina (O.) subquadrata?</i>	Conemaugh		Virgilian-Lower Wolfcampian
<i>M. (Myalinella) meeki?</i>	Lower Conemaugh	Middle Kewanee	Upper Desmoinesian-Wolfcampian
<i>Septimyalina perattenuata</i>	Upper Pottsville-Middle Conemaugh	Upper Kewanee	Atokan-Virgilian
<i>S. sinuosa</i>	Upper Pottsville-Middle Allegheny	Lower Kewanee	Upper Desmoinesian
<i>S. orthonota?</i>	Lower Pottsville		Morrowan

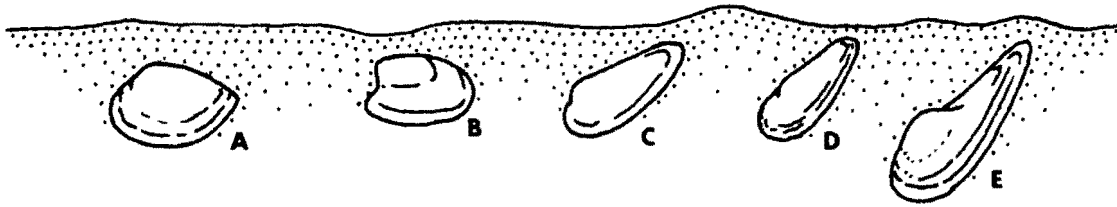


FIGURE 3.—Inferred life positions of A, B, *Nuculopsis*; C, *Palaeoneilo*; D, *Paleyoldia*; E, *Phestia*; all burrowing deposit feeders living a few centimeters below the surface of the substrate. All figures X1.

brachiopods are attached along the ventral margin. No attached bryozoan colonies or borings of acrothoracic barnacles were found.

Specimens of *Dunbarella knighti* in the fissile black shale of the Putnam Hill unit at locality Ms-3 have an abundance of the worm *Spirorbis* attached to them. Counts made on a large number of specimens do not indicate any preference for left or right valves or for position on the valves. The valves are mainly disarticulated and probably were used as a substrate for attachment by the spirorbids after the bivalves were dead.

Nuculoids

Nuculoids, represented in this study by the genera *Clinopistha*, *Nuculopsis*, *Palaeoneilo*, *Paleyoldia*, and *Phestia*, are the most abundant group of bivalves present in the collections and commonly have the valves articulated. Nuculoids were found associated with brachiopod faunas to a much greater extent than the other bivalve forms. This is probably due to the fact that they were rapid free burrowers and deposit feeders like modern forms (Stanley, 1970) and were therefore not in as much competition with the associated brachiopod faunas as were the other bivalves (fig. 3).

The nuculoids were found most commonly in dark shales which were calcareous and/or had a high silt content. Specimens of nuculoids collected from 113 of the 258 localities and stratigraphic units in the Ohio Pennsylvanian were distributed in the following manner: 77 occurrences in dark-gray to black shale; 14 in fine-grained black limestone; 13 in light-gray shale; 6 in fine-grained light-gray limestone, which may be nodular; and 3 in brown calcarenite. This distribution of sedimentological occurrences agrees well with those reported by Dickens (1963) and by Stanley (1970, 1972).

Solemyoids

The solemyoids, represented by two species of the genus *Solemya*, were found primarily in dark-gray to black

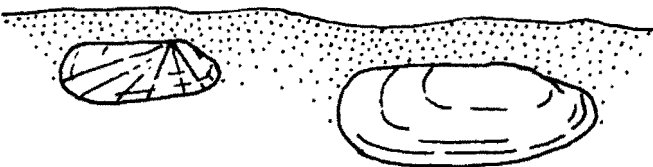


FIGURE 4.—Inferred life position of species of *Solemya*, a burrowing suspension feeder living a few centimeters below the surface of the substrate. X1.

shale, platy in many places, and in fine-grained dark-gray to black limestone. In a total of 56 occurrences, 42 were in dark-gray to black shale, 11 in dark-gray to black limestone, 2 in light-gray limestone, and 1 in brown calcarenite. Stanley (1970) reported that modern species of *Solemya* prefer organic-rich muddy medium-grained sand and sandy mud substrates. These forms are moderately rapid burrowers and are suspension feeders (fig. 4). None of the Y-shaped burrows reported by Stanley (1970) were found associated with the Pennsylvanian specimens; modern individuals normally inhabit the burrow at the junction of the arms 6-7 cm below the surface. In Pennsylvanian solemyoids both pedal and posterior gapes are present, so it is possible, as documented by E. S. Morse (1913), that such forms could also swim short distances by retraction of the foot, clapping the valves together, and expelling water through the posterior gape.

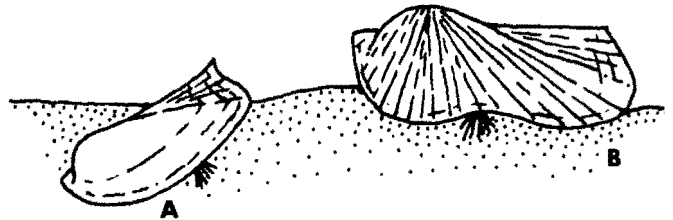


FIGURE 5.—Inferred life positions of species of *Parallelodon*; A, endobysate, B, epibysate. Both figures X1.

Arcoids

The arcoids are represented by five species of the genus *Parallelodon* in the collections under study. In 58 occurrences, 24 were in dark-gray to black shale, commonly calcareous, 16 in dark-gray to black limestone, 10 in light-gray limestone, and 8 in light-gray shale. In general, these forms appear to have preferred organic-rich calcareous sediments. The presence of well-developed radial ornamentation, a flattened ventral margin, thick shell material, and denticulation along the ventral margins tends to indicate that *Parallelodon* was a slow shallow burrower, endobysate or possibly epibysate (fig. 5).

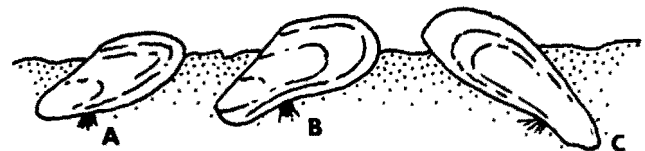


FIGURE 6.—Inferred life positions of A, *Modiolus*; B, *Promytilus*; C, *Volsellina*; all endobysate forms. All figures X1.

Mytilids

The genera *Modiolus*, *Promytilus*, and *Volsellina* are the only representatives of this group in our collections; they are not abundant forms. The specimens were found almost exclusively in dark-gray to black limestones with only 2 occurrences in 12 in a black shale. All of the above genera are modiolid in form, with an anterior lobe present, and are markedly prosocline. Stanley (1972) has indicated an endobysate life position for the modiolid types of the early Pennsylvanian (fig. 6).

Pinnids

Pteronites is the only genus of the Pinnidae present. Numerous specimens of *Pteronites americana* (Meek) were found in death assemblages in dark-gray to black shales, and a few specimens were found in near-life position in a light-gray-green shale. Hoare and Sturgeon (1972) postulated that the individuals lived in a near-vertical position and that compaction of the sediments had distorted the specimens and their positions to angles of approximately 35° from the horizontal (fig. 7). *Pteronites peracuta* (Shumard) is not a common form and was found primarily in calcarenites. Modern pinnids live in a near-vertical position as semi-faunal endobysate inhabitants (Stanley, 1970; Kaufman, 1969).

Pteroids

The Myalinidae are represented by the genera *Septimyalina* and *Myalina* and are a minor element of the bivalve faunas under study. In the upper Pennsylvanian a majority of occurrences are in limestone, from a fine-grained form to a calcarenite; in the lower half of the section occurrences in shale are as common as in limestone. *Myalina* (*O.*) *subquadrata*? lacks an anterior lobe, attains a large size, has an acline shape, and is an inequivalved form. These characteristics have led Stanley (1972) to propose an epifaunal byssally attached habit for this form (fig. 8B). *Septimyalina* also lacks an anterior lobe, is inequivalved, and has an acline shape; these features indicate that it was also an epibysate form (fig. 8A).

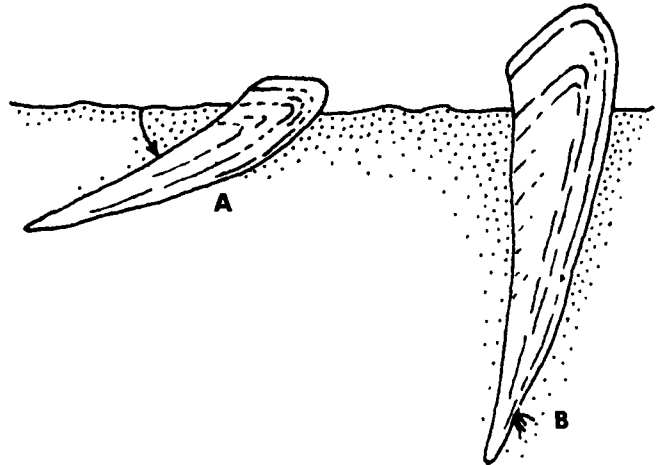


FIGURE 7.—Lateral views of specimens of *Pteronites*; A, angular relationship with sediment as collected; B, in inferred life position; endobysate form. Both views X0.5.

Monopterids

The genus *Monopteria* is represented in our collections by only one specimen, which was found in a black shale. The equivalved nature, lack of an anterior lobe, and the somewhat produced posterior auricle would infer an epifaunal habit for this form, which probably was attached by a small byssus in a position similar to that of the pteriids (fig. 9A).

Pteriids

Leptodesma and *Placopteria* are relatively rare forms in the collections under study and are found mainly in fine-grained dark-gray to black limestones, although a few occurrences are in dark shales. *Leptodesma*, with its small anterior lobe, strongly produced posterior auricle, and strongly curved posterior margin is probably an epifaunal form similar to *Pteria*, as documented by Stanley (1970, 1972). Although alcyonarians and gorgoniaceans were not

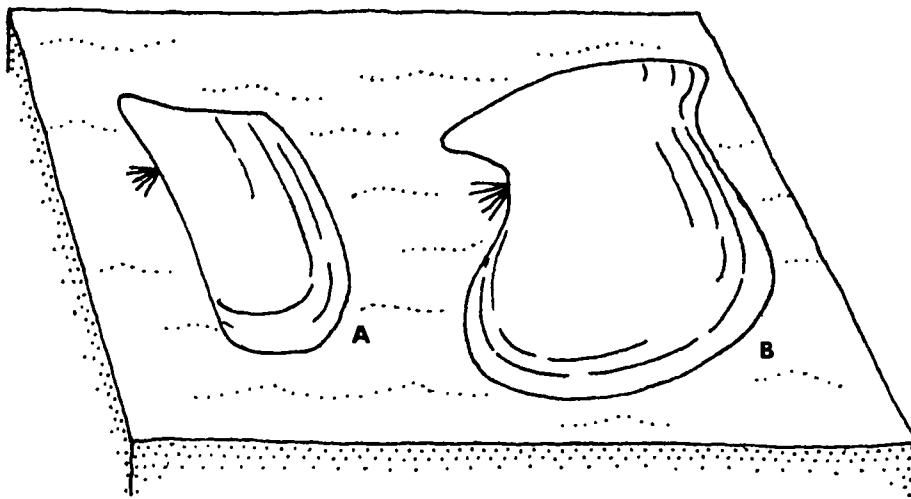


FIGURE 8.—Inferred life positions of A, *Septimyalina perattenuata*; B, *Myalina* (*O.*) *subquadrata*?; both epibysate forms. Both figures X0.5.

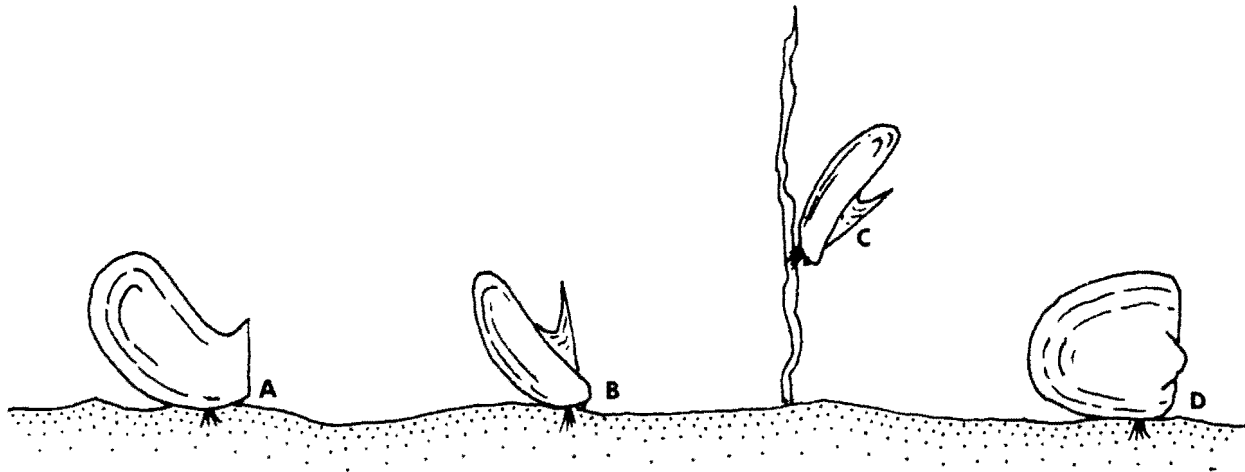


FIGURE 9.—Inferred life positions of A, *Monopteria*; B, C, *Leptodesma*; D, *Placopterina*; all epibyssate forms. Current direction from right to left. A, B, and C X1; D X2.

present in the Pennsylvanian, as noted by Stanley (1972), it is possible that these pteriids attached to a sediment substrate or to attached plants in the same fashion (fig. 9B, C). *Placopterina* is a more rounded form in lateral view and probably attached itself in much the same fashion as *Leptodesma* (fig. 9D).

Pectinids

Specimens of *Dunbarella* were found most commonly in dark-gray to black shale; 38 of 55 occurrences were of this type. *D. striata* was generally found, as noted by Murphy (1967), in somewhat calcareous light-gray shale, whereas *D. knighti* and *D. rectalaterarea?* were found in every case in fissile black shale. A few specimens of this genus were found in dark-gray to black limestone.

In 36 occurrences of *Aviculopecten*, 23 were in dark-gray to black shale and limestone, 11 in light-gray shale or limestone, and 2 in calcarenite.

In 35 occurrences of *Acanthopecten*, *A. carboniferous* was the most commonly found species, with 23 occurrences in dark-gray to black shale and limestone. *A. meeki* was found only in light-gray shale and limestone, and *A. bellosum* was abundant in a soft calcareous light-brown shale.

In 12 occurrences, *Fasciculiconcha* was found most commonly in light-gray limestone and shale. Four of the occurrences were in dark-gray to black limestone and shale; 8 were in limestone.

Streblochondria was found primarily in dark-gray to black shale and light-gray limestone.

Streblopteria was found only in black shale.

Chaenocardia was rare and was found only in black shale.

Of 23 occurrences of *Euchondria*, 19 were in dark-gray to black shale, 3 in dark-gray to black limestone, and 1 in light-gray limestone.

There did not seem to be any selectivity of sediment for *Pseudomonotis*. Specimens were found in both light and dark limestone and shale. Because the forms lived attached to other shells, they were not greatly affected by the

content of the sediment substrate.

In every occurrence *Posidonia* was found in very dark-gray or black shale and limestone.

Species of *Pernopecten* were found in dark-gray to black shale and limestone. Of 35 occurrences, 22 were in these sediment types, 11 in light-gray shale and limestone, and 2 in calcarenite. Twenty-five of the total occurrences were in limestone.

Specimens of *Palaeolima* were found about equally distributed between light and dark limestone and shale, being only slightly more common in dark-gray to black shale and limestone.

Stanley (1972) noted that all living Pectinidae belong to two life-habit groups, those byssate throughout life and those which are byssate as juveniles, but become free living as adults. The presence of morphological features such as an elongate anterior auricle, associated deep byssal notch, and flattened right valve is indicative of epibyssate forms, whereas near-equal auricles, large umbonal angles, and convex right valves distinguish free-living forms (Stanley, 1970, 1972). Using these factors, Stanley (1972) has erected a phylogeny based upon life habits from endobyssate to epibyssate to free-living forms in this group. On the basis of the same criteria, the genera *Dunbarella*, *Aviculopecten*, *Acanthopecten*, *Annuliconcha*, *Clavicosta*, *Fasciculiconcha*, *Streblochondria*, *Streblopteria*, *Chaenocardia*, *Euchondria*, and *Palaeolima* would appear to all have been epibyssate in form (fig. 10A, B, C). The genus *Pernopecten* has characteristics of a free-living form (fig. 10D). *Pseudomonotis* was epibyssate as a juvenile, but lost its byssus, filled in the byssal notch, and cemented itself by the right valve to a hard substrate such as another shell (fig. 11B). *Posidonia* has been postulated as a pseudoplanktonic form, being attached to floating seaweed (fig. 11A); it is normally found in black shales with no other unquestioned benthonic forms (Stanley, 1972). The occurrences in the Pennsylvanian of Ohio agree with this opinion. In the major occurrences of *Posidonia*, only a few small specimens of the bivalve *Pleurophorella sesquiplicata* Price were found associated with it; *P. sesquiplicata* may also have been a pseudoplanktonic form.

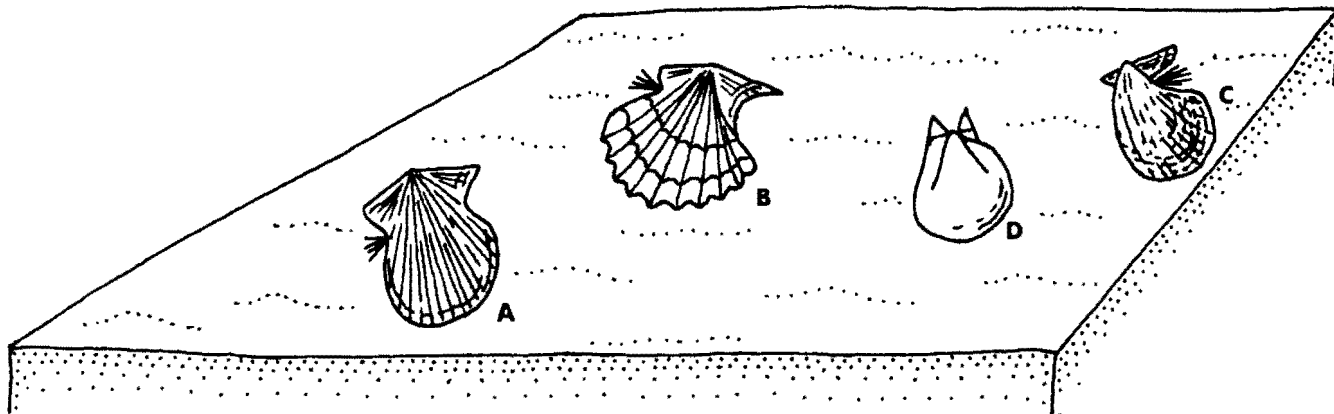


FIGURE 10.—Inferred life positions of A, *Aviculopecten*; B, *Acanthopecten*; C, *Streblochondria*; D, *Pernopecten*; A, B, and C epibyssate as adults; D free living in adult stage and possibly a swimming form. All figures X1.

Trigonoids

Schizodus is the only trigonoid genus present in the collections. Of 40 occurrences, 23 were in dark-gray to black shale, 7 in dark-gray to black fine-grained limestone, 5 in light-gray shale, and 5 in fine-grained light-gray limestone. Stanley (1970, 1972) indicated that the trigonoids are burrowers (fig. 12), with those having maximum shell width in a dorsal position being more rapid burrowers than those in which maximum width is located ventrally.

Veneroids

The veneroids are represented by the genera *Permophorus*, *?Pleurophorella*, *Astartella*, and *Cypricardinia* in the collections under study. In 36 occurrences of *Permophorus*, 11 were in dark-gray to black limestone, 9 in dark-gray to black shale, 5 in light-gray limestone, 5 in calcarenite, and 6 in light-gray shale. *?Pleurophorella* was found only in black shale and in association with *Posidonia*. *Astartella* is a common form in the collections. In 110 occurrences, 66

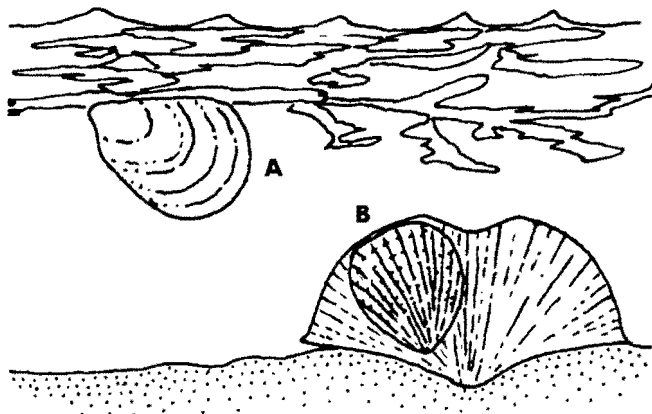


FIGURE 11.—Inferred life positions of A, *Posidonia*, a pseudo-planktonic form attached to floating algae; B, *Pseudomonotis*, cemented to the shell of *Neospirifer* (brachiopod) in the adult stage. Both figures X1. (*Posidonia* and *Pseudomonotis* not found associated.)

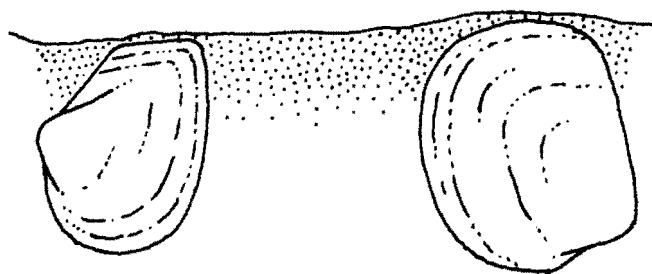


FIGURE 12.—Inferred life positions of species of *Schizodus*, a burrowing form. X1.

were in dark-gray to black shale, 20 in dark-gray to black limestone, 13 in light-gray shale, and 11 in light-gray limestone. The genus *Cypricardinia* is a rare form and was found in a variety of lithologies.

The genera *Cypricardinia* and *Permophorus* are modiolid in form and apparently were endobyssate (Stanley, 1972) (fig. 13A, B). *?Pleurophorella*, because of its association with *Posidonia* in black shales and because of the lack of known associated benthonic forms, was possibly also a pseudoplanktonic form living attached to algae by a byssus. *Astartella* is comparable in form to the modern genus *Astarte*, a shallow burrower (Stanley, 1970, 1972). The Pennsylvanian forms of *Astartella* may also have lived in a variety of orientations based upon the shape of the lateral outline of the shell (fig. 13C, D).

Pholadomyoids

In the Pennsylvanian section in Ohio the pholadomyoids include the genera *Edmondia*, *Cardiomorpha*, *Prothyris*, *Solenomorpha?*, *Exochorhynchus*, *Wilkingia*, *Sanguinolites*, and *Unklesbayella*. In 45 occurrences of *Edmondia*, 19 were in dark-gray to black shale, 12 in dark-gray to black limestone, 10 in light-gray shale, and 4 in light-gray limestone. *Cardiomorpha*, a rare form, was found only in black shale and limestone. *Prothyris* (*Prothyris*) is also rare and was found in all types of lithologies except calcarenites. *Solenomorpha?* was found only in black shale and limestone and was a minor faunal element. *Exochorhynchus* is

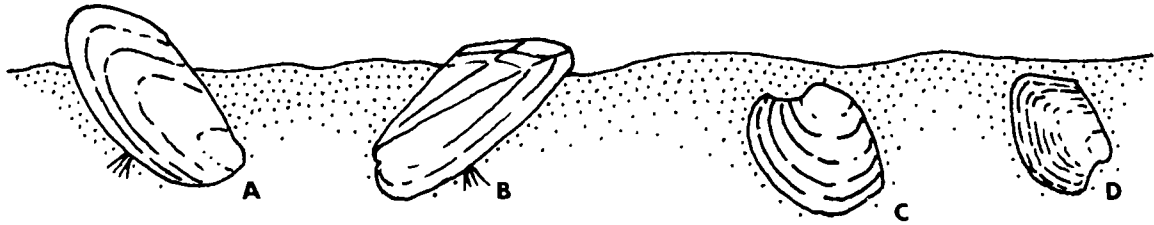


FIGURE 13.—Inferred life positions of *A*, *Cypricardinia*; *B*, *Permophorus*; *C*, *D*, *Astartella* species; *A* and *B* endobyssate forms, *C* and *D* shallow burrowing forms. *A* X2; *B*, *C*, and *D* X1.

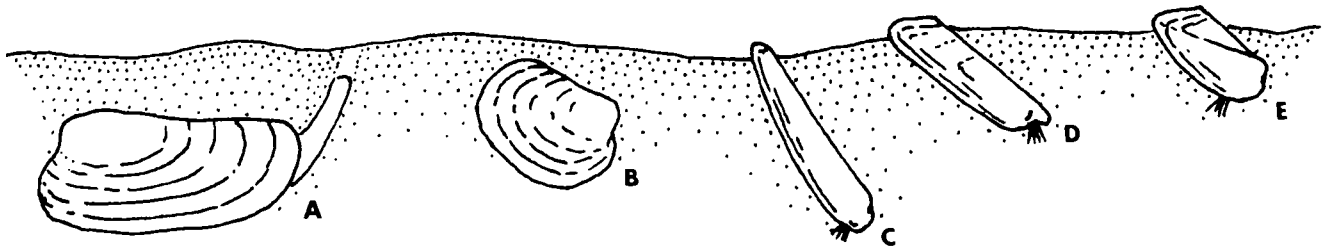


FIGURE 14.—Inferred life positions of *A*, *Wilkingia*; *B*, *Edmondia*; *C*, *Solenomorpha?*; *D*, *Prothyris*; *E*, *Cardiomorpha*; *A* a burrowing siphon feeder, *B* a burrowing form, *C*, *D*, and *E* endobyssate forms. All figures X1.

uncommon and was found only in black shale and limestone. *Wilkingia* was present at 32 localities; 16 were in dark-gray to black shale, 5 in dark-gray to black limestone, 6 in light-gray limestone, 4 in light-gray shale, and 1 in calcarenite. *Sanguinolites* is uncommon and was found in a variety of lithologies. *Unklesbayella* was found at 5 localities, 3 in light-gray shale and 2 in dark-gray shale.

Stanley (1972) indicated endobyssate habits for *Wilkingia* and possibly for *Prothyris* (fig. 14A, D). The triangular wedge-shaped forms of *Wilkingia* and of *Exochorhynchus* are similar. L. R. Cox (1969) described *Wilkingia* as an active burrower rather than a byssate form. Numerous specimens of *Wilkingia* were found crushed dorsoventrally on bedding planes, probably indicating that they lived at relatively shallow depths and nearly parallel to the substrate surface. The presence of a well-developed pallial sinus in this genus indicates it is one of the first siphon feeders (Stanley, 1972). *Cardiomorpha* and *Solenomorpha?* are modiolid in form and possibly were endobyssate in life habits, although they have isomyarian musculature (fig. 14C, E). *Edmondia*, like the genera described above, has isomyarian musculature. *Edmondia* is ovoid to elongate-ovate in lateral view, nearly equilateral, and has the greatest shell width near midheight.

It was probably a shallow slow-burrowing form (fig. 14B). *Sanguinolites* and *Unklesbayella* are presumably endobyssate forms with ventral sinuses.

Rostroconchids

The genus *Pseudoconocardium* is a relatively rare form and was found in light-brown to dark-gray shales. Pojeta and others (1972) have inferred a burrowing life mode based upon the large anterior gape, which allowed the extension of a large foot, with the organism being a deposit feeder (fig. 15).

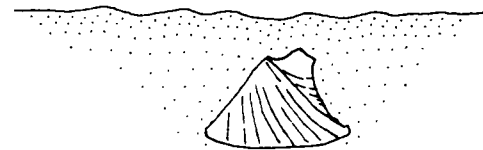


FIGURE 15.—Inferred life position of *Pseudoconocardium*, a burrowing deposit feeder. X8.

Chapter 4

SYSTEMATIC PALEONTOLOGY

Genus *Clinopistha* Meek & Worthen, 1870

Clinopistha laevis Meek & Worthen

Pl. 1, figs. 1-3

Clinopistha radiata var. *laevis* Meek & Worthen, 1870, p. 44; —, 1873, p. 584, pl. 27, figs. 7a-f; McAlester, 1968, p. 20, pl. 4, figs. 1-16.

Clinopistha radiata Hoare, 1961, p. 93, pl. 13, figs. 4, 5.

Clinopistha laevis Hoare & Sturgeon, 1975, p. 84, pl. 1, figs. 1-3, text-fig. 3.

Medium-sized strongly inequilateral equivalved inflated nuculids. Beaks small, tightly incurved, opisthogyrate; anterior margin broadly rounded; escutcheon absent; ovate external ligament marked by a callus posterior to umbones; surface marked by fine to moderately coarse growth lines; internal mold showing very faint low radiating ridges of unequal intensity, ridges not reflected on shell surface.

Dentition not observed, presumably taxodont and lacking a resilifer; muscle scars faintly impressed, with a large subquadrate anterior adductor scar located anterodorsally; smaller subovate posterior adductor scars located just ventral to posterior callus; pallial line absent (fig. 16). Other interior features not observed. Worthwhile measurements not possible.

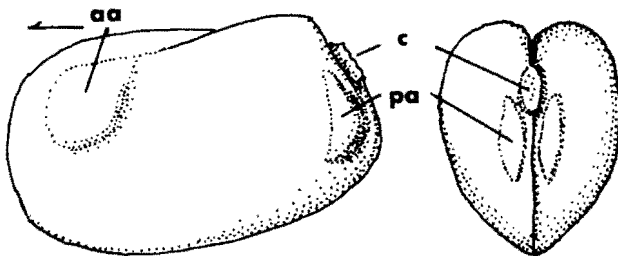


FIGURE 16.—Left lateral and posterior views of internal mold of *Clinopistha laevis* Meek & Worthen. Both figures X4. aa, anterior adductor scar; c, callus; pa, posterior adductor scar.

Discussion.—*Clinopistha laevis* is the only known species of this genus present in the Pennsylvanian of Ohio and is a rare form. Comparing the Ohio specimens with specimens collected from the Tebo Formation (Desmoinesian) of Missouri and identified by Hoare (1961) as *C. radiata* Hall, no difference can be seen in shape or ornamentation. The radiating ridges on the internal mold do not affect the shell surface in specimens from either area, but can be seen through the shell material where it is exfoliated.

Occurrence.—Rare to common in the Putnam Hill and Columbiana units; rare in the Vanport, Washingtonville, and

Cambridge units.

Repository.—Hypotypes, OSU-27143, 28993.

Genus *Nuculopsis* Girty, 1911

Nuculopsis girtyi Schenck

Pl. 1, figs. 4-8

Nucula ventricosa Hall (in Hall and Whitney), 1858, p. 716, pl. 29, figs. 4, 5a, b.

Nuculopsis ventricosa Girty, 1915a, p. 117, pl. 15, figs. 1-8 (see for synonymy up to this date); Plummer & Moore, 1921, p. 120, pl. 13, figs. 41, 42, pl. 21, figs. 24-27; Morningstar, 1922, p. 204, pl. 10, fig. 20; Sayre, 1930, p. 106, pl. 8, figs. 2-2c; Morse, 1931, p. 300.

Nuculopsis girtyi Schenck, 1934, p. 29, pl. 2, fig. 19, pl. 4, figs. 2a, b; Lintz, 1958, p. 100; McAlester, 1968, p. 39, pl. 12, figs. 10-18; Keen (in Moore, 1969), p. N231, figs. 7a-c; Hoare & Sturgeon, 1975, p. 85, pl. 1, figs. 4-8, text-fig. 4.

Nuculopsis (Nuculopsis) girtyi Schenck, 1939, p. 40.

Nucula (Nuculopsis) girtyi Hoare, 1961, p. 101, pl. 13, figs. 7, 8.

Medium-sized inequilateral equivalved subtrigonal inflated nuculids. Beaks small, incurved, opisthogyrate; posteroventral margin produced; lunule and escutcheon absent; surface marked by fine to coarse growth lines.

Hinge structure of taxodont dentition with up to 15 chevron-shaped denticles anterior to small resilifer and up to 6 denticles posterior to it; resilifer marked on top by denticles; muscle scars and pallial line strongly impressed; large ovate anterior adductor scars located anterodorsally; ovate posterior adductor scars located posteroventrally; small ovate anterior protractor scars present above and behind the anterior adductor scars; three or four small ovate scars, possibly representing the anterior retractor scars, located posterolaterally from the protractor scars (fig. 17). Measurements given in table 4.

Discussion.—This is the most common type of nuculid present in the Pennsylvanian of Ohio. It differs from *N. anodontoides* (Meek), with which it is found associated, by being less trigonal in shape, by having beaks more depressed, a relatively more inflated shell, a flatter or more depressed anterodorsal margin, and less strongly developed anterior retractor scars, by lacking posterior pedal retractor scars, and by having opisthogyrate rather than orthogyrate beaks. Other forms which are present in the collections are differentiated under those species.

Occurrence.—Rare to abundant in the Lower Mercer, Putnam Hill, Columbiana, Washingtonville, Brush Creek, and Cambridge units; rare to common in the Vanport and Portersville units; rare in the Upper Mercer and Ames units.

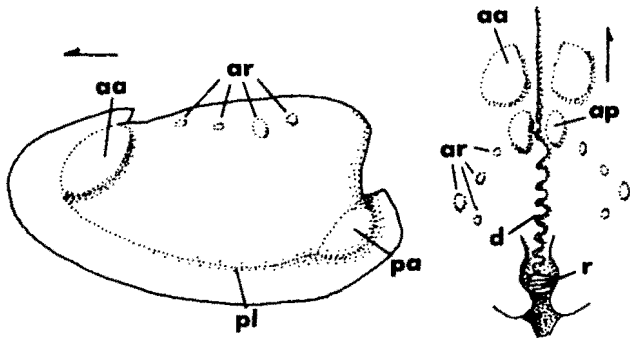


FIGURE 17.—Left lateral and dorsal views of internal mold of *Nuculopsis girtyi* Schenck. Both figures X4. *aa*, anterior adductor scar; *ap*, anterior protractor scar; *ar*, anterior retractor scar; *d*, dentition; *pa*, posterior adductor scar; *pl*, pallial line; *r*, resilifer.

TABLE 4.—Measurements of species of *Nuculopsis*

Species	Locality	Specimen	Length (mm)	Height (mm)	Width (mm)
<i>N. girtyi</i>	Ale-35	1	10.6	6.7	6.4
		2	10.8	7.0	5.8
		3	11.1	6.8	6.1
		4	10.8	7.1	5.0
		5	10.8	7.9	5.4
		6	12.0	7.8	6.6
		7	8.0	5.1	4.1
		8	11.0	6.9	6.5
	Me-1	1	10.8	7.2	6.8
		2	10.8	7.3	7.3
		3	9.0	5.8	5.2
		4	7.2	6.9	6.9
<i>N. anodontoides</i>	Ale-35	1	15.1	11.3	8.5
		2	15.5	10.4	8.9
		3	14.2	10.2	7.6
		4	13.2	10.2	6.9
		5	14.5	10.4	7.6
		6	11.7	8.5	6.2
	Mg-2	1	11.1	8.2	6.0
		2	12.4	8.9	7.0
		3	9.2	6.4	4.0
	<i>N. croneisi</i>	WVA:PR-1	1	3.0	2.6
2			3.1	2.8	1.9
3			3.6	3.1	2.2
4			2.1	1.7	1.2
5			2.5	2.1	1.4
6			2.8	2.3	1.8
7			1.7	1.5	1.0
8			4.2	3.7	2.5
9			4.8	4.3	2.6
10			4.1	3.7	2.5

Also reported from the Harrison and Sharon units by Morningstar (1922).
Repository.—Hypotypes, OSU-27166 to 27169.

Nuculopsis anodontoides (Meek)
 Pl. 1, figs. 9-14

Nucula anodontoides Meek, 1871b, p. 71; Mark, 1912, p. 306, pl. 14, fig. 14; Girty, 1915a, p. 111, pl. 13, figs. 1-5; Sayre, 1930, p. 104, pl. 8, figs. 8, 8a; Morse, 1931, p. 300.

Nucula ventricosa Hind, 1897, p. 180, pl. 14, figs. 16, 16a.
Nuculopsis anodontoides Lintz, 1958, p. 100; Hoare & Sturgeon, 1975, p. 86, pl. 1, figs. 9-14, text-fig. 5.

Medium-sized inequilateral equivalved subtriangular moderately inflated nuculids. Beaks elevated, small, incurved, orthogyrate; anterior margin narrowly curved; lunule and escutcheon absent; surface marked by fine evenly spaced growth lines and faint radial lirae.

Hinge structure taxodont with up to 9 large chevron-shaped denticles anterior to the resilifer and 7 smaller chevron-shaped denticles posterior to it; resilifer large and marked on top by denticles; muscle scars and pallial line strongly impressed; pallial sinus lacking; large ovate anterior and posterior adductor scars located anterodorsally and at the posterior extremity, respectively; small kidney-shaped anterior protractor scars located just posterior to the anterior adductors; narrowly ovate posterior protractors located just anterior to the posterior adductors; three subcircular to ovate scars anterior to the beaks possibly representing anterior retractor scars (fig. 18). Measurements given in table 4.

Discussion.—*Nuculopsis anodontoides* is differentiated from *N. girtyi* Schenck under the latter species. The presence of orthogyrate beaks is noted in extending the variability of this feature in the family Nuculidae (Keen, in Moore, 1969, p. N230).

Occurrence.—Rare to abundant in the Putnam Hill, Columbiana, Brush Creek, and Cambridge units; rare in the Washingtonville and Portersville units; rare in the Poverty Run, Lower Mercer, Upper Mercer, and Vanport units. Also reported from the Ames unit by Mark (1912).

Repository.—Hypotypes, OSU-27170 to 27173.

Nuculopsis croneisi Schenck
 Pl. 1, figs. 15-17

Nucula parva McChesney, 1859, p. 54; —, 1867, p. 39, pl. 2, figs. 8a-c; Meek & Worthen, 1873, p. 589, pl. 26, figs. 8a, b; Keyes, 1888, p. 233; —, 1894, p. 121; Miller, 1889, p. 495; Girty, 1911, p. 131; Mark, 1912, p. 297; Krebs & Teets, 1913, p. 133; Price, 1914, p. 514; Mather, 1915, p. 210, pl. 15, fig. 21; Price, 1918, p. 787; Morningstar, 1922, p. 202.

Nuculopsis (Palaeonucula) croneisi Schenck, 1939, p. 24, pl. 7, figs. 1-4.

Palaeonucula croneisi Lintz, 1958, p. 100.

Nuculopsis croneisi Hoare & Sturgeon, 1975, p. 87, pl. 1, figs. 15, 17.

Small inequilateral equivalved subtriangular nuculids. Beaks small, incurved, orthogyrate; anterior margin narrowly rounded; surface marked by fine evenly spaced lirae numbering up to 11 in a span of 1 mm at a distance of 3 mm ventral to the beak.

Hinge structure taxodont with up to 13 small chevron-shaped denticles anterior to a triangular-shaped resilifer and up to 8 chevron-shaped denticles posterior to resilifer; small subovate anterior and posterior adductor scars connected by a faint pallial line. Measurements given in table 4.

Discussion.—*Nuculopsis croneisi* differs from *N. girtyi* Schenck by being subtriangular in shape, having orthogyrate beaks, and having regular closely spaced concentric lirae. *N. anodontoides* (Meek) is a more strongly inflated species and

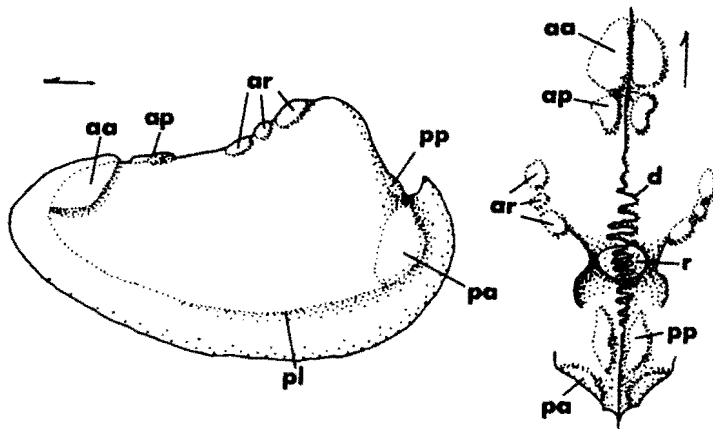


FIGURE 18.—Left lateral and dorsal views of internal mold of *Nuculopsis anodontoides* (Meek). Both figures X4. *aa*, anterior adductor scar; *ap*, anterior protractor scar; *ar*, anterior retractor scar; *d*, dentition; *pa*, posterior adductor scar; *pl*, pallial line; *pp*, posterior protractor scar; *r*, resiliifer.

lacks the concentric lirae of *N. croneisi*. It is possible that immature specimens of other species of concentrically marked *Nuculopsis* have been included here. The small size of the specimens prevents a comparison of distinguishing characteristics.

Occurrence.—Rare to abundant in the Lower Mercer, Putnam Hill, Vanport, Columbiana, Washingtonville, Cambridge, and Ames units; rare in the Upper Mercer, Brush Creek, and Portersville units.

Repository.—Hypotypes, OSU-27174, 27251, 28989.

Genus *Palaeoneilo* Hall & Whitfield, 1869
Palaeoneilo oweni (McChesney)
 Pl. 1, figs. 22-28

Leda oweni McChesney, 1859, p. 52.

Leda polita McChesney, 1859, p. 53.

Yoldia knoxensis McChesney, 1867, p. 39, pl. 2, figs. 9a-c.

Yoldia? *Oweni* McChesney, 1867, p. 38, pl. 2, figs. 10a-c.

Yoldia (*Palaeoneilo*?) *carbonaria* Meek, 1871b, p. 72; —, 1875, p. 336, pl. 19, fig. 5.

Yoldia carbonaria Miller, 1889, p. 516; Raymond, 1910, p. 155; Mark, 1912, p. 297.

Anthraconeilo taffiana Girty, 1911, p. 132; Price, 1914, p. 515, pl. 43, fig. 18; Girty, 1915a, p. 114, pl. 15, figs. 9-13; Lintz, 1958, p. 100; Hoare, 1961, p. 104, pl. 13, fig. 6; McAlester, 1968, p. 16, pl. 18, figs. 1-6; pl. 19, figs. 1-11.

Anthraconeilo bownockeri Morningstar, 1922, p. 208, pl. 10, fig. 21.

Palaeoneilo oweni Murphy, 1966, p. 868, pl. 101, figs. 1-8, 10-12, 14-20; Hoare & Sturgeon, 1975, p. 88, pl. 1, figs. 22, 23; pl. 2, figs. 1-5, text-fig. 6.

Large inequilateral equivalved elongate inflated nuculaniform shells. Beaks small, incurved, prosogyrate, located anterior of midlength; posterior margin somewhat attenuate to truncate; lunule absent and escutcheon narrowly elongate; surface marked by fine to moderately coarse growth lines; posterior radial groove broad and shallow.

Hinge structure taxodont with 6 larger denticles anterior to beak and 26 smaller teeth posterior to beak; resiliifer absent; muscle scars lightly impressed, with a large anterior adductor scar visible; other scars not discernible; faint pallial line paralleling margin anteriorly, not visible posteriorly (fig. 19). Other interior features not observed. Measurements given in table 5.

Discussion.—This is the only species of *Palaeoneilo* which can be identified with certainty in our collections. Morningstar's (1922) description of *Anthraconeilo bownockeri* from the Sharon unit is based upon poorly preserved internal molds which show little variation from those described here, with the exception that the holotype is less produced posteriorly and may be a slightly truncate specimen similar to some of the Allegheny and Conemaugh specimens of *P. oweni*. Murphy (1966) made an extensive comparison of described species of *Palaeoneilo* and concluded that most were synonymous with *P. oweni*.

Occurrence.—Rare to abundant in the Columbiana and Washingtonville units; common to abundant in the Brush Creek unit; rare to common in the Boggs and Putnam Hill units; rare in the Vanport, Cambridge, and Portersville units.

Repository.—Hypotypes, OSU-27175 to 27179.

Genus *Paleyoldia* Lintz, 1958
Paleyoldia stevensoni (Meek)
 Pl. 1, figs. 18-21

Yoldia Stevensoni Meek, 1871b, p. 72; —, 1875, p. 335, pl. 19, figs. 4a, b; Morningstar, 1922, p. 208.

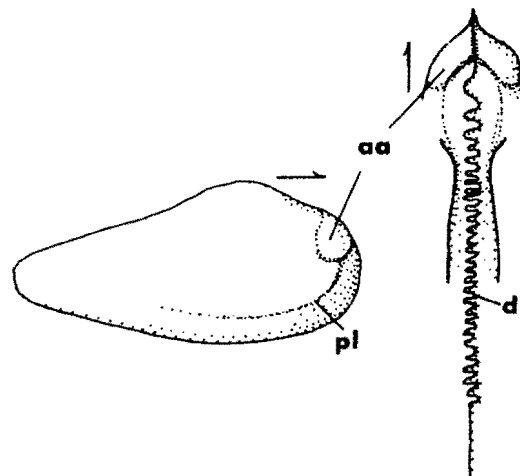


FIGURE 19.—Right lateral and dorsal views of internal mold of *Palaeoneilo oweni* (McChesney). Lateral view X3; dorsal view X4. *aa*, anterior adductor scar; *d*, dentition; *pl*, pallial line.

TABLE 5.—Measurements of *Palaeoneilo oweni* and *Paleyoldia stvensoni*

Species	Locality	Specimen	Length (mm)	Height (mm)	Width (mm)
<i>P. oweni</i>	CAR-2	1	12.4	6.7	5.2
		2	18.4	9.6	7.0
		3	19.4	10.5	9.2
		4	15.0	7.9	6.0
		5	16.0	8.2	6.0
		6	18.7	10.1	7.6
		7	14.0	7.9	6.3
		8	19.4	10.2	8.7
	Mg-2	1	17.3	10.6	7.3
		2	18.2	10.6	7.2
		3	15.7	9.7	6.2
		4	15.2	10.0	6.5
		5	16.1	9.3	6.1
		6	21.0	11.5	8.2
7		16.3	10.0	7.9	
<i>P. stvensoni</i>	Ale-35	1	17.5	8.5	3.6
	MEco-1	1	17.7	8.7	3.5
		2	13.9	7.2	3.0

Paleyoldia stvensoni Hoare & Sturgeon, 1975, p. 89, pl. 1, figs. 18-21, text-fig. 7.

Medium-sized equilateral compressed or noninflated nuculaniform shells. Beaks small, opisthogyrate, located near midlength; anterior margin more strongly curved dorsoanteriorly; posterior margin attenuate to narrowly truncate; lunule and escutcheon absent; narrow ligament gape on both sides of umbones; surface marked by fine concentric striae, 15-16 in a space of 2 mm measured at a distance of 3 mm from the beak; striae not paralleling the posteroventral margin, but approaching it at an oblique angle.

Hinge structure with taxodont dentition having 10 large denticles anterior to the beak and decreasing in size anteriorly and 7 denticles posterior to the beak; 5 intermediate denticles present above the resilifer; muscle scars and pallial line lightly impressed; large anterior adductor scars present; small subtriangular posterior adductor scars visible; strongly developed posterior pedal retractor scars present; pallial line showing a broad sinus below the posterior adductor scar and becoming obscure anteriorly (fig. 20). Measurements given in table 5.

Discussion.—*Paleyoldia stvensoni* has approximately the same form as *P. glabra* (Beede & Rogers, 1899). The two species apparently differ on the basis of external ornamenta-

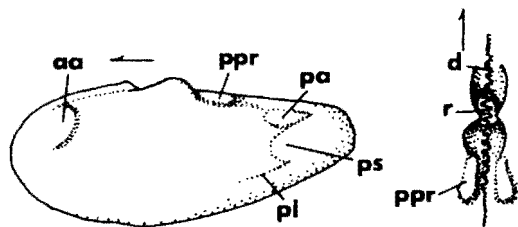


FIGURE 20.—Left lateral and dorsal views of internal mold of *Paleyoldia stvensoni* (Meek). Both figures X4. aa, anterior adductor scar; d, dentition; pa, posterior adductor scar; pl, pallial line; ppr, posterior pedal retractor scar; ps, pallial sinus; r, resilifer.

tion. Lintz (1958) describes the latter species as having approximately 4 striae per mm, whereas *P. stvensoni* has 7-8 striae per mm. The range of variation of ornamentation is unknown for these species; except for the above difference *P. stvensoni* would be included in synonymy with *P. glabra*.

Morningstar (1922) reports *Yoldia glabra* from the Putnam Hill unit, but does not illustrate the specimens. From her description it appears that she was describing specimens of the genus *Phestia*.

Occurrence.—Rare to abundant in the Brush Creek unit; rare to common in the Columbiana unit; rare in the Lower Mercer and Washingtonville units.

Repository.—Hypotypes, OSU-27180 to 27182.

Genus *Phestia* Chernyshev, 1951
Phestia bellistriata (Stevens)
 Pl. 2, figs. 1, 2

Leda bellistriata Stevens, 1858, p. 261; Hall (*in* Hall and Whitney), 1858, p. 717, pl. 29, figs. 6a-d; Girty, 1903, p. 442; Mark, 1911, p. 310, pl. 9, fig. 5; —, 1912, p. 297; Girty, 1915a, p. 122, pl. 14, figs. 1-9a; Mather, 1915, p. 212, pl. 15, fig. 19; Plummer & Moore, 1921, pl. 7, figs. 1, 5-6a, pl. 14, figs. 13, 14; Morningstar, 1922, p. 204, pl. 10, fig. 27; Morgan, 1924, pl. 48, figs. 7, 7a, 8; Sayre, 1930, p. 106, pl. 8, figs. 7-7c; Morse, 1931, p. 315, pl. 50, figs. 8-15; Chow, 1951, p. 25, pl. 3, fig. 3.

Nucula (Leda) Kazanensis Swallow & Hawn, 1858, p. 190. *Nuculana bellistriata* Herrick, 1887, p. 40, pl. 4, fig. 26; Beede, 1900, p. 148, pl. 20, figs. 14-14b; Raymond, 1910, p. 155; Tasch, 1953, p. 358; Hoare, 1961, p. 103, pl. 13, fig. 10.

Culunana bellistriata McAlester, 1968, p. 25, pl. 34, figs. 7-13; [*non*] Lintz, 1958, p. 106, pl. 16, figs. 16, 17.

Polidevcia bellistriata Driscoll, 1965, p. 80; —, 1966, p. 2, pl. 1, figs. 1-15, pl. 2, figs. 1-12, text-figs. 1-3; Murphy, 1967, p. 1498, pl. 195, fig. 3.

Phestia bellistriata Hoare & Sturgeon, 1975, p. 90, pl. 2, figs. 6, 7.

Medium-sized inequilateral equivalved inflated nuculiform shells. Beaks small, tightly incurved, opisthogyrate; anterior margin uniformly convex, posterior margin produced and narrowly convex, and ventral margin evenly convex; lunule and escutcheon narrowly triangular; ridge radiating from umbonal area to posterior extremity, causing posterodorsal valve area to be concave along hinge line posterior to beaks; surface marked by numerous closely spaced fine ridges and narrow interspaces with 10-15 ridges occupying a space of 3 mm at a distance of 2 mm ventral of the beak area and becoming obscure as they approach the radiating ridge, only fine growth lines continuing onto the concave valve area to the dorsal margin.

Hinge structure showing taxodont dentition with at least 8 chevron-shaped denticles anterior to the chondrophore and at least 7 denticles posterior to it; chondrophore with reduced denticles above it; muscle scars and pallial line not observed. Measurements given in table 6.

Discussion.—The differentiation of *Phestia bellistriata* and *P. arata* (Hall), with which it is most likely to be confused, is discussed under the latter species. Specimens which have been assigned to *P. attenuata* (Meek) are

TABLE 6.—Measurements of species of *Phestia*

Species	Locality	Specimen	Length (mm)	Height (mm)	Width (mm)
<i>P. bellistriata</i>	MUm-1	1	17.8	9.3	6.3
<i>P. arata</i>	Ale-35	1	21.6	10.7	8.3
		2	25.7	11.7	9.9
		3	17.2	8.8	5.7
		4	21.6	10.7	8.6
		5	23.9	11.2	8.0
		6	24.0	12.4	8.3
		7	16.4	8.2	5.6
		8	27.4	12.8	10.6
		9	23.2	11.4	9.5
		10	22.8	11.4	9.2
		11	22.6	11.3	7.2
		12	24.3	11.6	8.4
		13	21.2	10.5	7.2
		14	14.3	7.5	5.0
		15	18.4	9.3	6.9
		16	25.5	11.8	8.9
		17	26.7	12.7	9.6
		18	21.6	10.8	7.8
<i>P. attenuata</i>	Aa-41	1	8.3	3.6	2.0
		2	6.0	2.8	1.2
		3	8.0	3.6	

consistently smaller, with finer surface ornamentation and with more attenuate posterior shell areas. They do not appear to be juvenile specimens of *P. bellistriata*. The surface ornamentation of *P. bellistriata* and *P. arata* approach one another in some collections in terms of size and number of ridges. Differentiation can generally be made on shell form.

Occurrence.—Rare to abundant in the Putnam Hill, Brush Creek, and Ames units; rare to common in the Lower Mercer, Columbiana, and Washingtonville units; rare in the Vanport, Mason, and Portersville units. Also reported from the Lowellville and Boggs units by Morningstar (1922).

Repository.—Hypotype, OSU-27183.

Phestia bellistriata prolongata (Morningstar)
Pl. 2, fig. 3

Leda prolongata Morningstar, 1922, p. 206, pl. 10, figs. 28, 29.

Phestia bellistriata prolongata Hoare & Sturgeon, 1975, p. 91, pl. 2, fig. 8.

Large inequilateral equivalved elongate nuculiform shells. Anterior margin broadly rounded, posterior margin greatly produced, dorsal margin posterior to beaks concave, ventral margin broadly convex; lunule and escutcheon not seen; surface marked by fine closely spaced concentric ridges.

Hinge structure and other interior features not observed. Worthwhile measurements not possible.

Discussion.—The holotype specimen, designated by Morningstar (1922, pl. 10, fig. 28), is still available in the repository at The Ohio State University. No other specimens could be found in the collections there nor were others found in our collections. The much larger size and more produced posterior portion are distinctive of this form, which we feel is a subspecies of *P. bellistriata* (Stevens). The specimen is an internal mold and does not show features clearly, but does have faint impressions of the concentric ridges.

Occurrence.—Rare in the Lower Mercer unit. Also reported by Morningstar (1922) from the Boggs unit.

Repository.—Holotype, OSU-15254.

Phestia arata (Hall)
Pl. 2, figs. 4-9

Leda (Nucula) arata Hall, 1852, p. 413, pl. 2, figs. 5a, b.

Leda arata Girty, 1915b, p. 351, pl. 31, figs. 1-8.

Nuculana bellistriata White, 1884, p. 146, pl. 31, figs. 8, 9; Keyes, 1888, p. 233; —, 1894, p. 122, pl. 45, figs. 4a, b; Smith, 1896, p. 245.

Culunana bellistriata Lintz, 1958, p. 107, pl. 16, figs. 16, 17.

Polidevcia arata Driscoll, 1966, p. 7, pl. 3, figs. 1-14; Murphy, 1967, pl. 195, figs. 1, 2.

Phestia arata Hoare & Sturgeon, 1975, p. 92, pl. 2, figs. 9-14, text-fig. 8.

Medium-sized to large inequilateral equivalved inflated nuculaniform shells. Beaks small, tightly incurved, opisthogyrate; anterior margin uniformly curved and slightly produced, posterior margin produced and narrowly curved, and ventral margin evenly convex anteriorly, but straight to slightly concave posteriorly; lunule narrowly ovate and escutcheon narrowly triangular; ridge radiating from umbonal region to posterior extremity, with valve surface concave posterior to beaks along hinge line; surface marked by numerous angular ridges, steeper on the dorsal side, separated by flat to concave interspaces marked by fine growth lines, with 7-8 ridges occupying a space of 3 mm at a distance of 2 mm ventral from the beak area; ridges becoming obscure as they approach the posteriorly radiating ridge, fine growth lines continuing over the surface to the dorsal margin.

Hinge structure with taxodont dentition having up to 12 chevron-shaped denticles anterior to the chondrophore and up to 17 denticles posterior to it; chondrophore well developed with up to 6 reduced denticles above it; muscle scars well developed, consisting of prominent anterior and posterior adductors, small triangularly shaped anterior and posterior pedal retractors along the hinge line, small anterior protractor scars at the posterior edge of the anterior adductors, small subtriangular accessory scars of unknown function posterior to the posterior adductor scars, and 2 small scars of unknown function located just ventral to the umbonal area; a strong internal ridge running from the umbonal cavity, curving posteriorly; inner margin of valves finely crenulate; pallial line not visible (fig. 21). Measurements given in table 6.

Discussion.—*Phestia arata* differs from *P. bellistriata* by having more widely spaced and coarser concentric ridges, a posterior portion that is higher and less attenuate, and an anterior margin which is more produced, causing the beaks to be relatively nearer the midlength of the shell.

Occurrence.—Rare to abundant in the Brush Creek and Cambridge units; rare to common in the Putnam Hill unit; rare in the Vanport, Columbiana, Washingtonville, Dorr Run, and Portersville units.

Repository.—Hypotypes, OSU-27185 to 27189.

Phestia attenuata (Meek)
Pl. 2, figs. 10, 11

Nucula kazanensis Geinitz, 1866, p. 20, pl. 1, figs. 33, 34;

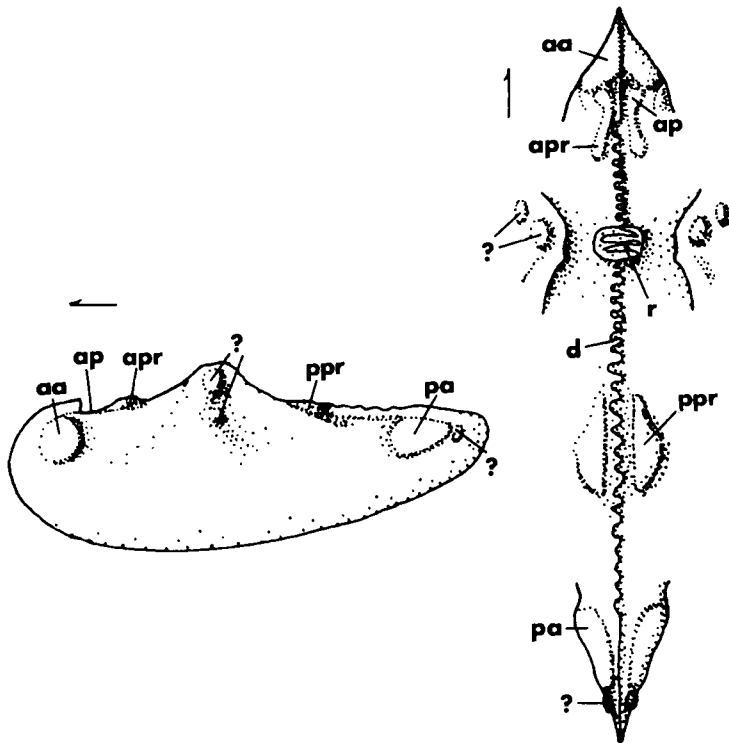


FIGURE 21.—Left lateral and dorsal views of internal mold of *Phestia arata* (Hall). Lateral view X2.25, dorsal view X3.25. *aa*, anterior adductor scar; *ap*, anterior protractor scar; *apr*, anterior pedal retractor scar; *d*, dentition; *pa*, posterior adductor scar; *ppr*, posterior pedal retractor scar; *r*, resilifer; ?, scars of unknown function.

[*non*] de Verneuil, 1845 (*vide* Morningstar, 1922, p. 206).

Nuculana bellistriata var. *attenuata* Meek, 1872, p. 206, pl. 10, figs. 11a, b; Beede, 1900, p. 149; Girty, 1915a, p. 125, pl. 14, figs. 10-11b.

Leda meekana Mark, 1912, p. 307, pl. 15, fig. 1; Morningstar, 1922, p. 206, pl. 10, figs. 25, 26.

Phestia attenuata Hoare & Sturgeon, 1975, p. 93, pl. 2, figs. 15, 16.

Small inequilateral equivalved slightly inflated nuculiform shells. Beaks small, tightly incurved, opisthogyrate; anterior margin uniformly convex and not produced, posterior margin attenuate and very narrowly curved, and ventral margin convex anteriorly and shallowly concave posteriorly; lunule and escutcheon narrow and not deeply impressed; surface marked by very fine concentric ridges and narrow interspaces with up to 17 ridges in a space of 3 mm just ventral to the beak area.

Hinge structure and other interior features not observed. Measurements given in table 6.

Discussion.—*Phestia attenuata*, originally designated by Meek (1872) as a variety of *P. bellistriata*, differs from the latter by the narrow and more attenuate posterior portion of

the shell, by consistently finer ornamentation, and by smaller shell size.

Occurrence.—Rare to common in the Columbiana unit; rare in the Putnam Hill, Brush Creek, and Portersville units. Also reported from the Lower Mercer unit by Morningstar (1922).

Repository.—Hypotypes, OSU-27190, 27191.

Genus *Solemya* Lamarck, 1818

Subgenus *Janeia* King, 1850

Solemya (Janeia) radiata Meek & Worthen

Pl. 2, figs. 12, 13

Solemya radiata Meek & Worthen, 1860, p. 457; ———, 1866b, p. 349, pl. 26, figs. 10a, b; Miller, 1889, p. 512; Beede, 1900, p. 160, pl. 22, figs. 5, 5a; Mark, 1912, p. 264, 286, 296; Price, 1918, p. 784, 787; Morningstar, 1922, p. 193; Chow, 1951, p. 12; Lintz, 1958, p. 100; Hoare, 1961, p. 94, pl. 12, fig. 12.

Medium-sized inequilateral equivalved elongate ovate compressed shells. Beaks low, slightly opisthogyrate; umbones low; posterior margin strongly curved into gently convex ventral margin, anterior margin more abruptly curved into dorsal than ventral margin, and dorsal margin nearly straight; valve surfaces evenly convex and marked by numerous fine growth lines and many irregularly spaced radial grooves.

Hinge edentulous and chondrophore not visible. Other interior features not observed. Measurements given in table 7.

Discussion.—*Solemya (J.) radiata* differs from *S. (J.) trapezoides* (Meek) in being consistently smaller in size and by having pronounced radial grooves. *S. (J.) parallella* Beede

TABLE 7.—Measurements of species of *Solemya*

Species	Locality	Specimen	Length (mm)	Height (mm)	Width (mm)
<i>S. (J.) radiata</i>	Ms-3	1	20.3	9.9	
		2	19.7	9.0	
		3	26.0	12.4	
		4	19.8	10.7	
<i>S. (J.) trapezoides</i>	Cuc-1	1	61.4	30.8	

& Rogers (1899) is a more elongate species with parallel dorsal and ventral margins.

Occurrence.—Rare to abundant in the Putnam Hill, Columbiana, and Washingtonville units; common in the Portersville unit; rare in the Lower Mercer, Vanport, Dorr Run, the shale over the Mason coal, and the Brush Creek units; questionably present in the Ames unit.

Repository.—Hypotypes, OSU-27192, 27193.

Solemya (Janeia) trapezoides (Meek)

Pl. 2, figs. 14-17

Solenomya sp. Meek & Worthen, 1873, pl. 27, figs. 1a, b.

Solenomya trapezoides Meek, 1874, p. 582; Beede & Rogers, 1899, p. 132, pl. 34, figs. 2a, b; Beede, 1900, p. 159, pl. 21, figs. 2a, b.

Solemya trapezoides Hoare, 1961, p. 96, pl. 12, fig. 14.

Medium-sized inequilateral equivalved elongate ovate compressed shells. Beaks small, depressed, slightly opisthogyrate; posterior and anterior margins broadly rounded into gently convex ventral margin, dorsal margin nearly straight, edges flared outward posterior to beak containing ligament; valve surfaces gently convex and marked by numerous faint to coarse irregularly spaced growth lines.

Hinge edentulous; chondrophore an inverted V-shaped structure just ventral and posterior of beak; internal ridge running from umbonal area around posterior adductor scar; posterior adductor scar large and subtriangular. Other interior features not observed. Measurements given in table 7.

Discussion.—*Solemya (J.) trapezoides* has a smaller width-length ratio than *S. (J.) radiata* Meek & Worthen and *S. (J.) parallella* Beede & Rogers and also differs in lacking the pronounced radial ornamentation of the last two species.

Occurrence.—Rare to abundant in the Washingtonville unit; rare to common in the Putnam Hill unit; rare in the Vanport and Columbiana units; questionably present in the Ames unit.

Repository.—Hypotypes, OSU-27194 to 27196, 28990.

Genus *Parallelodon* Meek & Worthen, 1866

Parallelodon obsoletus (Meek)

Pl. 2, fig. 18; pl. 3, figs. 1-3

Macrodon obsoletus Meek, 1871b, p. 71; —, 1875, p. 334, pl. 19, fig. 9; Keyes, 1891, p. 249; —, 1894, p. 120, pl. 44, fig. 1; Beede, 1900, p. 147, pl. 20, fig. 13; Girty, 1903, p. 443; Raymond, 1910, p. 155.

Parallelodon obsoletus Mark, 1912, p. 297; Price, 1918, p. 788; Morningstar, 1922, p. 209, pl. 11, figs. 1, 2; Morgan, 1924, pl. 47, fig. 17; Chow, 1951, p. 25, pl. 3, fig. 4; Hoare, 1961, p. 105, pl. 14, fig. 2.

Medium-sized strongly inequilateral equivalved elongate ovate shells. Beaks low, orthogyrate, located about one-fourth distance from anterior extremity; lunule and escutcheon absent; anterior margin forming near right angle with dorsal margin, then curving smoothly into ventral margin, which is gently convex to slightly sinuate, posterior margin meeting dorsal margin at right angle or broadly obtuse angle and curving abruptly into ventral margin; umbonal ridge prominent, extending to posteroventral extremity separating a concave posterodorsal area from the rest of the convex valve; a faint broad sulcus extending in some cases from the



FIGURE 22.—Hinge line of left valve of *Parallelodon obsoletus* (Meek & Worthen). X3.25. ac, anterior cardinal teeth; mc, medial cardinal teeth; p, posterior lateral teeth.

umbonal region to the ventral margin, corresponding to the sinuosity of the latter feature; surface of the concave posterodorsal area and extreme anterodorsal area marked by faint radial ribs; the rest of the valve surface smooth except for numerous lines of growth.

Hinge consisting of at least 3 anterior cardinal, 8 small medial cardinal, and 3 posterior lateral teeth (fig. 22). Other interior features not observed. Measurements given in table 8.

Discussion.—*Parallelodon obsoletus* is distinguished from *P. carbonarius* (Cox) under the latter species. *P. tenuistriatus* (Meek & Worthen, 1866a) has many faint radial costae across the entire posterodorsal surface, and *P. sangamonensis* (Worthen) has coarse radial ribs over most of the valve.

Occurrence.—Rare to abundant in the Lower Mercer, Putnam Hill, and Columbiana units; rare to common in the Washingtonville unit; rare in the Boggs, Vanport, Dorr Run, Cambridge, Portersville, and Ames units. Also questionably reported from the Lowellville unit by Morningstar (1922).

Repository.—Hypotypes, OSU-27197 to 27200.

Parallelodon carbonarius (Cox)

Pl. 3, figs. 4-8

Arca carbonaria Cox, 1857, p. 567, pl. 8, fig. 5.

Macrodon carbonaria Herrick, 1887, p. 32, pl. 4, figs. 14, 21.

Parallelodon carbonarius Mark, 1912, p. 297; Morningstar, 1922, p. 209.

Medium-sized strongly inequilateral equivalved elongate ovate inflated shells. Beaks low, orthogyrate, located approximately one-fourth distance from anterior extremity; lunule and escutcheon absent; anterior margin forming near right angle with dorsal margin, rounding smoothly into evenly convex ventral margin, posterior margin meeting ventral margin, forming a sharp obtuse angle, then rising

TABLE 8.—Measurements of species of *Parallelodon*

Species	Locality	Specimen	Length (mm)	Height (mm)	Width (mm)
<i>P. obsoletus</i>	Ty-3	1	30.0	13.0	
	Vs-3	1	31.0	14.3	
	Vel-11	1	16.5	8.4	
<i>P. carbonarius</i>	CAR-2	1	15.0	6.0	5.7
	LJho-1	1	31.7	16.9	
	Ms-3	1	44.0	18.4	
	Pr-1	1	18.2	8.6	
<i>P. sangamonensis?</i>	Ls-1	1	24.3	12.0±	
<i>P. tenuistriatus</i>	Pb-1	1	14.3	6.1	5.4
		2	12.7	5.0	4.6

vertically to meet dorsal margin at a right angle; umbonal ridge extending to posteroventral margin, setting off a gently concave posterodorsal area from the rest of the convex valve; surface marked by numerous pronounced radiating ribs, with those on the posterodorsal area being larger and more distinct; numerous fine lines of growth present, more conspicuous near the ventral margin; a broad sulcus from the umbo to ventral margin present in some specimens.

Hinge features not observed; subtriangular anterior adductor scar located in anterodorsal extremity; pallial line complete. Measurements given in table 8.

Discussion.—*Parallelodon carbonarius* differs from *P. obsoletus* (Cox) in having prominent radiating ribs on the valves; such ribs are lacking in the latter species. *P. sangamonensis* (Worthen) is a similar species, but has a more sinuate ventral margin and obsolescent ribs in the sulci, running ventrally from the umbonal area. *P. tenuistriatus* (Meek & Worthen) has very faint radial costae over all the posterodorsal surface.

Occurrence.—Rare to common in the Lower Mercer, Putnam Hill, and Vanport units; rare in the Upper Mercer, Columbiana, and Washingtonville units. Also reported from the Boggs unit by Morningstar (1922) and the Cambridge unit by Mark (1912).

Repository.—Hypotypes, OSU-27201 to 27203.

Parallelodon delicatus (Meek & Worthen)
Pl. 18, figs. 4, 5

Macrodon delicatus Meek & Worthen, 1870, p. 40; ---, 1873, p. 575, pl. 26, fig. 3.

Small strongly inequilateral equivalved elongate ovate shells. Beaks low, orthogyrate, located approximately one-fourth distance from anterior extremity; lunule and escutcheon absent; anterior margin forming near right angle with dorsal margin, rounding smoothly into evenly convex ventral margin, posterior margin meeting ventral margin, forming an obtuse angle, then sloping steeply to meet dorsal margin at right angle; umbonal ridge extending to posteroventral margin, setting off a concave posterodorsal area from the rest of the convex valve; surface marked by numerous closely spaced radiating ribs, with those in the posterodorsal area being more distinct; ribs crossed by numerous evenly spaced concentric lirae giving a cancellate appearance; a shallow sulcus from the umbo to ventral margin present.

Hinge has up to 3 posterior ridges and grooves, but other features not seen. Interior features not observed. Specimens all crushed, preventing valid measurements.

Discussion.—*Parallelodon delicatus* is most similar to *P. carbonarius* (Cox) and *P. sangamonensis* (Worthen) because of the presence of radiating ribs over the surface of the valve. It differs from these species by having more uniformly sized and evenly distributed radiating ribs and by the presence of the well-developed concentric lirae.

Occurrence.—Abundant in the Columbiana unit.

Repository.—Hypotypes, OSU-28998, 28999.

Parallelodon sangamonensis? (Worthen)
Pl. 3, figs. 9, 10

Macrodon sangamonensis Worthen, 1890, p. 123, pl. 21, figs. 3, 3a; Beede, 1900, p. 146, pl. 20, figs. 2, 2b.

Parallelodon sangamonensis Morningstar, 1922, p. 210, pl. 11, figs. 3, 4; Sayre, 1930, p. 108, pl. 9, figs. 17, 17a.

Medium-sized strongly inequilateral equivalved elongate ovate inflated shells. Beaks low, orthogyrate, located about one-fourth distance from anterior extremity; anterior margin meeting dorsal margin at near right angle, curving smoothly into ventral margin, which is convex to slightly sinuate; posterior margin truncate, possibly vertically; umbonal ridge extending to posteroventral margin; surface marked by coarse radial ribs except in sulcus, which extends ventrally from umbonal area, where the ribs are obsolescent; numerous growth lines present, more prominent near ventral border.

Hinge not observed except for 3 posterior lateral teeth; anterior adductor scar prominent at anterior extremity; pallial line extending posteriorly from adductor scar. Other interior features not observed. Measurements given in table 8.

Discussion.—We place the specimens described above in this species with some degree of uncertainty. In general they match those of Worthen but have less prominent radial ribs on the valves and less prominent sulci in most cases. The specimens are poorly preserved.

Occurrence.—Rare in the Cambridge and Portersville units. Also reported from the Lowellville, Lower Mercer, Upper Mercer, and Putnam Hill units by Morningstar (1922).

Repository.—Hypotypes, OSU-27204, 27205.

Parallelodon tenuistriatus (Meek & Worthen)
Pl. 3, figs. 11-13

Arca striata Geinitz, 1866, p. 20, pl. 1, fig. 32.

Macrodon tenuistriata Meek & Worthen, 1866a, p. 17; ---, 1873, p. 576, pl. 26, figs. 4a, b.

Parallelodon tenuistriatus Mark, 1912, p. 307, pl. 15, fig. 2; Morningstar, 1922, p. 210, pl. 10, figs. 30, 31.

Small strongly inequilateral equivalved inflated shells. Beaks low, orthogyrate, located one-fifth distance from anterior extremity; lunule and escutcheon lacking; anterior margin meeting dorsal margin at less than right angle, then curving uniformly into slightly convex ventral margin, posterior margin truncate to sinuate, curving sharply into ventral margin and meeting dorsal margin at an obtuse to right angle; prominent umbonal ridge extending to posteroventral extremity, setting off concave posterodorsal area from rest of shell body; surface marked by numerous fine closely spaced growth lines which cross entire shell; posterodorsal area has about 20 fine closely spaced radiating costae.

Hinge showing 4 anterior lateral teeth and 4 posterior lateral teeth, the latter being faintly ridged; a large subtriangular anterior adductor scar located in the anteroventral extremity; pallial line complete; posterior scar not evident. Measurements given in table 8.

Discussion.—*Parallelodon tenuistriatus* is easily distinguished by the large number of fine radiating costae in the posterodorsal area. No other known species has this characteristic.

Occurrence.—Abundant in the Ames unit; rare to common in the Portersville unit; rare in the Cambridge unit. Also reported from the Harrison, Lower Mercer, and Putnam Hill units by Morningstar (1922).

Repository.—Hypotypes, OSU-14032, 27206.

Genus *Modiolus* Lamarck, 1799

Subgenus *Modiolus* Lamarck, 1799

Modiolus (Modiolus) radiatus Hoare, Sturgeon & Kindt
Pl. 3, fig. 14

Modiolus (Modiolus) radiatus Hoare, Sturgeon & Kindt,
1978, p. 1023, pl. 1, fig. 1.

Small strongly inequilateral probably equivalved flattened shells. Beak located just back of anterior extremity; dorsal margin diverging from ventral margin to midlength, then curving convexly to meet ventral margin in a broadly rounded posterior extremity; surface marked by fine lines of growth and a few coarser growth lamellae near margins; numerous fine closely spaced radial riblets extend from umbonal area covering posterior two-thirds of valve.

Hinge structure and interior features not observed. Holotype 8.6 mm long and 4.7 mm high.

Discussion.—The above description is based upon a single well-preserved left valve. The radial riblets are arranged similarly to those in the modern genus *Geukensia* Poel, but are finer in character. In general form this species agrees well with *Volsellina* Newell except for the presence of the radial riblets and the lack of a distinct umbonal ridge. *Modiolus (Modiolus)* is described as lacking radial ornamentation, but, rather than creating either a new genus or subgenus based upon incomplete information, this species is assigned here.

Occurrence.—Rare in the Lower Mercer unit.

Repository.—Holotype, OSU-27207.

Genus *Promytilus* Newell, 1942

Promytilus pottsvillensis Hoare, Sturgeon & Kindt
Pl. 3, figs. 15-19

Myalina swallowi Morningstar, 1922, p. 219, pl. 11, fig. 13.
Promytilus pottsvillensis Hoare, Sturgeon & Kindt, 1978, p. 1024, pl. 1, figs. 2-6.

Small narrow shells. Hinge line relatively short and straight; anterior lobe developed; posterior margin broadly spatulate; beaks small, rising slightly above hinge line; umbonal ridge nearly straight, intersecting posteroventral margin; broad shallow sulcus running ventral to beaks and terminating in shallow byssal sinus ventrally; surface marked by numerous closely spaced growth lamellae.

Hinge structure and interior characteristics not observed. Measurements given in table 9.

Discussion.—A number of specimens, primarily from the Lower Mercer unit, form the basis for the above description. *P. pottsvillensis* differs from *P. swallowi* (McChesney) in having a smaller angle α and a greater form ratio, 6 specimens averaging 44° and 1.45, respectively. In general the posterior portion of the shell of *P. pottsvillensis* is less broadly spatulate in appearance than in *P. swallowi*. Other species of *Promytilus* possess smaller form ratios and, in general, larger values for angle α .

Occurrence.—Rare to common in the Lower Mercer unit; questionably present in the Zaleski flint unit.

Repository.—Holotype, OSU-4587-1; paratypes, OSU-4587-2, 27208 to 27210.

Promytilus cf. *P. annosus senex* Newell

Pl. 3, figs. 20, 21

Myalina swallowi Sayre, 1930, p. 116, pl. 10, figs. 8-8b.

Promytilus annosus var. *senex* Newell, 1942, p. 39, pl. 1, figs. 11, 12, pl. 2, figs. 4a, b, 6.

Small narrow elongate shells. Hinge line straight; posterior margin broadly spatulate; beaks small; sulcus shallow; shell material thin.

Hinge structure and other interior features not observed. Measurements given in table 9.

Discussion.—Two partial specimens, left and right valves, appear to compare favorably with *P. annosus senex*. The large size, the broader spatulate posterior margin, and comparable figures for angle α are diagnostic.

Occurrence.—Rare in the Vanport and Brush Creek units.

Repository.—Hypotypes, OSU-27211, 27212.

Genus *Volsellina* Newell, 1942

Volsellina subelliptica (Meek)
Pl. 3, fig. 22

Clidophorus (Pleurophorus) occidentalis Geinitz, 1866, p. 23, pl. 2, fig. 6.

Pleurophorus subellipticus Meek, 1867, p. 181.

Modiola? subelliptica Meek, 1872, p. 211, pl. 10, fig. 5.

Volsellina subelliptica Newell, 1942, p. 43, pl. 1, figs. 14-16b; Hoare, 1961, p. 118, pl. 15, fig. 11.

Small thin-shelled narrow spatulate shells. Dorsal and ventral margins diverging at angle of 24° ; beaks low, not extended above hinge line; umbonal ridge narrow, extending

TABLE 9.—Measurements of species of *Promytilus* and *Volsellina*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Great dimension (mm)	Form ratio	Angle α (degrees)
<i>P. pottsvillensis</i>	HOH-2	H	24.0	17.0	11.0	27.0	1.41	47
		P	16.2	11.3	11.0	18.0	1.45	43
	Llho-1	P	13.1	9.0	7.0	14.2	1.44	42
		P	19.0	11.0	12.0	19.0	1.73	40
	LIm-1	P	14.0	11.0	9.0	15.0	1.27	50
		3	10.0	7.0	7.0	11.0	1.43	43
<i>P. cf. P. annosus senex</i>	MUho-3	1	27.0	15.0	16.0	28.0	1.80	45
		1	40.0±	23.0±	27.0±	41.0±	1.74±	46±
<i>V. subelliptica</i>	MUho-3	1	22.8	12.2	11.2	22.8	1.87	36

¹H, holotype; P, paratype.

across valve from beaks to posteroventral margin in a low arc; hinge-line area about half valve length; surface marked by numerous closely spaced growth lamellae.

Hinge and interior features not observed. Measurements given in table 9.

Discussion.—One specimen, a nearly complete right valve, is present in the collections. All characteristics agree well with Newell's (1942) diagnosis and illustrations. The species is probably more common than indicated by the collections, but the thin-shelled nature of this form prevents abundant preservation or recognition.

Occurrence.—Rare in the Vanport unit.

Repository.—Hypotype, OSU-27213.

Genus *Pteronites* McCoy, 1844

Pteronites americana (Meek)

Pl. 4, figs. 1-4; pl. 17, fig. 7

Avicula pinnaeformis Geinitz, 1866, p. 31, pl. 2, fig. 13.

Aviculopinna americana Meek, 1867, p. 282; —, 1872, p. 197, pl. 9, figs. 12a-d; —, 1875, p. 337, pl. 20, fig. 2; Herrick, 1887, p. 38, pl. 1, fig. 20; Hyatt, 1892, p. 338; Keyes, 1894, p. 115; Beede, 1900, p. 143, pl. 18, fig. 2; Mark, 1912, p. 297; Girty, 1915a, p. 128, pl. 17, figs. 1, 1a; Morningstar, 1922, p. 211; Morse, 1931, p. 316, pl. 50, fig. 18; Chow, 1951, p. 7, 9, 12; Hoare & Sturgeon, 1972, p. 61, text-fig. 1.

Narrow elongate subtriangular shells. Dorsal margin nearly straight with keeled hinge line, ventral margin gently convex and rounding sharply at posterior margin to meet dorsal margin at nearly right angle; obsolete beaks located close to narrowly pointed anterior extremity; posterior gape large, but byssal gape not noticeable; shell material thin; surface of valves crossed by numerous fine ridges which run parallel to posterior and ventral margins.

Interior shell features not seen. Specimens range in length from 11.5 cm to 6.7 cm. Width of valves and thickness of shell indeterminate because all specimens are distorted.

Discussion.—*Pteronites americana* (Meek) differs only slightly from *P. illinoisensis* (Worthen, 1890) and was thought to be synonymous by Girty (1915a, p. 129). Because the types of the latter species were not seen it has not here been placed in synonymy with *P. americana*. *P. peracuta* (Shumard) has a ridged keel and is more cylindrical in cross-sectional shape.

Occurrence.—Rare to abundant in the Brush Creek unit. Also reported from the Boggs unit by Morningstar (1922) and from the Portersville and Ames units by Mark (1912).

Repository.—Hypotypes, OSU-27214 to 27216.

Pteronites peracuta (Shumard)

Pl. 4, figs. 5, 6

Pinna peracuta Shumard (*in* Shumard & Swallow, 1858), p. 214; Meek, 1872, p. 198, pl. 6, figs. 11a, b; White, 1877, p. 151, pl. 19, fig. 5a; Heilprin, 1886, p. 272, fig. 12, p. 273, fig. 12a; Keyes, 1894, p. 116, pl. 45, figs. 2a, b; Girty, 1899, p. 579; Beede, 1900, p. 144, pl. 18, figs. 3, 3b.

Pinna Adamsi McChesney, 1859, p. 74.

Aviculopinna peracuta Hyatt, 1892, p. 338; Girty, 1903, p. 432; —, 1909, p. 77; Chow, 1951, p. 26, pl.

3, figs. 5, 6.

Large elongate shells, broadly subrectangular in outline, oval in cross section. Hinge line nearly straight, keeled; ventral margin slightly curved; anterior extremity narrow and posterior extremity broadly expanded; surface marked by numerous lines of growth running parallel to posterior and ventral margins.

Beaks, gape, and interior features not observed. All specimens fragmentary. Largest specimen an incomplete internal mold measuring 12.5 cm long, 3.0 cm wide, and 4.2 cm high at large end; both ends missing, but projection of anterior angle and a minimal estimate of the posterior end giving a length of at least 24.0 cm.

Discussion.—Only fragmentary specimens are present and the identification is somewhat tentative, but several features indicate close similarity to the specimens described by Meek (1872). *P. peracuta* differs from *P. americana* (Meek) by being a much larger species, more broadly oval in cross section and with a stronger keel along the hinge line.

Occurrence.—Rare in the Brush Creek, Cambridge, and Ames units.

Repository.—Hypotypes, OSU-27217, 27218.

Genus *Myalina* de Koninck, 1842

Subgenus *Orthomyalina* Newell, 1942

Myalina (Orthomyalina) subquadrata? Shumard

Pl. 4, fig. 7; pl. 5, figs. 1, 2

Myalina subquadrata Shumard, 1855, p. 207, pl. C, fig. 17.

Myalina deltoidea Gabb, 1859, p. 297; —, 1860, p. 55, pl. 1, figs. 1a-c.

Myalina (Orthomyalina) subquadrata Newell, 1942, p. 58, pl. 9, figs. 1-4.

Large heavy nearly acline subquadrate shells. Relatively long hinge line; posterodorsal region with developed auricle; produced anteroventral margin; shallow sinus in posterior margin; beaks heavy, not extending above hinge line; umbones excavate; surface marked by strong relatively evenly spaced growth lamellae; ligament area marked by rather coarse widely spaced grooves, 5 in the space of 2.0 mm.

Interior features not observed. Measurements given in table 10.

Discussion.—Several poorly preserved or fragmentary specimens appear to fit the diagnosis of this species in general. The development of a posterior auricle and the acline, nearly opisthocline, orientation are most distinctive. Mark (1912) had previously recognized this species in the Conemaugh Group in Ohio.

Occurrence.—Rare to common in the Cambridge and Ames units; questionably present in the Brush Creek unit.

Repository.—Hypotypes, OSU-27219 to 27221.

Subgenus *Myalinella* Newell, 1942

Myalina (Myalinella) meeki? Dunbar

Pl. 5, fig. 3

Myalina meeki Dunbar, 1924, p. 201, figs. 3a, b.

?*Myalina pernaformis* Cox, 1857, p. 569, pl. 8, fig. 8.

?*Myalina? exasperata* Beede, 1899, p. 128, pl. 32, fig. 4.

Myalina (Myalinella) meeki Newell, 1942, p. 60, pl. 14, figs. 7-14.

TABLE 10.—Measurements of species of *Myalina* and *Septimyalina*

Species	Locality	Specimen	Length (mm)	Height (mm)	Great dimension (mm)	Angle α (degrees)	Angle β (degrees)
<i>M. (O.) subquadrata?</i>	Aam-7	1	58.0±	77.0±	78	68±	81.0±
	MUu-2	1	29.0		67	109	
<i>M. (M.) meeki?</i>	Cma-3	1	8.3	6.4	46	131	9.5
<i>S. perattenuata</i>	Ad-37	1	31.0±	51.0±	48	143	62.0±
	Ms-3	1	16.0	15.8	52	137	20.5
	MUc-5	1	45.0	47.0	58	124	51.6
	Vel-6	1	38.0±		52	131	
		2	22.0	26.0	47	98	30.3
<i>S. sinuosa</i>	Ts-4	1	52.0±	67.0±	53	42	81.0±
	Vel-14	1	50.0±	54.0±	44		70.0±
<i>S. orthonota?</i>	Jh-1	1	30.0±	21.0±	41	137	33.0±

Small subtriangular shells. Broadly rounded posteroventral margin; hinge margin straight, forming an obtuse angle with the posterior margin; beaks small, extended above hinge line; umbonal ridge straight except for arching in umbonal area; surface marked by a few growth lamellae but otherwise smooth.

Right valve and interior features not observed. Measurements given in table 10.

Discussion.—One small well-preserved specimen forms the basis for the above description. The specimen agrees well with the measurements and illustrations given by Newell (1942).

Occurrence.—Rare in the Brush Creek unit.

Repository.—Hypotype, OSU-27222.

Genus *Septimyalina* Newell, 1942

Septimyalina perattenuata (Meek & Hayden)

Pl. 5, figs. 4-11

Myalina perattenuata Meek & Hayden, 1858a, p. 77; —, 1859, p. 28; —, 1864, p. 32, pl. 1, figs. 12a-b.

?*Myalina kansasensis* Shumard (in Shumard & Swallow, 1858), p. 213.

Septimyalina perattenuata Newell, 1942, p. 66, pl. 13, figs. 3-12.

Narrow prosocline shells. Prominent beaks and umbonal areas; hinge margin straight, posterior margin broadly curved, forming obtuse angle with hinge line, and ventral margin narrowly rounded into anterior margin, which is straight to slightly sinuate, being convex ventrally and concave dorsally; ligament area narrow with 15 furrows in 5.0 mm; surface marked by more or less regularly spaced growth lamellae with those on left valve more prominent than those on right valve; umbones deeply excavate, floored by umbonal deck.

Right valve with small tooth at anterior end of hinge and corresponding depression in left valve. Other interior features not observed. Measurements given in table 10.

Discussion.—One nearly complete valve and several fragmentary specimens form the basis for the above description. They appear to agree with descriptions and illustrations of Newell (1942) and Meek and Hayden (1864). The number of ligamental furrows and the growth lamellae on the left valve are fewer than described by Newell (1942).

Occurrence.—Rare to common in the Lower Mercer and Cambridge units; rare in the Boggs, Putnam Hill, and Brush Creek units; questionably present in the Vanport and Columbiana units.

Repository.—Hypotypes, OSU-27223 to 27229.

Septimyalina sinuosa (Morningstar)

Pl. 5, figs. 14, 15

Myalina recurvirostris var. *sinuosa* Morningstar, 1922, p. 219, pl. 11, figs. 10-12.

Septimyalina sinuosa Newell, 1942, p. 69, pl. 12, figs. 10-13.

Moderately large prosocline shells. Beaks slender, prominent, extending above hinge line; subrhombic in shape except for extended posterodorsal extremity; umbonal ridge narrow and nearly straight; surface marked by nearly uniform growth lamellae.

Ligament area marked by 12 or more fine furrows, several of which descend to the hinge axis at a low angle. Umbonal deck massive in right valve. Dentition and musculature not observed. Measurements given in table 10.

Discussion.—The above description is based mainly on fragmentary specimens. Morningstar's (1922) type specimens from the Lower Mercer were studied by Newell (1942), but appear now to be lost.

The development of a posterodorsal extension with small angle β appears to be diagnostic of this species.

Occurrence.—Common in the Columbiana unit; rare in the Zaleski unit. Also reported by Morningstar (1922) from the Lower Mercer unit.

Repository.—Hypotypes, OSU-27230, 27231.

Septimyalina orthonota? (Mather)

Pl. 5, figs. 12, 13

Myalina orthonota Mather, 1915, p. 221, pl. 15, fig. 4.

Myalina pernaformis var. Morningstar, 1922, p. 218, pl. 11, figs. 5, 6.

Septimyalina orthonota Newell, 1942, p. 67, pl. 13, figs. 1, 2.

Small subquadrangular shells. Short hinge line; anterior and posterior margins nearly parallel; beaks slender, not extending above hinge line; ventral margin subquadrangular

in shape; umbonal ridge relatively straight.

Ligamental area and interior features not observed. Measurements given in table 10.

Discussion.—Two poorly preserved specimens described by Morningstar (1922) appear to be referable to *S. ortho-nota*. One specimen in particular shows the outline characteristics well and has a small angle α . These specimens are larger than those described by Mather (1915) from the Hale Formation of Arkansas. Poor preservation does not allow a complete diagnosis.

Occurrence.—Rare in the Harrison unit.

Repository.—Hypotypes, OSU-15267, 15268.

Genus *Monopteria* Meek & Worthen, 1866

?*Monopteria subalata* Beede & Rogers

Pl. 6, fig. 1

Monopteria subalata Beede & Rogers, 1899, p. 133, pl. 34, figs. 3a, b.

Limopteria subalata Beede, 1900, p. 131, pl. 21, figs. 3a, b; Hoare, 1961, p. 114, pl. 14, fig. 12.

Medium-sized strongly prosocline shells without extended or produced posterior wing. Dorsal margin probably short and straight; posterior margin forming a broad smooth curve from the produced extremity to where it meets the dorsal margin at an obtuse angle; ventral margin smoothly convex, rounding narrowly into the posterior margin; umbonal carina or shoulder running to posterior extremity, paralleling the curve of the posterior margin.

Left valve, anterior margin of right valve, and interior features not observed. A specimen from the Lower Mercer unit approximately 21.0 mm long and 16.5 mm high.

Discussion.—One partial internal mold is the basis for the above description. Growth lines on the mold indicate no winglike extension of the posterior auricle as is typical in the genus *Monopteria*.

Occurrence.—Rare in the Lower Mercer unit.

Repository.—Hypotype, OSU-27232.

Genus *Placopterina* Hoare, Sturgeon & Kindt, 1978

Placopterina ohioensis Hoare, Sturgeon & Kindt

Pl. 6, figs. 2-5

Placopterina ohioensis Hoare, Sturgeon & Kindt, 1978, p. 1025, pl. 1, figs. 7-10.

Small moderately inequilateral nearly equivalved shells. Hinge line straight; beaks small, prosogyrate, raised slightly above the hinge line; anterior wing or auricle small, meeting dorsal margin in an obtuse angle; anterior margin uniformly convex and posterior margin meeting dorsal margin at right angle and having less convexity than anterior margin; posterior auricle a broad winglike structure not set off from body of shell; surface marked by numerous closely spaced fine lines of growth, no evidence of any radial ornamentation; both valves with the same ornamentation; shell material thin.

Hinge structure not seen except for fine posterior parallelodont laterals. Other interior features not observed. Holotype 10.8 mm long and 12.1 mm high.

Discussion.—One specimen forms the basis for the above description. It consists of nearly perfect external and internal molds of both valves, with small pieces of shell

material adhering to the internal molds. No other known species is assignable to this genus.

Occurrence.—Rare in the Lower Mercer unit.

Repository.—Holotype, OSU-27233.

Genus *Leptodesma* Hall, 1883

Subgenus *Leptodesma* Hall, 1883

Leptodesma (Leptodesma) ohioense (Herrick)

Pl. 6, figs. 6, 7

Gervillia? ohioense Herrick, 1887, p. 36, pl. 3, fig. 12, pl. 4, fig. 13.

Avicula (Gervillia) ohioense Herrick, 1887, p. 145, pl. 14, fig. 22.

Pteria ohioense Morningstar, 1922, p. 212.

Pteria longa Hoare, 1961, p. 113, pl. 14, figs. 6, 7.

Small strongly prosocline pteroid shells. Anterior auricle small and angular, posterior auricle produced in a long acuminate wing; posterior umbonal fold more prominent than anterior, separated from wing by relatively deep sinus; posterior portion of valve produced, extending farther posteriorly than wing; ventral margin evenly convex or slightly sinuate, rounding gently into anterior margin, which rises nearly vertically to dorsal margin; beaks rising slightly above hinge line; angle between dorsal margin of wing and posterior umbonal fold averaging 27°; surface marked by numerous irregularly spaced growth lines.

Right valve and internal features not observed. Measurements given in table 11.

Discussion.—*Leptodesma (L.) ohioense* differs from *L. (L.) sulcata* (Geinitz) by lacking the radiating sulci on the anterior auricle, by having much smaller anterior auricles, and by having a smaller angle between the wing and umbonal ridge. *L. (L.) longa* (Geinitz) is a narrower elongate form, more produced posteriorly, more narrowly rounded posteriorly, and with a larger angle between the wing and umbonal ridge.

Occurrence.—Rare in the Putnam Hill and Vanport units; rare to common in the Lower Mercer unit. Also reported by Morningstar (1922) as questionably present in the Zaleski unit.

Repository.—Hypotypes, OSU-27234, 27235.

Leptodesma (Leptodesma) sulcata? (Geinitz)

Pl. 6, figs. 8, 9

Gervillia sulcata Geinitz, 1866, p. 33, pl. 11, fig. 16.

Avicula? sulcata Meek, 1872, p. 200, pl. 9, fig. 9.

Pteria sulcata Beede, 1900, p. 126, pl. 16, fig. 3.

TABLE 11.—Measurements of species of *Leptodesma*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Angle α (degrees)
<i>L. (L.) ohioense</i>	LIho-1 Vel-7	1 LV	8.7	15.0	28
		1 LV	6.5	10.3	33
<i>L. (L.) sulcata?</i>	Cfr-1	1 LV	7.1	11.0±	42
		2 RV	6.2	9.5	30
<i>L. (L.) longa</i>	Pb-1	1 LV	6.3	12.5	34

¹ LV, left valve; RV, right valve.

Small strongly prosocline pteroid shells. Left valve with anterior auricle relatively large and posterior auricle produced into a broadly acuminate wing; posterior sinus broad and deep; posterior margin straight to gently convex, curving broadly into ventral margin, which is sinuate; 2 sulci radiate from the umbonal area on the anterior portion of the body, just posterior of the anterior auricle; numerous closely spaced growth lines present; beaks rising slightly above hinge line; valve inflated; 42° angle between dorsal margin of posterior wing and umbonal fold.

Right valve less inflated, with a smaller angle between wing and umbonal fold and only 1 radial sulcus anteriorly. Internal characteristics not observed. Measurements given in table 11.

Discussion.—Two specimens, partial left and right valves, form the basis for the above description. The specimens are distorted by compaction, which makes precise identification difficult. The presence of the sulci on the anterior portion of the valves appears diagnostic.

Occurrence.—Rare in the Brush Creek unit.

Repository.—Hypotypes, OSU-27236, 27238.

Leptodesma (Leptodesma) longa (Geinitz)

Pl. 6, fig. 10

Gervillia longa Geinitz, 1866, p. 32, pl. 2, fig. 15.

Avicula longa Meek, 1872, p. 199, pl. 9, fig. 8; Meek & Worthen, 1873, p. 578, pl. 26, figs. 1a, b.

Pteria longa Beede, 1900, p. 125, pl. 16, fig. 4; Sayre, 1930, p. 110, pl. 9, figs. 13, 14.

Small strongly prosocline pteroid shells. Anterior auricle small and angular, and posterior auricle produced in a long acuminate wing; posterior umbonal fold strong, only slightly more so than anterior fold; posterior sinus between wing and fold strongly developed; posterior portion of valve greatly produced, with posterior margin nearly straight, rounding narrowly into ventral margin, which is slightly convex; anterior margin rising vertically to dorsal margin; beaks

extending slightly above hinge line; left valve inflated; angle between dorsal margin of posterior wing and umbonal fold about 34°; surface ornamentation unknown; internal mold smooth.

Right valve and internal features not observed. Measurements given in table 11.

Discussion.—One specimen, an internal mold of a left valve, is the basis for the above description. The narrowness of the body, with a nearly straight posterior margin, and the size of the angle between the wing and posterior fold appear distinctive.

Occurrence.—Rare in the Portersville unit.

Repository.—Hypotype, OSU-27237.

Genus *Dunbarella* Newell, 1937

Dunbarella striata (Stevens)

Pl. 6, figs. 11-14

Posidonomya striata Stevens, 1858, p. 265.

Aviculopecten whitei Meek, 1872, p. 195, pl. 4, figs. 11a-c.

Dunbarella whitei Newell, 1937, p. 39, pl. 1, figs. 9-11; pl. 2, figs. 12-18.

Dunbarella appalachiensis Lintz, 1958, p. 111, pl. 16, figs. 21, 23.

Dunbarella striata Murphy, 1967, p. 1500, pl. 195, figs. 8-12.

Small prosocline orbicular shells. Anterior auricle small, noncostate or having 3-4 obsolescent costae; posterior auricle large, smooth or faintly costate, flat, and not set off from shell body; beak located close to anterior extremity of hinge line; anterior fold moderately developed along with pronounced anterior sulcus; left valve with 16-28 low rounded costae, which increase by intercalation; right valve with similar number of costae increasing by bifurcation; numerous fine growth lines crossing shell body and auricles; angle at posterodorsal extremity broadly obtuse.

Hinge structure and internal features not observed. Measurements given in table 12.

TABLE 12.—Measurements of species of *Dunbarella*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)	No. of costae on anterior auricle	No. of body costae	
<i>D. striata</i>	Cfr-1	1 LV	9.6	10.1	7.0	96	0	18	
		2 LV	12.9	13.5	8.2	98	0	28	
		3 LV	15.0	16.0	11.3	103	0	26+	
		4 LV	10.4	11.5	7.8	106	0	21+	
		5 RV	13.0		9.8	100	0	23	
		6 RV	9.0	9.5	7.4	104	0	16	
	Vel-15	1 LV	11.0	11.1	8.5	104	2-3	26	
		2 LV	11.1	15.8	10.0	102	0	25	
		3 LV	13.1	12.2	9.9	105	0	27	
	<i>D. knighti</i>	Ms-3	1 LV	24.2	23.0	18.9	118	7	56+
			2 LV	21.0	21.0+	17.3	103	5	55+
			3 LV	23.5	24.0	17.6	108	3+	78
4 LV			23.8	23.5	13.4	107	7	44+	
5 LV			23.0	23.0	20.1	112	5	53	
6 RV			21.5	18.8+	20.0	115	5	42+	
<i>D. rectalaterarea?</i>	Ms-3	1 LV	24.0	25.7	19.6	106	4+	42	
		2 LV	34.2	34.0	30.0+	108	8	61	
	Cc-4	1 LV	29.5	31.1	20.6	109	5+	68+	

¹ LV, left valve; RV, right valve.

Discussion.—*Dunbarella striata* is easily distinguished from *D. rectalaterarea* (Cox) and *D. knighti* Newell by the small number of body costae and smooth to faintly costate auricles. The last two species generally reach a much larger size than does *D. striata*.

Occurrence.—Rare in the Columbiana unit and the shale over the Mason coal; rare to common in the Vanport and Washingtonville units; common in the Dorr Run unit; rare to abundant in the Putnam Hill and Brush Creek units; questionably present in the Boggs unit. Also recently found in the Birmingham shale unit approximately 75 feet above the Ames limestone.

Repository.—Hypotypes, OSU-27239 to 27242.

Dunbarella knighti Newell
Pl. 6, figs. 15-23

Dunbarella knighti Newell, 1937, p. 40, pl. 2, figs. 8-10.

Large prosocline orbicular to subquadrate shells. Anterior auricle small, triangular, with 5-7 costae, and set off from shell body by distinct sulcus and moderate umbonal fold; posterior auricle broad, costate, and not well defined from shell body; beak located just anterior of midlength of hinge line; left valve with up to 78 costae, which increase by intercalation; right valve with similar number of costae, which increase by bifurcation; numerous fine growth lines crossing shell body and auricle; the posterior and dorsal margins meeting at a narrowly obtuse or right angle.

Hinge structure and other internal features not observed. Measurements given in table 12.

Discussion.—*Dunbarella knighti* differs from *D. striata* (Stevens) by reaching a larger size, having costate auricles, and having more numerous body costae. *D. rectalaterarea* (Cox) differs in being more rectangular in form, with a straighter posterior margin. The specimens described above agree closely with Newell's (1937) description and illustrations, although a number appear to have fewer body costae. Preservation, mainly as internal molds, makes counting difficult and the counts given in table 12 may be smaller than they should be in most cases.

Occurrence.—Rare in the Vanport unit; rare to common in the Columbiana and Brush Creek units; rare to abundant in the Putnam Hill, Washingtonville, and Dorr Run units; abundant in the Tuscarawas, shale over the Mason coal, and Skelley units; questionably present in the Lower Mercer unit.

Repository.—Hypotypes, OSU-27243 to 27249.

Dunbarella rectalaterarea? (Cox)
Pl. 6, fig. 24

Avicula rectalaterarea Cox, 1857, p. 571, pl. 9, fig. 2.
Dunbarella rectalaterarea Newell, 1937, p. 40, pl. 2, figs. 5-7.

Large prosocline subquadrate shells. Anterior auricle small, subtriangular, with 4-8 costae, and set off from shell body by distinct sulcus; posterior auricle broad, costate, and not distinctly set off from shell body; beak located anterior to midlength of hinge line; left valve with up to 68 or more intercalate costae; numerous fine growth lines cross shell body and auricle; posterior margin nearly straight and meeting dorsal margin at right angle.

Right valve and internal structures not observed. Measurements given in table 12.

Discussion.—A few specimens, occurring with a large number of specimens of *D. knighti* Newell, appear to fit the description of *D. rectalaterarea*. The subquadrate nature of the shell is the only distinguishing feature between this species and *D. knighti* Newell. It is possible that the specimens under consideration here are only growth variations of the latter species.

Occurrence.—Rare in the Washingtonville unit; common in the Putnam Hill unit; questionably present in the Lower Mercer unit.

Repository.—Hypotype, OSU-27250.

Genus *Aviculopecten* M'Coy, 1851: emend. Newell, 1937
Aviculopecten halensis? Mather
Pl. 7, figs. 1, 2

Aviculopecten halensis Mather, 1915, p. 223, pl. 15, fig. 17;
Newell, 1937, p. 59, pl. 5, figs. 5, 6.
Aviculopecten arkansanus Mather, 1915, p. 226, pl. 15, fig. 13.

Small acline convex shells. Hinge length approximately equal to shell length and height slightly greater than length; anterior umbonal fold more conspicuous than posterior fold; anterior auricle with shallow sulcus and 6-8 narrow costae; posterior auricle with shallow sulcus and 5 faint costae; umbonal angle approximately 80°; body costae in three ranks numbering up to 22 with at least 7 primaries; posterior body costae not enlarged; closely spaced concentric fila, 44-47 per 2 mm, cross costae and interspaces producing spinelike projections on costae; fila curved convexly toward the dorsal margin in interspaces and extending across the auricles.

Right valve flattened with deep anterior sulcus; anterior auricle with at least 4 costae; posterior auricle with at least 2 faint narrow costae; body costae broad with narrow interspaces, numbering 18 and increasing by bifurcation; fila probably like those on left valve, but not as prominent and not forming spinelike projections crossing costae.

Internal features unknown. Measurements given in table 13.

Discussion.—A number of specimens from the Pottsville and Lower Allegheny agree fairly closely with Mather's (1915) description and Newell's (1937) diagnosis. The specimens have a somewhat smaller umbonal angle and a larger number of costae on the anterior auricle, although the inner 3-4 are quite faint. *A. egalensis* (Price, 1916b) differs in having fewer body costae and lacks projections formed by the fila crossing the costae. *A. germanus* Miller & Faber has a more quadrate form.

Occurrence.—Rare in the Lower Mercer, Putnam Hill, and Vanport units.

Repository.—Hypotypes, OSU-27252, 27253.

Aviculopecten germanus Miller & Faber
Pl. 7, figs. 3-6

Aviculopecten germanus Miller & Faber, 1892, p. 81, pl. 1, fig. 19; Newell, 1937, p. 55, pl. 4, figs. 13a, b, 14.

Small acline to slightly prosocline subquadrate shells. Height and length nearly equal and hinge line about equal to

length; anterior sulcus shallow and posterior sulcus shallow to absent; anterior auricle set off by low umbonal fold, and posterior auricle not set off from body of shell; anterior auricle with 5 costae; umbonal angle 79°-85°; body costae, of at least 3 ranks, number up to 27; fine closely spaced fila, 15 per 2 mm, crossing costae and broadly flattened interspaces, curving convexly in a dorsal direction and extending across auricles.

Right valve and internal features not observed. Measurements given in table 13.

Discussion.—*Aviculopecten germanus* is easily distinguished from other species of this genus by the shallow anterior sulcus, subquadrate shape, and the lack of an umbonal fold setting off the posterior auricle on the left valve.

Occurrence.—Rare in the Lower Mercer and Putnam Hill units.

Repository.—Hypotypes, OSU-27254 to 27257.

Aviculopecten sorer Herrick
Pl. 7, figs. 7, 8, 10

Aviculopecten sorer Herrick, 1887, p. 27, pl. 1, fig. 3, pl. 3, fig. 16; Morningstar, 1922, p. 227.

Medium-sized acline to slightly opisthocline suborbicular shells. Height and length about equal and hinge line slightly shorter than length; anterior and posterior umbonal

folds nearly straight; anterior auricle with up to 12 costae, and posterior auricle very acute and with about the same number of costae, but not as strongly developed; umbonal angle 80°-85°; body costae in 3 to 4 ranks evenly inserted and distributed with each rank of different height and numbering from 26 to over 60; fine concentric fila cross costae, producing projections.

Right valve and internal features not observed. Measurements given in table 13.

Discussion.—*Aviculopecten sorer* is easily distinguished from other species of this genus by the uniform arrangement of body costae and very acute posterior auricle of the left valve. It is similar to *A. gradicosta* Newell (1937) but differs in having fewer body costae, a larger umbonal angle, and shallower posterior sinus.

Occurrence.—Rare in the Lower Mercer, Putnam Hill, and Vanport units.

Repository.—Hypotypes, OSU-27258 to 27260.

Aviculopecten occidentalis (Shumard)
Pl. 7, figs. 13-15

Pecten occidentalis Shumard, 1855, p. 207, pl. C, fig. 18.
Aviculopecten occidentalis Newell, 1937, p. 51, pl. 4, figs. 4-9, pl. 5, fig. 7.

Medium-sized acline to slightly prosocline suborbicular shells. Valve with low convexity and with height greater

TABLE 13.—Measurements of species of *Aviculopecten*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)	Convexity (mm)	No. of auricle costae		No. of body costae at given height (mm)					
								Anterior	Posterior						
<i>A. halensis?</i>	MUho-3	1 LV	6.5	8.5	5.5	70	1.0±	5	7	22	5				
		LIm-1	1 LV	6.5	7.5	7.0±						80	8	22	5
		Llho-1	1 LV	4.5	5.0	4.5±						77	6	14	5
		Vel-22	1 RV	6.0	6.0	6.5						86	4	2+	18
<i>A. germanus</i>	Pr-2	1 LV	5.5	6.5	5.0	79		3+	8	24	5				
		Vel-7	1 LV	10.3	11.0	9.4						85	5	4+	30
<i>A. sorer</i>	MUc-5	1 LV	14.0	14.0	13.5	87		8±	12	62	14				
		2 LV	16.5	15.2	11.5	85						26	10		
<i>A. occidentalis</i>	MEco-1	1 LV	22.0	26.0	18.5	81	3.0	10	8	39	25				
		2 LV	13.0	13.0	12.0	80						7	34	13	
<i>A. coxanus</i>	Pr-2	1 LV	8.5	9.5		70	1.5	10	9+	37	9				
		Llho-4	1 LV	11.0	11.5	9.2						72	49	11	
		2 LV			9.1	75						8	16	24	6
<i>A. arctisulcatus</i>	MEco-1	1 LV	30.0	31.0		83		5+	12	41	30				
		2 RV	24.0	25.5	22.0	101						30	25		
		3 LV	32.5	30.0	25.0	82						8	4	44	32
<i>A. bascilicus?</i>	Ay-21	1 LV	33.0	34.0	22.5	88	6.5			35	20				
		2 LV	32.0	35.0	27.0	82						5.0			
		Cma-7	1 LV	20.0	25.0	16.0±						84	5.5		
<i>A. columbianus</i>	Cs-3	P LV	7.0	8.2	5.1	75	2.0	3+	3+	14	7				
		P RV	4.1	4.4	4.0	84						0	13±	4	
		H LV	7.9	7.2	6.9	83						1.9	2+	17±	7
	Mg-7	1 LV	5.6	7.0	4.5	60	2.0	2+		18	5				
		Cp-3	1 LV	9.5	10.2	6.4						81	1.8	2	0
<i>A. appalachianus</i>	Vel-22	H LV	19.0	19.0	16.0	85	2.5+	5	6	50+	19				
		P LV	9.0	9.5	7.1	89						6	12±	38	9
		Hfg-6	1 LV			13.2						83	6	10	30

¹ LV, left valve; RV, right valve; P, paratype; H, holotype.

than length and hinge line shorter than length; anterior umbonal fold much more distinct than posterior and flaring out more sharply; anterior auricle with 5 primary costae, about the same number of secondaries, and posterior auricle with 8-10 costae; umbonal angle about 80°; body costae closely spaced, irregular, and numbering from 24 to 39; costae on anterior fold crowded, and first posterior costa enlarged and bearing short heavy spines; closely spaced fila present and more prominent on anterior auricle.

Right valve and internal features not observed. Measurements given in table 13.

Discussion.—*Aviculopecten occidentalis* is most easily confused with *A. moorei* Newell (1937), but the latter species is more spinose. *A. arctisulcatus* Newell has smooth to faintly costate posterior auricles, a more distinct posterior umbonal fold, and a stronger convexity. *A. basilicus* Newell lacks spines on the body costae and has broader and flatter costae.

Occurrence.—Abundant in the Ames unit; rare to common in the Brush Creek unit; questionably present in the Portersville unit. Also reported from the Boggs, Lower Mercer, and Putnam Hill units by Morningstar (1922) and from the Cambridge unit by Mark (1912).

Repository.—Hypotypes, OSU-27261, 27262.

Aviculopecten coxanus Meek & Worthen
Pl. 7, figs. 9, 11, 12

Aviculopecten coxanus Meek & Worthen, 1860, p. 453; Herrick, 1887, p. 26, pl. 1, figs. 4, 17; Morningstar, 1922, p. 226.

Small acline to slightly prosocline suborbicular shells. Height slightly greater than length and hinge line equal to length; anterior umbonal fold more pronounced than posterior and more outwardly flaring; anterior auricle with 10 costae and posterior auricle with 9-10 costae; umbonal angle 70°-75°; body costae in 3 ranks and at least 49 in number; surface crossed by fine fila, numbering 12 in 2 mm near ventral border, extending across auricles and not forming projections where they cross body costae.

Right valve and internal features not observed. Measurements given in table 13.

Discussion.—*Aviculopecten coxanus* differs from *A. soreri* Herrick by having less regularly spaced costae, no projections where fila cross costae, and a small umbonal angle. *A. halensis* Mather has projections from costae, finer fila, and fewer body costae.

Occurrence.—Rare in the Lower Mercer unit. Also reported from the Harrison, Sharon, Lowellville, Boggs, Upper Mercer, Putnam Hill, and Zaleski units by Morningstar (1922) and from the Brush Creek and Portersville units by Mark (1912).

Repository.—Hypotypes, OSU-27263 to 27265.

Aviculopecten arctisulcatus Newell
Pl. 7, figs. 16-19

Aviculopecten arctisulcatus Newell, 1937, p. 50, pl. 4, figs. 1-3.

Medium-sized acline moderately convex suborbicular shells. Height slightly greater than length and hinge line less than valve length; anterior umbonal fold pronounced,

posterior less pronounced; anterior auricle with 8 costae, posterior with 4-5 faint costae, which become obsolescent before reaching margin; umbonal angle 80°-82°; body costae broadly rounded to somewhat flattened, numbering 41-44; posterior body costae enlarged and bearing coarse spines; entire valve surface filose with 26 fila per 22 mm on anteroventral portion of valve.

Right valve with umbonal angle about 100°; narrow anterior sulcus; anterior auricle with 4-6 closely spaced broadly rounded coarsely filose costae; posterior auricle acuminate and filose, with up to 12 faint and narrow costae; body costae broad and low with narrow indistinct interspaces and numbering about 30; valve body faintly filose.

Internal features not observed. Measurements given in table 13.

Discussion.—*Aviculopecten arctisulcatus* is distinguished from *A. occidentalis* (Shumard) under the latter species. *A. moorei* Newell is much more spinose. *A. exemplarius* Newell (1937) lacks fila on adult portions of the valve and *A. basilicus* Newell has broader and heavier costae and lacks spines.

Occurrence.—Rare in the Brush Creek unit; common in the Ames unit.

Repository.—Hypotypes, OSU-27266, 27267.

Aviculopecten basilicus? Newell
Pl. 7, figs. 20-22

Aviculopecten basilicus Newell, 1937, p. 52, pl. 6, figs. 13-16b.

Medium-sized to large acline to slightly opisthocline strongly convex shells. Umbonal folds strongly developed; auricles costate; umbonal angle up to 88°; body costae broad and rounded, wider than interspaces, and lacking spines; surface filose.

Right valve and internal features not observed. Measurements given in table 13.

Discussion.—Several poorly preserved specimens from two localities in the Cambridge unit agree fairly well with Newell's (1937) description of this species. Preservation prevents a more exact and complete description. The shape of the costae and the lack of spines appear diagnostic.

Occurrence.—Common in the Cambridge unit.

Repository.—Hypotypes, OSU-27268 to 27270.

Aviculopecten columbianus Hoare, Sturgeon & Kindt
Pl. 8, figs. 4-7

Aviculopecten columbianus Hoare, Sturgeon & Kindt, 1978, p. 1025, pl. 1, figs. 14-17, text-fig. 1.

Small acline to slightly prosocline strongly convex orbicular shells. Anterior umbonal fold strong, posterior fold distinct; anterior auricle small, subtriangular, with possibly 2 faint costae; posterior auricle small, not acuminate and apparently noncostate; umbonal angle about 75°-83°; body costae narrow, low, with 7 primaries and up to 15 secondaries and tertiaries where there are 3 ranks present; most commonly only 2 ranks are present with an average of 15 costae; interspaces much wider than costae; spines not evident; surface apparently filose; shell substance with a crossed-lamellar concentric structure.

Left valve interior with a U-shaped pallial line, divided

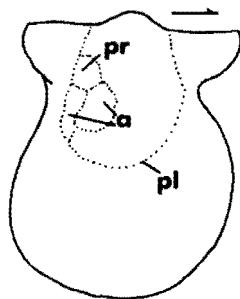


FIGURE 23.—Interior view of left valve of *Aviculopecten columbianus* Hoare, Sturgeon & Kindt. X6. *a*, divided adductor scar; *pl*, pallial line; *pr*, pedal retractor scar.

adductor muscle scar, and small pedal retractor scar visible (fig. 23).

Right valve with small anterior sulcus and indistinct posterior umbonal fold; anterior auricle with possibly 3 faint costae, and posterior auricle smooth; body costae low and broad, numbering about 13; surface, including auricles, faintly filose. Measurements given in table 13.

Discussion.—*Aviculopecten columbianus* may be a derivative of *A. germanus* Miller & Faber, but it can easily be distinguished by its greater convexity, deeper posterior sulcus, stronger umbonal folds, and fewer costae. *A. egalensis* (Price) and *A. halensis* Mather have more costae on the auricles, are more strongly filose, and have fewer costae per given height.

Occurrence.—Rare in the Columbiana unit.

Repository.—Holotype, OSU-27271; paratypes, OSU-27272 to 27274.

Aviculopecten appalachianus Hoare, Sturgeon & Kindt
Pl. 8, figs. 1-3

Aviculopecten appalachianus Hoare, Sturgeon & Kindt,
1978, p. 1026, pl. 1, figs. 11-13.

Medium-sized slightly prosocline moderately convex shells. Anterior umbonal fold strongly developed, posterior

fold distinct but more gentle; anterior auricle with 5-6 rounded primary costae and posterior auricle large and acuminate with 6-8 fine faint costae; umbonal angle 83°-89°; body costae narrow, rounded to flat topped, numbering up to 50; posterior body costae not enlarged; no evidence of spines on valves; fila numbering up to 16 per 2 mm on valve and auricles.

Right valve and internal features not observed. Measurements given in table 13.

Discussion.—*Aviculopecten appalachianus* is most similar to *A. mazonensis* Worthen (1890), but differs in having a more pronounced anterior umbonal fold, more widely spaced fila, and a larger number of costae. The spinose characteristic in *A. occidentalis* (Shumard) and *A. arctisulcatus* Newell distinguishes these species from *A. appalachianus*. *A. basilicus* Newell is more strongly convex and is slightly opisthocline in character.

Occurrence.—Rare in the Lower Mercer, Putnam Hill, and Vanport units.

Repository.—Holotype, OSU-27275; paratypes, OSU-27276, 27277.

Genus *Acanthopecten* Girty, 1903
Acanthopecten carboniferous (Stevens)
Pl. 8, figs. 8-12

Pecten carboniferous Stevens, 1858, p. 261.

Pecten Hawni Geinitz, 1866, p. 36, pl. 2, figs. 19a, b.

Aviculopecten carboniferous Herrick, 1887, pl. 3, fig. 13.

Acanthopecten carboniferous Mark, 1912, p. 308, pl. 15, fig. 4; Morningstar, 1922, p. 229; Sayre, 1930, p. 121, pl. 12, figs. 5, 6; Newell, 1937, p. 72, pl. 12, figs. 8a-10.

Acline semicircular shell with pronounced auricles and low convexity. Left valve with 15-18 broad rounded costae, each with a narrow central keel; keel widening and becoming more rounded ventrally; surface of valve crossed by numerous concentric closely spaced fila; coarse nonvaulted concentric fila crossing shell at average shell lengths of 5.5, 7.0, 9.0, 11.0, 13.0, 16.0, and 20.0 mm; coarse fila projecting ventrally as spines in the intercostal grooves; posterior auricle large, with cardinal costae and at least 4 auricular costellae present; posterior umbonal fold low; anterior auricle well developed, crossed by fila; narrow deep angular

TABLE 14.—Measurements of species of *Acanthopecten*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)	No. of auricle costae		No. of body costae	No. of coarse fila
							Anterior	Posterior		
<i>A. carboniferous</i>	Llho-1	1 LV	8.5	8.0	7.5	96			17	4
		2 LV	21.0	20.0		91			15	8
		3 LV	19.0	18.0		99			15	4
		4 LV	20.0	15.0		97			14	4
	Llfr-2	1 LV	14.0	12.0	12.0	100		3	16	3
		2 LV	12.0	11.5	11.0	99			16	3
	Llm-1 MUmu-1	1 LV	18.0	18.0	16.0	97		4+	17	5
		1 LV	20.0	18.0	14.0	98		4+	19	6
<i>A. bellosum</i>	Hfg-6	P LV	27.0±	25.0	21.0±	94			16	6
		H LV	24.0	21.0	21.0±	98			17	8
		H RV	22.0±	19.0±	21.0	99				
		4 LV	30.0±	28.0±	25.0	95	5	4	15	11
		P LV	25.0±	24.0	22.0±	97		5	15	9
		P RV	23.0	26.0	23.0	98				

¹ LV, left valve; P, paratype; H, holotype; RV, right valve.

anterior sulcus; anterior umbonal fold pronounced and outcurved.

Right valve and internal features not observed. Measurements given in table 14.

Discussion.—*Acanthopecten carboniferous* differs from *A. meeki* Newell by the lower convexity of the left valve, nonvaulted fila, and keeled costae. *A. bellosum* Hoare, Sturgeon & Kindt lacks keels on the costae.

Occurrence.—Rare to abundant in the Lower Mercer and Vanport units; rare to common in the Brush Creek unit; rare in the Putnam Hill, Zaleski, Washingtonville, Cambridge, Portersville, and Ames units. Also reported by Morningstar (1922) from the Upper Mercer unit.

Repository.—OSU-27278 to 27281.

Acanthopecten meeki Newell
Pl. 8, figs. 13, 14

Acanthopecten meeki Newell, 1937, p. 73, pl. 12, figs. 1a-5.

Left valve with 17 broadly rounded body costae; keels on costae indistinct or lacking; surface marked by numerous closely spaced fila on young portion; strongly vaulted imbricating lamellae at 6.0, 8.0, 10.0, and 13.0 mm; lamellae extending ventrally as U-shaped spines in intercostal grooves. Other characteristics not observed. Worthwhile measurements not possible.

Discussion.—Four fragmentary left valves form the basis for the above brief description. Although the specimens are incomplete, the rounded and vaulted nature of the body costae is diagnostic.

Occurrence.—Rare in the Brush Creek and Cambridge units; questionably present in the Ames unit.

Repository.—OSU-27282, 27283.

Acanthopecten bellosum Hoare, Sturgeon & Kindt
Pl. 8, figs. 15-19

Acanthopecten bellosum Hoare, Sturgeon & Kindt, 1978, p. 1029, pl. 1, figs. 18-21.

Acline semicircular shell with pronounced auricles, low convexity, and a long hinge line. Left valve with 15-17 broadly rounded body costae; surface of valve crossed by coarse vaulted concentric fila at average lengths of 3.0, 5.0, 7.0, 9.5, 11.5, 14.0, 17.0, and 20.0 mm; fila projecting ventrally as long spines in intercostal grooves; posterior auricle large, with cardinal costae and up to 5 auricular costae; posterior umbonal fold low but distinct; anterior auricle crossed by fine fila; narrow deep anterior sulcus; pronounced outcurved anterior umbonal fold.

Right valve with very low convexity; marked by numerous, 6-7 per 2.0 mm, body costellae at a distance of 10.0 mm from beak; costellae narrow, bifurcating, and partially bundled, corresponding in number to body costae of left valve; intercostal grooves wider than costae and nearly flat; posterior auricle broad, shallowly concave, without a pronounced umbonal fold; anterior auricle with a deep V-shaped byssal notch, somewhat pronounced umbonal fold, and marked by up to 5 costae.

Internal features not observed. Measurements given in table 14.

Discussion.—*Acanthopecten bellosum* differs most noticeably from *A. meeki* Newell by possessing a relatively

longer hinge line, by being less acline, having lower or less pronounced body costae on the left valve, and having more widely spaced coarse fila during earlier stages of shell growth. *A. carboniferous* (Stevens) is distinct in having keeled body costae.

Preservation of numerous specimens, used as a basis for the description of *A. bellosum*, does not show the numerous closely spaced fila which are noted on other described species. The presence of numerous body costellae on the right valve distinguishes this species from *A. carboniferous*, but corresponding information concerning this feature in *A. meeki* is unknown. Presumably this characteristic differs from species to species and is not invariably, as mentioned by Newell (1937, p. 72), a 1:1 relationship with the intercostal grooves of the left valve.

Occurrence.—Known only from the Putnam Hill shale at locality Hfg-6, where it is abundant.

Repository.—Holotype, OSU-27284; paratypes, OSU-27285 to 27287.

Genus *Annuliconcha* Newell, 1937
Annuliconcha interlineata (Meek & Worthen)
Pl. 8, fig. 22

Aviculopecten interlineatus Meek & Worthen, 1860, p. 454; —, 1866b, p. 329, pl. 26, figs. 7a, b; White, 1884, p. 145, pl. 30, fig. 9; Beede, 1900, p. 116, pl. 13, fig. 6.

Posidonomya lasallensis Miller & Gurley, 1896, p. 12, pl. 1, figs. 17, 18.

Annuliconcha interlineata Newell, 1937, p. 76, pl. 13, figs. 6a-10; Hoare, 1961, p. 111, pl. 14, fig. 4.

Small acline suborbicular shells. Auricles acute but not produced; hinge line straight; 2 ranks of concentric fila cross body of shell and auricles; at least 10 coarse fila present in a shell height of 11.0 mm, those on the umbonal area being indistinguishable; 10 fine fila present between the coarse fila at a shell height of 7.0 mm; no radial ornamentation observed.

Right valve and interior features not observed. Worthwhile measurements not possible.

Discussion.—Only one partial specimen forms the basis for the above description. Characteristics of the fila arrangement and the orbicular shape are distinctive. Measurements impossible.

Occurrence.—Rare in the Vanport unit. Also reported from the Portersville unit by Mark (1912).

Repository.—Hypotype, OSU-27288.

Genus *Clavicosta* Newell, 1937
Clavicosta echinata? Newell
Pl. 8, fig. 20

Clavicosta echinata Newell, 1937, p. 79, pl. 13, figs. 1-5.

Medium-sized subequivalved acline shells. Anterior auricle apparently smooth and posterior auricle costate; umbonal angle at beak of right valve 85° and of left valve 80°; surface of valves costate with 2 intercalaries between primary costae; primary costae spinose with the posterior 1 or 2 primaries having more abundant and coarser spines.

Other features not observable. Worthwhile measurements not possible.

Discussion.—One badly weathered and incomplete specimen forms the basis for the above description. The features preserved indicate the generic assignment without question and agree with the specific assignment as far as can be determined. Newell's (1937) species is based upon specimens found much higher in the Pennsylvanian section of the Midcontinent region than was this occurrence.

Occurrence.—Rare in the Putnam Hill unit.

Repository.—Hypotype, OSU-27289.

Clavicosta sp.

Pl. 8, fig. 21

Small acline shells. Right valve with prominent anterior and posterior umbonal folds, the former flaring more than the latter; anterior auricle narrow, long, with prominent sulcus near umbonal shoulder, and 3 primary costae in addition to the cardinal costae; posterior auricle broadly triangular with 8-9 faint costae in addition to the prominent cardinal costae; byssal notch not deep; umbonal angle about 80°; body costae numbering 28 at a length of 10.0 mm with 2 nearly equal-sized and equally spaced intercalate costae between each primary costa; concentric fila more prominent on auricles than on body of shell; spines not evident.

Left valve and interior features not seen. A partial specimen with hinge length of 8.2 mm and umbonal angle of 80°.

Discussion.—If spines were evident on this internal mold, the specimen would be placed in the species *C. echinata* Newell. However, there is no evidence of spines or coarse projections of the fila on the body costae on any portion of the valve. The arrangement of the costae, the umbonal angle, the number of auricular costae, and the shape of the auricles are similar to the corresponding features of other specimens of *Clavicosta*.

Occurrence.—Rare in the Brush Creek unit.

Repository.—Hypotype, OSU-27290.

Genus *Fasciculiconcha* Newell, 1937

Fasciculiconcha scalaris (Herrick)

Pl. 9, figs. 1-4

Aviculopecten scalaris Herrick, 1887, p. 26, pl. 1, fig. 8.

Deltopecten scalaris Morningstar, 1922, p. 228, pl. 13, figs. 5, 6.

Fasciculiconcha scalaris Newell, 1937, p. 66, pl. 7, fig. 4.

Medium-sized acline orbicular shells with hinge shorter than shell length, height and length about equal, and low convexity. Anterior umbonal fold curved slightly outward; posterior fold nearly straight; margin of anterior auricle forming a broadly rounded sinus and bearing 7 low broadly rounded costae; posterior auricle produced with a broadly rounded sinus and bearing 5 narrow faint costae; umbonal angle about 88°; body costae fascicled, with the fascicles irregular in spacing and development and the interspaces between fascicles narrow; lateral costae of fascicles formed by fission; concentric fila apparently not present.

Right valve with strongly developed umbonal folds; deep and narrow anterior sinus; 8 costae on anterior auricle and at least 10 faint costae on posterior auricle; body costae narrow and increased by intercalation, numbering up to 38; filose markings on valve. Measurements given in table 15.

Discussion.—*Fasciculiconcha scalaris* differs from *F. knighti* Newell in having a low convexity, irregular arrangement of fascicled costae, and no concentric fila on the left valve. *F. providencensis* (Cox) has uniform fascicles, evenly flaring form from midline of valve, posterior and anterior umbonal folds approximately evenly curved, a larger umbonal angle, and abundant fila.

Newell (1937) mentioned the possibility that the lateral costae of the fascicles might be developed by fission; this possibility is confirmed here.

Occurrence.—Rare to common in the Lower Mercer unit. Also reported from the Boggs, Upper Mercer, Putnam Hill, and Zaleski units by Morningstar (1922).

Repository.—Hypotypes, OSU-15287, 27291, 27292.

Fasciculiconcha knighti Newell

Pl. 9, figs. 5, 6

Aviculopecten fasciculatus Keyes, 1894, p. 113, pl. 42, fig. 7; [non] *A. fasciculatus* Hall, 1883.

Fasciculiconcha knighti Newell, 1937, p. 65, pl. 6, figs. 19a-c; pl. 7, figs. 1-3, 5, 6; pl. 8, figs. 2a, b; Hoare, 1961, p. 108, pl. 14, fig. 11.

Medium-sized to large acline orbicular shells with hinge line less than length, length and height of valve nearly equal, and strong convexity. Anterior umbonal fold curved outward and posterior fold nearly straight; anterior auricle with margin broadly curved in sigmoidal shape and bearing 10 narrow costae; posterior auricle with 11-12 costae; umbonal

TABLE 15.—Measurements of species of *Fasciculiconcha*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)	Convexity (mm)	No. of auricle costae		No. of fascicles	No. of body costae
								Anterior	Posterior		
<i>F. scalaris</i>	Vel-6	1 LV	28.2	25.4	18.2	88	3.0	7	5	22	58
		2 LV	25.2	26.1	87						
		3 LV			18.6	88					
		4 RV	21.0	20.0	20.0	87		8	10		
		5 RV	22.0±	20.0±	22.0±	93		8			
<i>F. knighti</i>	Vel-15	1 LV	62.0	61.3	35.2	93	6.5	10	11+	25±	100+
		2 LV			34.8			99	8.0		
<i>F. providencensis</i>	Vel-12 LIho-1	1 LV				101	4.0+	13		30+	158+
		1 RV						7	5+		

¹ LV, left valve; RV, right valve.

angle up to 93°; body costae fascicled with wide interspaces; costae not present in auricular sulci; numerous concentric fila cross costae, 6-7 per 2 mm on the posteroventral area; fila produced as spines in crossing costae on posterior auricle.

Right valve with a deep anterior sinus, low convexity, and numerous widely spaced narrow nonfascicled body costae.

Hinge structure and interior features not observed. Measurements given in table 15.

Discussion.—*Fasciculiconcha knighti* is differentiated from *F. scalaris* (Herrick) under the latter species. *F. providencensis* (Cox) differs by having more evenly flared umbonal folds, costae in the auricular sulci, more closely spaced concentric fila, more spreading of the fascicles, and less convexity of the left valve.

Occurrence.—Rare in the Lower Mercer, Putnam Hill, and Columbiana units; abundant in the Cambridge unit; questionably present in the Vanport unit.

Repository.—Hypotypes, OSU-27293, 27294.

Fasciculiconcha providencensis (Cox)

Pl. 9, figs. 7-9

Pecten providencensis Cox, 1857, p. 566, pl. 8, fig. 1.

Aviculopecten providencensis Sayre, 1930, p. 118, pl. 12, figs. 1, 2.

Fasciculiconcha providencensis Newell, 1937, p. 66, pl. 7, figs. 7, 8; pl. 8, figs. 1a, b.

Large acline orbicular shells with hinge line much shorter than shell length and moderate convexity. Anterior and posterior umbonal folds about equally curved; anterior auricle with 13 narrowly rounded costae, of which 6 are primary and the rest secondary by intercalation, and interspaces about equal in width to costae; posterior auricle with 5 fine primary costae; others unknown; umbonal angle of 101°; body costae fascicled, spreading evenly from midline of shell; fascicles even, with broad distinct interspaces; posterior body costae enlarged and spinose; surface marked by numerous concentric fila, 16 per 2 mm on posteroventral surface, fila extending onto the auricles.

Anterior auricle of right valve with 7 broad flat costae with narrow interspaces and marked by closely spaced concentric fila; posterior auricle with at least 5 narrow costae with broad interspaces and concentric fila; umbonal area flat, with faint low narrow costae.

Hinge structure and other features not observed. Measurements given in table 15.

Discussion.—The above description is based upon two partial specimens. The features easily distinguish the species from *F. knighti* Newell and *F. scalaris* (Herrick), as described under those species.

Occurrence.—Rare in the Lower Mercer and Putnam Hill units.

Repository.—Hypotypes, OSU-27295, 27296.

Genus *Limipecten* Girty, 1904

Limipecten sp.

Pl. 9, fig. 10

Discussion.—One fragmentary specimen of a large pectinoid form shows broadly rounded costae with wide interspaces; this ornamentation is similar to that of *Limipecten*

texanus Girty (1904). Without more material it is impossible to make a specific assignment.

Occurrence.—Rare in the Cambridge unit.

Repository.—Hypotype, OSU-27297.

Genus *Streblochondria* Newell, 1937

Streblochondria hertzeri (Meek)

Pl. 9, figs. 11-15

Aviculopecten (Streblopteria) hertzeri Meek, 1871c, p. 61; ---, 1875, p. 330, pl. 19, figs. 13a-c.

Aviculopecten hertzeri Herrick, 1887, p. 25, pl. 1, figs. 5, 10; Morningstar, 1922, p. 226, pl. 13, fig. 4, [non] fig. 3.

[non] *Aviculopecten hertzeri* Mark, 1912, p. 307, pl. 15, fig. 3.

Streblochondria hertzeri Newell, 1937, p. 82, pl. 16, figs. 6, 10, 12-15.

Medium-sized slightly opisthocline shells with height greater than length and well-defined auricles. Left valve with slightly convex anterior umbonal fold and narrowly rounded auricular sulcus; posterior fold nearly straight and auricular sulcus more sharply defined; beak sharp and narrow; surface of shell body marked by numerous closely spaced costellae crossed by pronounced closely spaced concentric fila; anterior auricle marked by numerous costellae and crossed by fila continuous from shell body; posterior auricle marked by fila only.

Right valve with body ornamentation similar to left valve; anterior auricle marked by sharp narrow byssal notch with 6 or more costellae, with that costella-bounding notch being larger; posterior auricle marked by 1 or 2 faint costellae, which are crossed by fila as in anterior auricle.

Other features not seen. Measurements given in table 16.

Discussion.—*Streblochondria hertzeri* differs from *S. stantonensis* Newell by having a larger umbonal angle and a larger length-to-height ratio. *S. tenuilineata* (Meek and Worthen) lacks the body ornamentation of this species. Although not present in the collections under study, *S. sculptilis* (Miller, 1891) most closely resembles *S. hertzeri*. The former species differs in having more depressed auricles and more numerous costellae on the shell body and on the anterior auricles.

Occurrence.—Rare in the Putnam Hill and Columbiana units; rare to abundant in the Lower Mercer unit; questionably present in the Vanport unit. Also reported from the Zaleski unit by Morningstar (1922) and from the Cambridge, Portersville, and Ames units by Mark (1912).

Repository.—Hypotypes, OSU-15246, 27298 to 27301.

Streblochondria stantonensis Newell

Pl. 9, figs. 16, 17

Aviculopecten hertzeri Mark, 1912, p. 307, pl. 15, fig. 3.

Streblochondria stantonensis Newell, 1937, p. 83, pl. 15, figs. 1a, b, 3, 4.

Small narrow slightly opisthocline shell with broadly rounded auricular sulci. Left valve with high beak; anterior auricle with a few low widespread costellae; body costellae low and widely spaced; concentric fila present but not pronounced.

Other features not observed. Measurements given in table 16.

Discussion.—One specimen of a left valve, described by Mark (1912), appears to fit this species. Although the preservation is poor, the nearly acline shape, high narrow beak, and small number of body and auricular costellae appear diagnostic.

Occurrence.—Rare in the Portersville unit; common in the Ames unit; questionably present in the Washingtonville unit. Also reported by Mark (1912) from the Cambridge unit.

Repository.—Hypotypes, OSU-14033, 27302.

Streblochondria tenuilineata (Meek & Worthen)
Pl. 10, figs. 1-5

Pecten tenuilineatus Meek & Worthen, 1860, p. 452.

Streblopteria? tenuilineata Meek & Worthen, 1866b, p. 334, pl. 26, figs. 9a-b.

Crenipecten Foerstii Herrick, 1887, p. 28, pl. 3, figs. 9, 9a; Morningstar, 1922, p. 230, pl. 13, figs. 7, 8.

Streblopteria tenuilineata Sayre, 1930, p. 121, pl. 11, figs. 3-3a.

Streblochondria? tenuilineata Newell, 1937, p. 84, pl. 1, fig. 3, pl. 15, figs. 10-16.

Streblochondria(?) tenuilineata Elias, 1957, p. 772, pl. 94, figs. 3, 4, pl. 95, figs. 10, 11.

Streblochondria tenuilineata Hoare, 1961, p. 109, pl. 14, figs. 9, 10.

Medium-sized slightly opisthocline semicircular shells with nearly smooth shell body. Right valve with anterior auricle separated from shell body by a deep byssal notch and distinct umbonal sulcus; auricle marked by a few coarse radial costellae crossed by elevated fila; posterior auricle slightly smaller than anterior and umbonal sulcus broad and shallow; fine growth lines marking adult portion of valve; indistinct fine fila and fine radiating lines marking area of beak.

Left valve with nearly flat auricles, anterior larger and defined by a more pronounced umbonal sulcus than

posterior; indistinct shell body ornamentation in beak area as in right valve; beak high and relatively narrow; anterior umbonal margin broadly flaring and convex; posterior umbonal margin nearly straight.

Other features not observed. Measurements given in table 16.

Discussion.—*Streblochondria tenuilineata* may be distinguished from other species of this genus in the collections under study by the reduced shell body ornamentation, fewer costellae on the anterior auricles, and a broader flare of the anterior umbonal margins.

The preservation of most specimens studied does not show the fine reticulate ornamentation in the beak areas or the denticulate margin noted by Newell (1937). It is possible that some of the fragmentary specimens may be representatives of the genus *Streblopteria*.

Occurrence.—Rare to abundant in the Lower Mercer and Putnam Hill units; common in the Vanport unit; rare in the Zaleski, Columbiana, and Brush Creek units; questionably present in the Washingtonville unit. Also reported by Morningstar (1922) from the Boggs and Upper Mercer units and by Mark (1912) from the Cambridge unit.

Repository.—Hypotypes, OSU-15288, 15289-1, 15289-2, 27303 to 27305.

Genus *Streblopteria* M'Coy, 1851
Streblopteria oklahomensis Newell
Pl. 10, figs. 6-8

Avicula orbicula Stevens, 1858, p. 264.

Streblopteria oklahomensis Newell, 1937, p. 88, pl. 14, figs. 8a-12; Murphy, 1965, p. 280, text-fig. 1.

Medium-sized slightly opisthocline semicircular shells, somewhat higher than long, with smooth valve surfaces, and valve convexity equal. Right valve with hinge line about one-half as long as valve; posterior auricle smooth, not set off by distinct umbonal sulcus and fold, and with obtuse posterodorsal angle of about 142°; anterior auricle separated from shell body by deep narrow sulcus and umbonal fold which flares anteriorly, with deep byssal notch and numer-

TABLE 16.—Measurements¹ of species of *Streblochondria*

Species	Locality	Specimen ²	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)		Convexity (mm)	No. of anterior auricle costellae	No. of body costellae
						Maximum	Beak			
<i>S. hertzeri</i>	LIIm-1	1 RV	11.0	11.5	6.0	96	85	1.5	8	87
		2 LV	9.0	11.0	4.5	98	82	1.5	8	51+
		3 LV	12.0	14.0	7.5	96	89			
		4 LV	9.5	10.5	6.0	97	83±	1.0	9	48+
	LIho-1	1 RV	15.0	17.0	4.0	95	80	1.5	8	
		2 LV	24.0	28.0	13.0	92	75	3.5	11	74
<i>S. stantonensis</i>	MUmu-1	1 LV	7.0	9.0	4.0	81	69		5	37+
<i>S. tenuilineata</i>	Mg-4 LIho-1	1 RV	24.0	27.0	15.0	105	84	4.0	3	0
		1 LV	14.0	14.0	7.5	114	74	2.5		0
		2 LV	14.0	15.0	7.5	112	78	2.0		0
		3 LV	12.0	13.0	6.5	109	74	1.5		0
		4 RV	13.0	14.0	7.0	111	73		3	0
		5 RV	14.5	15.0	8.0	119	89	1.0	3	0
		6 RV	20.0	20.0	12.0	113	74		3	0
		7 RV	18.0	18.0	10.0	112	78		3	0

¹ Approximate measurements because of missing shell margins.

² RV, right valve; LV, left valve.

ous concentric fila crossed by 4 costae.

Left valve with smooth auricles; posterior auricle not distinctly set off from shell body; anterior auricle with relatively deep and narrow sulcus and umbonal fold.

Shell material homogeneous. Internal features not observed. Measurements given in table 17.

Discussion.—*Streblopteria oklahomensis* is the only Pennsylvanian species recognized so far in North America. It is most easily confused with *Streblochondria tenuilineata* (Meek and Worthen), which it resembles in general form. The lack of cancellate ornamentation in the umbonal areas and larger angle where the posterior auricle meets the hinge line are diagnostic of *S. oklahomensis*.

Occurrence.—Abundant in the Brush Creek unit; rare in the Portersville unit.

Repository.—Hypotypes, OSU-27306 to 27308.

TABLE 17.—Measurements of *Streblopteria oklahomensis*

Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Convexity (mm)
Cfr-1	1 RV	16.5	19.1	8.5	2.0 1.5
	2 RV	19.0	19.0	8.4	
	3 RV	12.0	12.2	5.5	
	4 RV	5.5	6.0	3.0	
	5 LV	14.1	14.9	8.1	
	6 LV	16.5	16.3	9.0	
	7 RV	13.0+	15.0	8.2	
	8 LV	5.5	6.0	3.0	

¹ RV, right valve; LV, left valve.

Genus *Chaenocardia* Meek & Worthen, 1869

Chaenocardia ovata Meek & Worthen
Pl. 10, figs. 9, 10

Chaenocardia ovata Meek & Worthen, 1869, p. 170; —, 1873, p. 586, pl. 27, figs. 5a, b; Newell (*in* Moore, 1969), p. N340, figs. C64.2a-c.

Medium-sized prosocline ovate shells with short hinge line. Beak small, low, prosogyrate; lunule absent and escutcheon narrow; left valve with anterior auricle not well developed but arched to receive byssus; posterior auricle broad, not differentiated from shell body, and forming an obtuse angle at posterodorsal extremity; surface marked by numerous concentric growth lines and more widely spaced growth lamellae; faint obsolescent costae on the ventral portion of valve.

Right valve with a large distinct subcircular anterior auricle with a deep triangular byssal notch. Shape of shell body and ornamentation similar to left valve.

Hinge structure edentulous. Ligament situated on 2 flat, diverging interareas (fig. 24). Other internal features not



FIGURE 24.—Hinge line of left valve of *Chaenocardia ovata* Meek & Worthen. X4. *la*, diverging ligamental areas.

TABLE 18.—Measurements of *Chaenocardia ovata*

Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)
Mc-1	1 LV	24.0	26.0+	10.7
Mg-4	1 RV	11.0+	15.5	

¹ LV, left valve; RV, right valve.

observed. Measurements given in table 18.

Discussion.—*Chaenocardia ovata* is easily distinguished from other pectinoids by the obsolescent costae, deep byssal notch, and subcircular anterior auricle on the right valve and the arched anterior auricle on the left valve.

Occurrence.—Rare in the Putnam Hill unit.

Repository.—Hypotypes, OSU-27309, 27310.

Genus *Euchondria* Meek, 1874

Euchondria ohioensis (Mark)
Pl. 10, figs. 11-15

Acanthopecten ohioensis Mark, 1912, p. 308, [non] pl. 15, fig. 5.

Euchondria ohioensis Newell, 1937, p. 107, pl. 19, figs. 8, 9.

Small inequivalved prosocline shells. Left valve with small anterior auricle, broadly rounded on margin; posterior auricle larger, extending farther ventrally; anterior margin rounded; posterior margin slightly produced and more sharply rounded where it joins ventral margin; hinge line straight; surface of valve costate, with up to 27 narrow costae present on body of valve; anterior auricle with 4-6 costae and posterior auricle with at least 4 fine costae; closely spaced concentric fila cross costae and wider interspaces, giving a cancellate appearance; fila more closely spaced than costae and extending across auricles; shell material with fine concentric crossed-lamellar structure.

Right valve suborbicular with straight hinge line. Posterior auricle small, acuminate, with shallowly rounded margin below hinge line; anterior auricle produced and sharply set off from valve by pronounced umbonal fold; anterior margin convex from umbonal fold, curving uniformly into ventral margin; posterior margin curved more abruptly; anterior auricle with 3-6 broadly rounded costae in addition to the cardinal costae, and the posterior auricle with up to 6 fine costae; surface without body costae but with numerous fine concentric fila extending over auricles and more closely spaced than on left valve.

Internal features not observed. Measurements given in table 19.

Discussion.—In his discussion of *Euchondria ohioensis*, Newell (1937) noted the discrepancy between Mark's (1912) description, illustration, and specimens. It appears that the illustration was an artist's attempt to make a reconstruction from a poorly preserved specimen. The illustration (Mark, 1912, pl. 15, fig. 5) does not agree in any way with the specimens. An additional specimen has been found at the type locality in the Portersville limestone; in addition, a number of specimens collected from the Brush Creek unit appear to be conspecific with Mark's species and are described above. One specimen, although half again as large, has almost exactly the same proportions as those of the Portersville specimens and shows the reticulate nature of the

TABLE 19.—Measurements of species of *Euchondria*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)	Convexity (mm)	No. of auricle costae		No. of body costae
								Anterior	Posterior	
<i>E. ohioensis</i>	Aa-41	1 RV	5.2	5.5	4.1	79	0.5	3+		16
		2 LV	3.3	3.7	2.7			4+	4+	
	Aw-48	1 RV	4.4	5.0	3.1	83		5	6	
		Cma-3	1 LV	6.8	7.0	3.5±	75			
	Cfr-1	1 LV	5.0	4.8	3.2±				4+	27
<i>E. levicula</i>	Tl-4	1 LV	10.0	9.0	5.5	97		4		42
	Aa-41	1 LV	4.4	4.3	3.2	88			3+	32+
	Llho-4	1 RV	5.3	5.7	5.0	84		3		0
	MUho-1	1 LV	7.2	6.5	4.7	94		4	5	47
<i>E. smithwickensis?</i>	Mg-2	1 RV	24.2	24.0	17.7+	104	3.5			

¹ RV, right valve; LV, left valve.

shell just anterior to the umbonal area.

Occurrence.—Rare to common in the Vanport, Brush Creek, and Portersville units.

Repository.—Hypotypes, OSU-27311 to 27315.

Euchondria levicula Newell
Pl. 10, figs. 16-20

Euchondria levicula Newell, 1937, p. 107, pl. 1, figs. 6, 7, pl. 19, figs. 5, 10, 11, 18.

Small inequivalved strongly prosocline shells. Left valve with anterior auricle slightly smaller than posterior, the latter acuminate and the former rounded on the anterior margin; hinge line straight; posterior margin produced, with posterior umbonal fold flaring posteriorly; anterior and posterior auricles with 3-4 costae; body surface costate with up to 42 costae present; costae crossed by closely spaced concentric fila which extend across auricles.

Right valve with straight hinge line. Anterior auricle with up to 4 costae; auricular sinus deep and V-shaped, set off sharply from shell body; posterior auricle subtriangular with 4-5 fine costae in addition to cardinal costae, not set off sharply from shell body; anterior margin produced, flaring evenly into ventral margin; posterior margin gently convex below a broad sinus below auricle; surface of body marked only by faint growth lines; fila showing up on auricles.

Internal features not observed. Measurements given in table 19.

Discussion.—*Euchondria levicula* differs from *E. ohioensis* (Mark) by being more produced posteriorly and by having a larger umbonal angle and more numerous body costae.

Occurrence.—Rare in the Poverty Run, Lower Mercer, Columbiana, Washingtonville, and Brush Creek units; rare to common in the Putnam Hill unit; common in the Ames unit; questionably present in the Dorr Run unit.

Repository.—Hypotypes OSU-27316 to 27320.

Euchondria smithwickensis? Newell
Pl. 10, figs. 21, 22

Euchondria smithwickensis Newell, 1937, p. 106, pl. 19, figs. 12-13b.

Small to large inequivalved prosocline shells. Right valve

acline with large anterior auricle set off from body of valve by strong umbonal fold; posterior auricle much smaller and umbonal fold not as distinct; deep V-shaped sinus ventral to anterior auricle; anterior margin produced, truncate, rounding into convex ventral margin; posterior margin gently convex ventral to small sinus between body and auricle; shell material thick; valve surface smooth.

Interior of right valve showing a distinct and complete pallial line, what appears to be a divided adductor scar, a small oval pedal retractor scar, and a small subtriangular gill suspensory scar (fig. 25).

Left valve not observed. Measurements given in table 19.

Discussion.—A large well-preserved specimen is the basis for the above description. The specimen agrees well with Newell's (1937) description and figures, but without the left valve we hesitate to make more than a questionable assignment to this species. *E. smithwickensis* attains a larger size than do other known species of *Euchondria* and lacks the auricular costae that are present on the right valve in other species.

Occurrence.—Rare in the Columbiana unit.

Repository.—Hypotype, OSU-27321.

Genus *Pseudomonotis* von Beyrich, 1862
Pseudomonotis carbonaria (Meek & Worthen)
Pl. 10, figs. 23, 24

Placunopsis carbonaria Meek & Worthen, 1866a, p. 13;

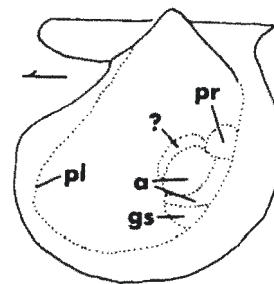


FIGURE 25.—Interior view of right valve of *Euchondria smithwickensis?* Newell. X1.5. a, divided adductor scar; gs, gill suspensory scar; pl, pallial line; pr, pedal retractor scar; ?, scar of unknown function.

---, 1873, p. 578, pl. 27, figs. 2-2d; Beede, 1900, p. 111, pl. 20, fig. 18.

Placunopsis recticardinalis Meek, 1875, p. 331, pl. 19, fig. 12; Herrick, 1887, p. 43, pl. 4, fig. 11; Morningstar, 1922, p. 233, pl. 12, fig. 19.

Medium-sized acline to slightly prosocline subrectangular shells. Dorsal margin nearly straight, anterior and posterior margins subparallel, and ventral margin convex; auricles not produced, right angled to sharply curved, anterior more angular than posterior; beak small, located just anterior to midlength of dorsal margin, extending slightly above margin; surface marked by fine radiating costae crossed by fine concentric growth lines and some irregular growth undulations; surface also crossed by undulations at various angles on different specimens, undulations being reflections of the ornamentation of the host to which the specimen was attached.

Right valve and internal features not observed. Measurements given in table 20.

Discussion.—*Pseudomonotis carbonaria* appears to be the only species of this genus distinguishable in the Pottsville at this time. *P. recticardinalis* (Meek) from the Lower Mercer was recognized by Herrick (1887) and Morningstar (1922) and is thought to be synonymous. A great variance in outline is present in the species, dependent upon growth stage and the shape of the host shell.

Occurrence.—Rare in the Lower Mercer unit. Also reported from the Ames unit by Mark (1912).

Repository.—Hypotypes, OSU-4609, 27322.

Pseudomonotis precursor Mather
Pl. 11, figs. 1-4

Pseudomonotis precursor Mather, 1915, p. 217, pl. 15, figs. 1, 1a; Newell, 1937, p. 101, pl. 17, figs. 8a-c.

Small nearly equilateral inequivalved subcircular shells. Beaks located near midlength; left valve evenly convex; surface marked by more than 85 closely spaced fine costae which are slightly sinuous in pattern; concentric undulations of growth patterns.

Right valve flattened, with a cicatrix of attachment present in the umbonal region. Surface costate, with broad undulations of growth.

Hinge structure and internal features not observed. Measurements given in table 20.

Discussion.—The evenly convex nature of the left valve and the large number of fine costae are diagnostic of *Pseudomonotis precursor*. The specimens in our collections are not as strongly convex as the types, but have been distorted by compaction.

Occurrence.—Rare in the Putnam Hill unit.

Repository.—Hypotypes, OSU-27323 to 27326.

Pseudomonotis millhorni Hoare, Sturgeon & Kindt
Pl. 11, figs. 5, 6

Pseudomonotis millhorni Hoare, Sturgeon & Kindt, 1978, p. 1030, pl. 2, figs. 12, 13, text-fig. 2.

Medium-sized inequivalved prosocline convex subtriangular shells with a short hinge line. Left valve with small obscure auricles; beak small, slightly incurved over hinge

TABLE 20.—Measurements of species of *Pseudomonotis*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Convexity (mm)
<i>P. carbonaria</i>	Pr-3	1 LV	23.0	23.6	15.8	
<i>P. precursor</i>	Hfg-6	1 LV	11.2	10.5	9.1	
		2 LV	22.0	21.5		
		3 LV	13.0	14.9	9.0±	
<i>P. millhorni</i>	CAr-2	H LV	18.6	20.0	7.8	5.1
		H RV	16.2	16.0	7.8	

¹ LV, left valve; H, holotype; RV, right valve.

line; umbo inflated; surface marked by 2 ranks of widely spaced costae, numbering 39, with the secondaries added by intercalation; numerous growth lines and lamellae crossing costae and interspaces; the lamellae developing short spine-like projections, similar to those in the genus *Acanthopecten*, in which they cross both ranks of costae; umbonal region marked by coarse irregular ridges and grooves reflecting the ornamentation of the host shell.

Right valve concave with narrow anterior auricle set off from shell body by an open narrow deep byssal notch; posterior auricle small, meeting dorsal margin at an obtuse angle; surface marked by bifurcating broad low indistinct costae with narrow interspaces; a few widely spaced coarse growth lamellae present; umbonal region and anterior auricle showing coarse irregular ridges and grooves reflecting the ornamentation of the host shell; entire surface pitted, denoting attachment to host shell.

Hinge structure edentulous with amphidetic ligament located on longitudinally striated narrowly triangular interareas; small subrectangular resilifer located beneath both beaks; a small ligament pit present on both valves at the posterior end of the interareas (fig. 26).

Other interior features not observed. Measurements given in table 20.

Discussion.—*Pseudomonotis millhorni* differs from other species of this genus in its combination of subangular outline, small number of costae, and spine-like projections on the costae. It is similar to *P. hawni sinuata* (Meek & Worthen, 1866b) in outline and convexity, but the latter form is known only from internal molds; hence there is no way of comparing the ornamentation. *P. hawni* (Meek & Hayden, 1858a) has a more strongly developed anterior auricle, the ornamentation is not well known, and it has fine intercalating costae on the right valve.

The holotype is a beautifully preserved specimen containing both valves and free from matrix. A specimen of



FIGURE 26.—Hinge line of left valve of *Pseudomonotis millhorni* Hoare, Sturgeon & Kindt. X4. i, interarea; lp, ligament pit; r, resilifer.

the inarticulate brachiopod *Crania modesta* White & St. John (1867) is attached to the anterodorsal area of the left valve.

Occurrence.—Rare in the Washingtonville unit.

Repository.—Holotype, OSU-27327.

Pseudomonotis spp.

Pl. 10, figs. 25-27

Discussion.—Several specimens scattered through the section are referable to the genus *Pseudomonotis*, but are too incomplete or too poorly preserved to make specific identifications. Two of the specimens are internal molds of the left valve, showing irregular costae of more than one size and crossed by coarse undulations. One specimen, an external mold of a right valve (pl. 10, fig. 27), shows well the closed byssal notch of an adult form and the weakly developed costae on the juvenile portion; the surface changes to noncostate in the mature portion.

Occurrence.—Rare in the Lower Mercer, Vanport, and Cambridge units. Mark (1912) reported *P. hawni* (Meek & Hayden) from the Ames unit.

Repository.—Hypotypes, OSU-27328 to 27330.

Genus *Posidonia* Bronn, 1828

Posidonia fracta (Meek)

Pl. 11, figs. 7-10

Posidonomya fracta Meek, 1875, p. 333, pl. 19, figs. 7a, b.

Posidonia girtyi Morningstar, 1922, p. 214, pl. 12, figs. 1-4.

Posidonia vintonensis Morningstar, 1922, p. 216, pl. 12, figs. 5, 6.

Posidonia fracta Newell, 1937, p. 37, pl. 3, figs. 15-17.

Large prosocline subovate shells with low convexity. Beaks small, oblique, extending slightly above low hinge line; anterior auricle small, forming broadly acute angle with nearly straight anterior margin; posterior margin broadly rounded, meeting hinge line at an obtuse angle; hinge line straight and shorter than length; surface marked by concentric undulations, which differ slightly in height and spacing; shell material thin.

Internal features not observed. Measurements given in table 21.

Discussion.—Comparison of numerous specimens with Morningstar's (1922) material lends agreement with Newell's (1937) assignment of *P. vintonensis* Morningstar and *P. girtyi* Morningstar to *P. fracta*.

Occurrence.—Rare to abundant in the Lower Mercer unit; abundant in the Boggs unit; rare in the Putnam Hill and Dorr Run units. Also questionably reported by Morningstar (1922) from the Lowellville unit.

Repository.—Hypotypes, OSU-15274, 27331 to 27333.

Genus *Pernopecten* Winchell, 1865

Pernopecten ohioensis Newell

Pl. 11, figs. 14, 16-18

Entolium aviculatum Herrick, 1887, p. 23, pl. 1, figs. 1, 2; pl. 3, fig. 10; Morningstar, 1922, p. 232, pl. 13, fig. 9.

Pernopecten ohioensis Newell, 1937, p. 112, pl. 20, figs. 1-3, 5, 6; Hoare, 1961, p. 116, pl. 15, figs. 15, 16.

Large prosocline subcircular shells. Left valve with small

TABLE 21.—Measurements¹ of *Posidonia fracta*

Locality	Specimen ²	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)
Vel-26	1 RV	35.0	36.0	16.0	66
	2 RV	30.0	33.0	16.0	67
	3 LV	9.0	8.0	8.0	56
	4 LV	9.0	7.0	7.0	51
	5 LV	22.0	25.0	12.0	66
	6 LV	34.0	39.0	20.0	61
	7 RV	34.0	40.0	20.0	63
	8 RV	35.0	43.0	19.0	67
	9 RV	22.0	26.0	18.0	59
	10 RV	34.0	43.0	16.0	62

¹ Approximate measurements because of indeterminate margins.

² RV, right valve; LV, left valve.

high-pointed auricles; extended and rounded anterior margin; abbreviated posterior margin; anterodorsal and posterodorsal margins separated by shallow sulci; low convexity.

Right valve with straight cardinal margin; auricles forming obtuse angles, set off from shell body by distinct flaring umbonal folds; anterior auricle lower than posterior, having distinct byssal notch in early growth stages, notch becoming obsolete at maturity; anterior and posterior margins developing projections near or just dorsal to midheight at maturity.

Degree of shell gape, hinge structure, and interior features not observed. Measurements given in table 22.

Shell material of left valve with crossed-lamellar structure in both inner and outer ostraca. In right valve the outer ostracum is crossed lamellar, inner ostracum is of concentrically arranged rows of hexagonal prisms.

Discussion.—*Pernopecten ohioensis* Newell differs from *P. proseri* (Mark) by having anterior and posterior projections on the right valve and in being more oblique. *P. attenuatus* (Herrick) has a smaller umbonal angle and a larger height-width ratio than *P. ohioensis*. Although size distinctions are not necessarily diagnostic, specimens of *P. ohioensis* at maturity are normally smaller than *P. proseri* and larger than *P. attenuatus*. The major apparent difference between the specimens in this study and those studied by Newell (1937) is in the convexity of the valves. The lesser convexity noted here may be a result of compaction.

Occurrence.—Rare in the Putnam Hill, Zaleski, Vanport, and Washingtonville units; abundant in the Lower Mercer unit. Also reported by Morningstar (1922) from the Upper Mercer unit and by Mark (1912) from the Brush Creek, Cambridge, Portersville, and Ames units.

Repository.—Hypotypes, OSU-27334 to 27337.

Pernopecten attenuatus (Herrick)

Pl. 11, figs. 11-13, 15

Entolium attenuatum Herrick, 1887, p. 24, pl. 1, fig. 11.

Pernopecten attenuatus Newell, 1937, p. 113, pl. 20, fig. 4; Hoare, 1961, p. 115, pl. 15, fig. 14.

Small prosocline suboval shells. Left valve with short hinge line; small slightly raised auricles; evenly rounded anterior and ventral margins; nearly straight posterior margin; shallow sulci separating posterodorsal and antero-

TABLE 22.—Measurements of species of *Pernopecten*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)	Convexity (mm)
<i>P. ohioensis</i>	MUc-1	1 LV	22.0	22.5	8.0	111	
		2 LV	19.0	21.0	7.0	118	
	LIho-1	1 RV	17.5	17.0	6.2	107	1.0
		2 RV	11.0	11.0	4.8	110	0.3
		3 LV	20.0	22.0	6.1	113	1.0
		4 RV	15.6	16.0	6.5	112	0.5
		5 LV	17.5	20.0	5.5	107	0.8
		6 RV	16.7	17.3	6.0	106	1.1
		7 RV	11.3	11.0	4.5	109	0.2
8 LV	5.4	6.2	2.3	110			
<i>P. attenuatus</i>	Vel-20	1 LV	12.0	14.0	4.2	102	
		2 RV	12.3	13.5	4.6	102	
		3 RV	12.1	13.2	4.8	96	
		4 RV	12.5	13.1	4.2	101	
	MUho-3	1 LV	9.0	10.0	3.6	98	
		2 LV	9.2	10.6	3.0	102	
	LIho-4	1 LV	10.0	12.1	4.0	100	
		2 LV	11.3	12.6	4.1	104	
	<i>P. prosseri</i>	MUu-2	1 RV	30.0	31.0	10.0+	114

¹ LV, left valve; RV, right valve.

dorsal margins; low convexity.

Right valve with short straight cardinal margin; subequal auricles, posterior slightly higher than anterior, set off from shell body by umbonal folds; byssal notch lost in mature growth stage; anterior and posterior projections only slightly developed or not at all.

Degree of shell gape not observed. Shell material as in *P. ohioensis*. Measurements given in table 22.

Discussion.—Differences between this form and other species of *Pernopecten* in the Pennsylvanian of Ohio are given under *P. ohioensis*. The most distinguishing characteristics of *P. attenuatus* are the smaller umbonal angle and greater relative height. True measurements of convexity could not be made.

Occurrence.—Rare in the Vanport and Portersville units; rare to common in the Putnam Hill and Columbiana units; rare to abundant in the Lower Mercer unit.

Repository.—Hypotypes, OSU-27338 to 27341.

Pernopecten prosseri (Mark)

Pl. 11, fig. 19

?*Pecten aviculatus* Swallow (in Shumard & Swallow, 1858), p. 213.

Entolium prosseri Mark, 1912, p. 309, pl. 15, figs. 6-8.

Pernopecten prosseri Newell, 1937, p. 111, pl. 20, figs. 12, 13, 17, 18.

Large slightly prosocline subcircular shells. Left valve with deep sulci separating anterodorsal and posterodorsal areas from shell body. Other features not observed.

Right valve with slightly concave cardinal margin; auricles sharply set off by broadly flaring umbonal folds; posterior auricle higher than anterior; shell body broadly and evenly convex; no evidence of anterior or posterior projections on margins.

Gape relationships and convexity not observed. Shell material as in *P. ohioensis*. Measurements given in table 22.

Discussion.—*Pernopecten prosseri* is distinguished from

other species in the collections under *P. ohioensis*. Most of the specimens present are fragmentary or small youthful forms.

Occurrence.—Rare to common in the Ames unit; rare in the Brush Creek unit.

Repository.—Hypotype, OSU-27342.

Genus *Palaeolima* Hind, 1903

Palaeolima retifera (Shumard)

Pl. 12, figs. 1-3

Lima retifera Shumard (in Shumard & Swallow, 1858), p. 214; Girty, 1915a, p. 137, pl. 17, fig. 8 (see for synonymy up to this date); Mark, 1912, p. 309, pl. 15, fig. 9; Morningstar, 1922, p. 233, pl. 13, fig. 10; Hoare, 1961, p. 117, pl. 15, figs. 12, 13; Murphy, 1967, pl. 195, fig. 4.

Small equivalved opisthocline moderately convex shells with short hinge line and length-height ratio about equal. Auricles form obtuse angles with hinge line, not distinctly set off from body of shell by umbonal ridges or sulci; umbonal angle about 97°; valve surfaces marked by narrow angular costae, averaging 25 in number, which bifurcate mainly on the posterior portion of valve; interspaces much wider than costae; numerous closely spaced concentric fila marking surface, fila more pronounced near border of valve.

Interior features not observed. Measurements given in table 23.

Discussion.—*Palaeolima retifera* differs from *P. triplistriata* (Stevens) by having fewer and less crowded costae, which do not bifurcate by threes, a smaller umbonal angle, and a narrower oblique form. *P. inequicostata* Mather (1915) appears to be a synonym of *P. retifera*, although we have not seen the type specimens.

Occurrence.—Rare in the Upper Mercer, Columbiana, Washingtonville, Brush Creek, Cambridge, and Ames units; rare to common in the Putnam Hill and Vanport units; rare to abundant in the Lower Mercer unit. Also reported by

TABLE 23.—Measurements of species of *Palaeolima*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)	Umbonal angle (degrees)	No. of body costae
<i>P. retifera</i>	Llho-1	1 RV	12.0	11.9	5.1	98	26
		2 RV	10.0	10.3	4.1		23
		3 RV	14.9	15.0	6.3	100	26
		4 LV	8.2	9.0	4.0	95	22
		5 LV	11.0	11.1	4.9	97	25
<i>P. triplistriata</i>	Cfr-1	1 LV	15.1	15.0	5.5	96	41
		2 RV	8.6	10.0	3.6	107	42
		3 LV	8.5	8.8	4.1	103	41
		4 RV	7.6	7.6			54
		4 LV	7.1	8.2		106	52
		5 LV	12.2	13.2	5.1	103	55

¹ RV, right valve; LV, left valve.

Mark (1912) from the Portersville unit.

Repository.—Hypotypes, OSU-27343 to 27345.

Palaeolima triplistriata (Stevens)

Pl. 11, figs. 20-22

Avicula triplistriata Stevens, 1858, p. 265.

Limatula? fasciculata Girty, 1911, p. 134; —, 1915a, p. 138, pl. 17, figs. 6, 7; Sayre, 1930, p. 122, pl. 12, figs. 7-8a.

Lima krotovi Mark, 1912, p. 310, pl. 15, fig. 10; [non] Stuckenbergh, 1898, p. 336, pl. 1, fig. 28.

Lima triplistriata Murphy, 1967, p. 1501, pl. 195, figs. 5-7.

Small equivalved opisthocline moderately convex shells with short hinge line and near-equal length and height. Auricles small, meeting hinge line at obtuse angles, not distinctly set off from shell body by umbonal ridges or sulci; umbonal angle about 105°; valve surface marked by narrow angular costae, numbering up to at least 55; costae coarser but much narrower than interspaces over much of anterior area, and finer and more closely spaced on posterior half of shell, where they increase by bifurcation and intercalation; fine concentric fila crossing costae and interspaces.

Interior features not observed. Measurements given in table 23.

Discussion.—*Palaeolima triplistriata* is distinguished from *P. retifera* under the discussion of the latter species.

Occurrence.—Rare in the Cambridge and Portersville units; rare to abundant in the Brush Creek unit. Also reported from the Washingtonville unit by Murphy (1967).

Repository.—Hypotypes, OSU-27346 to 27348.

Genus *Schizodus* de Verneuil & Murchison, 1844

Schizodus cuneatus Meek

Pl. 12, figs. 10-14

Schizodus cuneatus Meek, 1875, p. 336, pl. 20, fig. 7; Walcott, 1884, p. 252, pl. 20, fig. 8; Heilprin, 1886, p. 275, figs. 9, 9a; Herrick, 1887, p. 42, pl. 4, fig. 23; Smith, 1896, p. 245, pl. 22, fig. 3; [non] Girty, 1903, p. 439, pl. 9, fig. 10; Raymond, 1910, p. 155; Mark, 1912, p. 297; Price, 1918, p. 797, pl. 44, figs. 4, 4a; —, 1920, p. 604, pl. 35, fig. 5; Morningstar, 1922, p. 223, pl. 13, figs. 1, 2; Chow, 1951, p. 30, pl. 3, fig. 15.

Medium-sized to large inequilateral equivalved trigonally ovate shells. Beaks incurved, prosogyrate; umbonal area high

above hinge line; anterior and ventral margins smoothly curved and posterior margin obliquely truncate; marginal carina rounded, running from umbonal slope to postero-ventral margin, separating convex flank from concave area near dorsal margin; escutcheon lacking; surface marked by numerous fine growth lines.

Right valve with large anteriorly directed tooth; posterior tooth small, nearly obsolete; left valve with large triangularly shaped median tooth; anterior tooth marginal, nearly obsolete; posterior tooth nearly obsolete.

Other interior features not observed. Measurements given in table 24.

Discussion.—*Schizodus cuneatus* differs from *S. amplus* Meek & Worthen by being trigonally ovate instead of subrectangular in shape and by having a truncate posterior margin. *S. wheeleri* Swallow has lower umbonal areas, is more produced anteriorly, and is more obliquely truncate posteriorly. *S. affinis* Herrick is subovate and subequilateral in form.

Occurrence.—Rare to abundant in the Putnam Hill unit;

TABLE 24.—Measurements of species of *Schizodus*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Thickness (mm)
<i>S. cuneatus</i>	Vel-19 Llho-1	1 RV	48.0	42.5	15.4
		1 LV	55.0	42.3	8.5
		2 RV	56.3	44.5	9.0
<i>S. wheeleri</i>	MEco-1 Ale-18	1	37.1	29.3	17.9
		2	32.0	27.3	15.8
		1	35.2	27.0	18.2
<i>S. amplus</i>	Hfg-5 MUho-3	1 LV	73.2	56.6±	17.3
		1 LV	56.7	47.1	13.1
		2 RV	69.8	58.1	17.1
		3 LV	68.3	55.7	16.9
		4 LV	62.4	52.4	14.7
<i>S. affinis</i>	Ms-3 MUmu-1 CAr-2	1 LV	29.3	25.9	8.3
		1 LV	23.7	20.4	7.4
		1	25.3	20.8	14.7
		2	16.3	14.1	9.6
<i>S. subcircularis</i>	Jje-2	1 LV	16.6	16.2	3.8
		2 RV	16.9	16.3	2.8
		3 LV	15.3	13.3	2.8
<i>S. acuminatus</i>	Llho-4	H	41.7	32.6	27.3

¹ RV, right valve; LV, left valve; H, holotype.

rare to common in the Lower Mercer unit; rare in the Columbiana unit. Also reported from the Brush Creek unit by Mark (1912).

Repository.—Hypotypes, OSU-4591, 27349, 27350.

Schizodus wheeleri (Swallow)

Pl. 12, figs. 6-9

Schizodus obscurus Swallow (in Shumard & Swallow, 1858), p. 198; Geinitz, 1866, p. 20, pl. 1, figs. 30, 31.

Cypricardia? wheeleri Swallow, 1863, p. 96.

Schizodus wheeleri Meek, 1872, p. 209, pl. 10, figs. 1a-f; Beede, 1900, p. 155, pl. 22, figs. 1-1c; Mark, 1912, p. 297; Morningstar, 1922, p. 225.

Medium-sized subequilateral equivalved subtrigonal shells. Beaks incurved, slightly prosogyrate, umbones elevated; anterior margin produced, curving smoothly into ventral margin; posterior margin attenuate and obliquely truncate; marginal carina broadly rounded, extending to posterodorsal margin; flank convex and area concave; slight ridge bordering dorsal margin; surface marked by fine growth lines.

Large subrectangular posterior and anterior adductor scars; small elongate anterior pedal retractor scars just posterior to anterior adductors; small elongate posterior pedal retractor scars along dorsal margin anterior to posterior adductor scars; pallial line complete; umbonal cavity filled with nipplelike extensions of the internal mold.

Other interior features not observed. Measurements given in table 24.

Discussion.—*Schizodus wheeleri* is distinguished from *S. amplus* Meek & Worthen and *S. cuneatus* Meek under the discussions of those species. *S. affinis* Herrick is more equilateral in form with a less attenuate posterior margin.

Occurrence.—Rare to abundant in the Brush Creek unit; rare in the Portersville unit; questionably present in the Cambridge unit. Also reported from the Ames unit by Mark (1912) and from the Boggs, Lower Mercer, Upper Mercer, Sand Block, and Putnam Hill units by Morningstar (1922).

Repository.—Hypotypes, OSU-27351, 27352.

Schizodus amplus Meek & Worthen

Pl. 13, figs. 7-11

Schizodus amplus Meek & Worthen, 1870, p. 41; —, 1873, p. 579, pl. 27, figs. 6a, b; Morningstar, 1922, p. 222, pl. 12, fig. 18; Newell & Boyd, 1975, p. 106, figs. 42, 43; [non] Hoare, 1961, p. 121, pl. 15, figs. 3, 4.

Large inequilateral equivalved subrectangular shells. Beaks incurved, depressed, prosogyrate; anterior margin slightly produced; posterior margin convex and not truncate; dorsal and ventral margins subparallel; marginal carina obsolete; escutcheon lacking; surface marked by numerous growth lines.

Right valve with large elongate posteriorly directed medial tooth, posterior tooth obsolete; left valve with a strong triangular medial tooth, small marginal anterior tooth, obsolete posterior tooth; large suboval posterior adductor scar located at posterodorsal extremity; smaller subtriangular anterior adductor scar located at anterior extremity; no myophoric buttress present; pallial line complete.

Other interior features not observed. Measurements

given in table 24.

Discussion.—*Schizodus amplus* is the largest species of this genus present in our Pennsylvanian collections. Its subrectangular shape, extreme inequilateral nature, and lack of posterior truncation are distinctive.

Occurrence.—Abundant in the Vanport unit; rare to abundant in the Putnam Hill unit; rare to common in the Lower Mercer unit. Also reported from the Boggs unit by Morningstar (1922).

Repository.—Hypotypes, OSU-27353 to 27356.

Schizodus affinis Herrick

Pl. 13, figs. 1, 2

Schizodus affinis Herrick, 1887, p. 41, pl. 4, figs. 22, 22a; Girty, 1899, p. 582, pl. 72, figs. 4a-f; —, 1915a, p. 131, pl. 17, figs. 2, 2a; Morningstar, 1922, p. 223, pl. 12, fig. 17; Morse, 1931, p. 300; Hoare, 1961, p. 120, pl. 15, figs. 1, 2.

Small subequilateral equivalved subovate shells. Beaks low, incurved, slightly prosogyrate; anterior margin uniformly convex, rounding smoothly into ventral margin; posterior margin not produced and partially truncate; marginal carina obsolete, not differentiating flanks and areas; surface gently convex and marked by numerous fine growth lines.

Hinge structure and interior features not observed. Measurements given in table 24.

Discussion.—*Schizodus affinis* is characterized by its subovate shape and nearly equilateral form. *S. affinis* is not as ovate as *S. subcircularis* Herrick.

Occurrence.—Rare to abundant in the Columbiana unit; rare to common in the Washingtonville unit; rare in the Lower Mercer, Putnam Hill, Vanport, and Cambridge units. Also reported from the Harrison and Boggs units by Morningstar (1922).

Repository.—Hypotypes, OSU-27357, 27358.

Schizodus subcircularis Herrick

Pl. 12, figs. 4, 5

Schizodus subcircularis Herrick, 1887, p. 41, pl. 4, fig. 24; p. 145, pl. 14, fig. 18; Morningstar, 1922, p. 225, pl. 12, figs. 14-16.

Small nearly equilateral equivalved subcircular shells. Beak extending above hinge line near midlength of shell; anterior, posterior, and ventral margins about equally convex.

Other exterior and interior features not observed. Measurements given in table 24.

Discussion.—Three specimens of Morningstar's (1922) collection are still extant. These poorly preserved internal molds show the characteristic outline of Herrick's species. None of the specimens in our collections approach this form or are, in some cases, complete enough to compare with it.

Occurrence.—Rare in the Putnam Hill unit. Also reported from the Harrison unit by Morningstar (1922).

Repository.—Hypotypes, OSU-15282 to 15284.

Schizodus acuminatus Hoare, Sturgeon & Kindt

Pl. 13, figs. 5, 6

Schizodus cuneatus? Girty, 1903, p. 439, pl. 9, fig. 10.
Schizodus acuminatus Hoare, Sturgeon & Kindt, 1978, p.

1031, pl. 2, figs. 17, 18.

Medium-sized inequilateral equivalved subtrigonal shells. Beaks high, incurved, prosogyrate; umbonal areas high and inflated; anterior margin uniformly curved, not produced; posterior margin sharply truncate, forming an acute angle with the ventral margin; marginal carina strongly developed, separating convex flanks from concave areas; escutcheon lacking.

Suboval anterior adductor scar located at anterior extremity; pallial line complete.

Other interior features and surface ornamentation unknown. Measurements given in table 24.

Discussion.—Girty (1903) illustrated a specimen of *Schizodus* from the Permian Rico Formation of Colorado; he tentatively assigned this specimen to *S. cuneatus* Meek. The specimen is much more truncate than *S. cuneatus* and is less produced anteriorly. Our specimen described above lacks most of the shell material and is slightly crushed dorsoventrally. If reconstructed it matches Girty's illustration very closely. Although there is a significant difference in stratigraphic position of the specimens, we have placed Girty's specimen in synonymy. It is possible that they are both distinct species, differing from *S. cuneatus*.

S. acuminatus differs from *S. wheeleri* (Swallow) by being more abruptly truncate posteriorly, by being less produced anteriorly, with the beaks located closer to the anterior extremity, and by having a much stronger marginal carina. *S. amplus* Meek & Worthen lacks the carina and is not truncate.

Occurrence.—Rare in the Lower Mercer unit.

Repository.—Holotype, OSU-27359.

Genus *Permophorus* Chavan, 1954
Permophorus tropidophorus (Meek)
Pl. 13, figs. 3, 4; pl. 14, figs. 1, 2

Pleurophorus tropidophorus Meek, 1875, p. 338, pl. 19, figs. 10a, b; Beede, 1900, p. 162, pl. 20, fig. 7; Mark, 1912, p. 298; Morningstar, 1922, p. 240, pl. 13, figs. 20, 21; Sayre, 1930, p. 125, pl. 12, figs. 14, 15; Hoare, 1961, p. 124, pl. 15, figs. 9, 10.

Medium-sized inequilateral equivalved elongate subrectangular shells. Beaks low, prosogyrate, located about one-fourth distance from anterior extremity; lunule and escutcheon present; anterior margin flatly rounded, curving abruptly into gently convex to slightly sinuate ventral margin; posterior margin obliquely truncate dorsally and vertically truncate ventrally, curving sharply into the ventral margin; dorsal and ventral margins subparallel; umbonal ridge prominent, running to posteroventral margin; a second ridge runs from the umbonal slope to change in truncation of posterior margin, dividing the concave posterodorsal area into two areas; surface marked by numerous fine to coarse growth lines, which change direction sharply at the umbonal ridges.

Hinge structure of right valve with weakly developed elongate 3a and 3b cardinal teeth, a submarginal posterior lateral tooth, and a nymph; anterior adductor scar small and deep, separated from a shallow pedal scar by a myophoric buttress; posterior adductor scar large, elongate oval, and located under the posterior end of hinge line.

Other interior features not observed. Measurements

given in table 25.

Discussion.—*Permophorus tropidophorus* is stratigraphically the most abundant and widespread species of this genus in our collections. This species differs from *P. immaturus* (Herrick) by having only 2 umbonal ridges. *P. costatiformis* (Meek & Worthen) has 4-5 umbonal ridges, which are less distinct, and *P. oblongus* (Meek) has only 1 umbonal ridge. The specimen described above shows the hingement of the right valve, but is worn, and possibly the cardinal teeth are not as prominent as normal.

Occurrence.—Rare to common in the Lower Mercer, Vanport, and Columbiana units; rare in the Putnam Hill, Brush Creek, and Cambridge units. Also reported from the Lowellville, Upper Mercer, and Zaleski units by Morningstar (1922) and from the Portersville and Ames units by Mark (1912).

Repository.—Hypotypes, OSU-27360 to 27362.

TABLE 25.—Measurements of species of *Permophorus* and ?*Pleurophorella*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Thickness (mm)
<i>P. tropidophorus</i>	MUho-3	1 LV	17.3	7.6	
		2 LV	21.7	11.3	
		3 RV	33.3	16.1	
		4 LV	21.6	8.8	
<i>P. immaturus</i>	Llho-1	1 LV	14.8	5.9	
<i>P. spinulosa</i>	LIm-1	1 RV	43.2	19.8	4.5±
		2 LV	42.0	18.0	4.5±
<i>P. oblongus</i>	Mg-3 Cuc-1 CAr-2	1 LV	9.4	5.1	2.4
		1 RV	10.2	5.9	2.1
		1 RV	8.8	5.0	1.9
<i>P. costatiformis</i>	Ale-18	1 RV	31.9	15.4	
		2 LV	39.7	19.9	
? <i>P. sesquiplicata</i>	Vel-26	1 LV	13.1	8.6	
		2 LV	12.5	7.9	
		3 RV	12.3	7.5	

¹ LV, left valve; RV, right valve.

Permophorus immaturus (Herrick)
Pl. 14, figs. 5-8

Pleurophorus immaturus Herrick, 1887, p. 145, pl. 14, fig. 17; Morningstar, 1922, p. 236, pl. 14, figs. 5-8.

Small inequilateral equivalved elongate oval shells. Beaks small, low, prosogyrate; lunule and escutcheon not observed; anterior margin extended, rounding into gently convex to slightly sinuate ventral margin; posterior margin truncate dorsally, rounding smoothly into ventral margin; dorsal and ventral margins subparallel; umbonal ridge not prominent; up to 7 radial ridges extending from the umbonal slope to the posterior and ventral margins; surface marked by fine concentric lines of growth, which change direction sharply at the 3 dorsal radial ridges.

Hinge structure and interior features not observed. Measurements given in table 25.

Discussion.—*Permophorus immaturus* is distinguished from *P. tropidophorus* (Meek) under the discussion of the

latter species. *P. oblongus* (Meek) has a pronounced umbonal ridge and no other radial ridges. *P. costatiformis* (Meek & Worthen) has up to 5 radial ridges and has a more sinuate ventral margin.

Occurrence.—Rare to abundant in the Lower Mercer unit; questionably present in the Portersville unit. Also reported from the Putnam Hill and Zaleski units by Morningstar (1922).

Repository.—Hypotypes, OSU-27363, 27364, 1503-1, 1503-2.

Permophorus occidentalis (Meek & Hayden)
Pl. 18, figs. 6, 7

Pleurophorus occidentalis Meek & Hayden, 1858a, p. 80; —, 1864, p. 35, pl. 1, fig. 11a; Meek, 1872, p. 212, pl. 10, fig. 12.

Clidophorus Pallasi Geinitz, 1866, p. 23, pl. 2, figs. 3, 6? [in part].

Small inequilateral equivalved elongate subovate shells. Beaks low, prosogyrate, located near anterior extremity; narrow lunule and escutcheon present; anterior margin sharply curved, rounding smoothly into slightly convex ventral margin; posterior margin uniformly curved; dorsal and ventral margins subparallel; umbonal ridge distinct, running to posteroventral extremity; posterodorsal area subdivided by 2 other radial ridges; 1 or 2 radial ridges present in many specimens below umbonal ridge; entire surface marked by numerous fine closely spaced radial and concentric lirae forming a fine cancellate pattern.

Hinge structure and interior features not observed. A partially crushed specimen approximately 8.6 mm long and 4.3 mm high.

Discussion.—*Permophorus occidentalis* differs from all other species of this genus by the presence of its fine cancellate ornamentation and the extra radiating ridges below the umbonal ridge.

Occurrence.—Common in the Ames unit. Also reported by Mark (1912) from the Portersville unit.

Repository.—Hypotypes, OSU-29000, 30351.

Permophorus spinulosa (Morningstar)
Pl. 14, figs. 3, 4

Pleurophorus spinulosa Morningstar, 1922, p. 239, pl. 14, figs. 9-11.

Large strongly inequilateral equivalved elongate subrectangular shells. Beaks low, prosogyrate, located about one-fifth distance from the anterior extremity; lunule and escutcheon not visible because of preservation; anterior margin abruptly curved, rounding smoothly into nearly straight ventral margin; posterior margin uniformly curved or with several short truncations between radial ridges; dorsal and ventral margins subparallel; umbonal ridge distinct, running to posteroventral extremity; posterodorsal area subdivided evenly by 3 other radial ridges; surface marked by numerous fine growth lines and more widely spaced growth lamellae, which change direction at the intersection with each radial ridge and which are most prominent anteriorly; shell material with coarse widely spaced spinulose structure.

Hinge structure and interior features not observed.

Measurements given in table 25.

Discussion.—*Permophorus spinulosa* differs from *P. immaturus* (Herrick) by having fewer radial ridges and in reaching a much larger size. *P. tropidophorus* (Meek) is smaller and has only 2 radial ridges. Other species of *Permophorus* are either smaller in size or have a different surface sculpture.

The specimen figured by Morningstar (1922, pl. 14, fig. 10, OSU-15249) is herein selected as the holotype. The specimen consists of a partial external mold and complete internal mold of a right valve. Morningstar illustrated it as a cast of the external mold. The other specimen illustrated by Morningstar (pl. 14, figs. 9, 11, OSU-15248), an external mold, is the only known paratype.

Occurrence.—Rare in the Lower Mercer unit.

Repository.—Holotype, OSU-15249; paratype, OSU-15248.

Permophorus oblongus (Meek)
Pl. 14, figs. 9-11

Clidophorus Pallasi Geinitz, 1866, p. 23, pl. 2, fig. 4.

Pleurophorus oblongus Meek, 1872, p. 212, pl. 10, figs. 4a-c; Meek & Worthen, 1873, p. 589, pl. 26, fig. 6a; Morningstar, 1922, p. 238.

Small inequilateral equivalved elongate suboval shells. Beaks low, prosogyrate, located about one-fifth distance from anterior extremity; lunule and escutcheon present; anterior margin narrowly rounded anteroventrally, rounding into straight to slightly convex ventral margin; posterior margin rounded to somewhat truncate, curving sharply into ventral margin; dorsal and ventral margins divergent at a low angle; rounded umbonal ridge running to posteroventral margin; surface marked by fine somewhat irregular growth lines, which are more prominent anteriorly and ventrally; no radial ridges present except the umbonal shoulder.

Hinge structure not observed; anterior adductor scar small and separated from a smaller pedal retractor scar by a narrow strong myophoric buttress; pallial line complete.

Other interior features not observed. Measurements given in table 25.

Discussion.—*Permophorus oblongus* differs from *P. tropidophorus* (Meek), *P. immaturus* (Herrick), and *P. costatiformis* (Meek & Worthen) by having 1 rounded umbonal shoulder or fold rather than 2 or more such radiating features.

Occurrence.—Rare to abundant in the Lower Mercer unit; rare to common in the Putnam Hill unit; rare in the Boggs, Vanport, Columbiana, Dorr Run, Brush Creek, Portersville and Ames units; questionably present in the Washingtonville unit. Also reported by Morningstar (1922) from the Sharon unit and by Mark (1912) from the Cambridge unit.

Repository.—Hypotypes, OSU-27365 to 27367.

Permophorus costatiformis (Meek & Worthen)
Pl. 14, figs. 12-14

Pleurophorus costatiformis Meek & Worthen, 1868, p. 535, pl. 19, fig. 5.

Pleurophorus costatus Beede, 1900, p. 162.

Medium-sized inequilateral equivalved elongate oval

shells. Beaks small, low, prosogyrate; lunule and escutcheon present; anterior margin produced, strongly curved into a slightly sinuous to straight ventral margin; posterior margin truncate to gently convex dorsally, meeting dorsal margin at an obtuse angle and curving abruptly into ventral margin; umbonal ridge prominent, extending to posteroventral margin; 4 or 5 faint radiating ridges extending from umbonal slope to posterior and ventral margins; surface marked by fine closely spaced growth lines, which curve sharply at radial ridges.

Hinge structure and internal features not observed. Measurements given in table 25.

Discussion.—This species designation is somewhat tentative. The specimens are all partially exfoliated and the surface sculpture partially destroyed. In general the specimens agree well with the description and illustration of Meek & Worthen (1868).

Occurrence.—Rare to abundant in the Brush Creek unit; rare in the Cambridge unit. Also reported from the Lower Mercer and Putnam Hill units by Morningstar (1922).

Repository.—Hypotypes, OSU-27368 to 27370.

Genus ?*Pleurophorella* Girty, 1904

?*Pleurophorella sesquiplicata* Price
Pl. 14, figs. 15-17

Pleurophorella sesquiplicata Price, 1919, p. 290; —, 1920, p. 606, pl. 35, figs. 7-12; Morningstar, 1922, p. 235, pl. 13, figs. 16, 17.

Small inequilateral equivalved subrectangular shells. Beaks small, incurved, not raised above hinge line, located about one-fourth distance from anterior extremity; lunule and escutcheon probably present but not observed; dorsal and ventral margins nearly parallel; anterior margin only slightly produced, rounding abruptly into ventral margin; posterior margin subtruncate, joining dorsal margin at an obtuse angle and rounding sharply into ventral margin; umbonal angulation extending to posteroventral extremity; surface marked by fine growth lines and several coarser growth undulations.

Hinge structure and internal features not observed. Measurements given in table 25.

Discussion.—Without examples of the hinge structure and other internal characteristics, this assignment to the genus *Pleurophorella* is open to question. Except for the lack of any visible radial ornamentation in the posterodorsal area, the specimens agree well with the description and illustrations of Price (1920). Morningstar (1922) mentioned an obscure radial ridge on her specimens, but none is present in the collection we have from the same locality.

Occurrence.—Abundant in the Lower Mercer unit.

Repository.—Hypotypes, OSU-27371 to 27373.

Genus *Astartella* Hall, 1858
Astartella concentrica (Conrad)
Pl. 14, figs. 18-23

Nuculites concentrica Conrad, 1842, p. 248.

Posidonia Moorei Gabb, 1859, p. 297; —, 1860, p. 55, pl. 1, fig. 2.

Astartella portersvillensis Mark, 1912, p. 311, pl. 15, figs. 15, 16.

Astartella vera Mark, 1912, p. 311, pl. 15, figs. 13, 14.

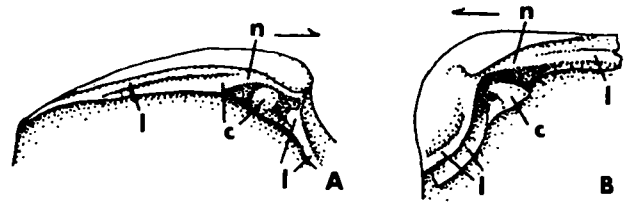


FIGURE 27.—Hinge line of A, left valve, and B, right valve of *Astartella concentrica* (Conrad). Both figures X4. c, cardinal teeth; l, lateral teeth; n, nymph.

Astartella concentrica Girty, 1915a, p. 142, pl. 18, figs. 2-9; Price, 1918, p. 788; Morningstar, 1922, p. 241, pl. 13, figs. 11-13; Morgan, 1924, pl. 46, fig. 5; Morse, 1931, p. 319, pl. 52, fig. 3; Chow, 1951, p. 33, pl. 4, fig. 3; Nicol, 1955, p. 157, figs. 2, 3; Elias, 1957, p. 783, pl. 96, fig. 6; Lintz, 1958, p. 101; Hoare, 1961, p. 126, pl. 15, fig. 6.

Medium-sized to large inequilateral equivalved inflated shells. Beaks small, incurved, prosogyrate; subrhomboidal in shape; truncate posterior margin, shallow concavity on ventral margin near posterior end; broad ridge running from umbo to posteroventral margin; lunule and escutcheon deeply impressed; valve surface between ridge and lunule flat to concave with rest of valve surface strongly convex; surface marked by sharp angular concentric ridges separated by flat to gently concave wide interspaces marked by fine concentric lirae; ridges coarse, numbering 4-6 in a space of 3 mm at a distance of 2 mm from the beak.

Hinge structure of the right valve with trigonal 3b, nymph, oblique 5b, and marginal laterals; left valve with large 2, nymph, raised AII lunular margin, strong and oblique 4b, and elongate PII (fig. 27); posterior and anterior adductors subovate and small; pallial line distinct; inner margins of valves crenulate. Measurements given in table 26.

Discussion.—*Astartella concentrica* differs from *A. newberryi* Meek by being more truncate posteriorly, by having the beaks located nearer the anterior extremity, and by having a smaller number of concentric ridges with corre-

TABLE 26.—Measurements of species of *Astartella*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Thickness (mm)
<i>A. concentrica</i>	Mg-10	1	10.4	9.3	5.4
		2	10.6	9.1	6.9
		3	10.5	9.6	7.1
		4	6.4	4.9	3.3
		5	8.1	6.6	5.3
		6	11.1	9.0	6.6
<i>A. varica</i>	Vel-12	1	18.9	15.1	11.4
		2	16.7	13.2	9.4
		3	19.2	15.6	10.2
<i>A. newberryi</i>	Vel-12	1	9.9	7.6	5.8
		2	11.7	8.7	6.0
		3	10.3	8.0	5.1
		4	6.8	4.4	3.4
<i>A. compacta</i>	Mc-2 MUF-3	1 LV	15.9	13.0	5.2
		1	6.0	4.3	3.0

¹ LV, left valve.

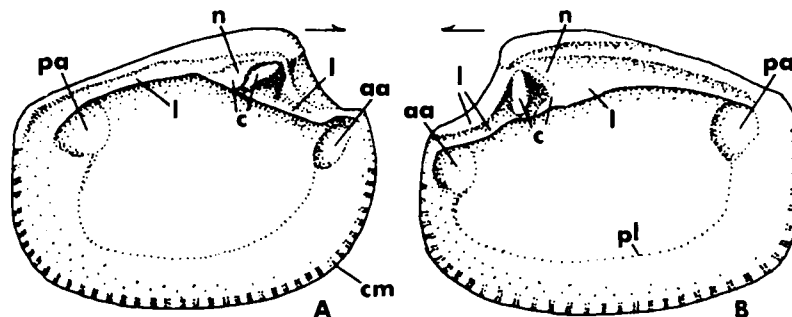


FIGURE 28.—Interior views of *A*, left valve, and *B*, right valve, of *Astartella varica* McChesney. Both figures X4. *aa*, anterior adductor scar; *c*, cardinal teeth; *cm*, crenulate margin; *l*, lateral teeth; *n*, nymph; *pa*, posterior adductor scar; *pl*, pallial line.

sponding wider interspaces per unit distance. *A. compacta* Girty differs in having much more closely spaced concentric ridges with roughened edges, and *A. varica* McChesney has much coarser and more widely spaced concentric ridges. *A. vera* Hall has coarser and more angular concentric ridges, which are not as regularly arranged as in *A. concentrica*.

Occurrence.—Rare to abundant in the Lower Mercer, Putnam Hill, Vanport, Columbiana, Brush Creek, Portersville, and Ames units; rare to common in the Cambridge unit; rare in the Zaleski and Washingtonville units; questionably present in the Upper Mercer unit. Also reported from the Lowellville and Boggs units by Morningstar (1922).

Repository.—Hypotypes, OSU-27374 to 27377.

Astartella varica McChesney
Pl. 14, figs. 24, 25; pl. 15, figs. 1, 2

Astartella varica McChesney, 1859, p. 55; Morningstar, 1922, p. 243, pl. 14, figs. 1-4.

Medium-sized inequilateral equivalved strongly convex inflated shells. Beaks small, tightly incurved, prosogyrate; anterior margin produced; posterior margin truncate; ventral margin smoothly convex; ridge radiating from umbo, curving to posteroventral extremity; lunule and escutcheon deeply impressed; valve surfaces marked by extremely heavy widely spaced concentric ridges, separated by wide flat to gently concave interspaces marked by fine concentric lirae; 2 ridges occupy a space of 3 mm at a distance of 2 mm below the beak.

Hinge structure, muscle scars, pallial line, and crenulate inner valve margin (fig. 28) are the same as for *A. concentrica*. Measurements given in table 26.

Discussion.—The very coarse nature of the surface ornamentation of *Astartella varica* distinguishes it from all other species of this genus even in the juvenile stage.

Occurrence.—Rare to abundant in the Lower Mercer, Putnam Hill, and Cambridge units; rare to common in the Vanport and Ames units; rare in the Boggs, Upper Mercer, Washingtonville, and Brush Creek units. Also reported from the Portersville unit by Mark (1912).

Repository.—Hypotypes, OSU-27378 to 27380.

Astartella newberryi Meek
Pl. 15, figs. 3-6

Astartella newberryi Meek, 1875, p. 340, pl. 19, fig. 3;

Morningstar, 1922, p. 242, pl. 13, fig. 14.

Medium-sized to large inequilateral equivalved inflated shells. Beaks small, tightly incurved, prosogyrate; anterior margin produced; posterior margin obliquely truncate and produced; ventral margin uniformly convex; radial ridge running from the umbonal area to the produced posteroventral extremity; lunule and escutcheon deeply impressed; valve surface evenly convex except for concave area located posterodorsally from ridge; valve surface marked by coarse angular concentric ridges with interspaces about as wide as ridges and marked by fine concentric lirae, 6-7 ridges present in a space of 3 mm at a distance of 2 mm from the beak.

Hinge structure (fig. 29) is the same as in *A. concentrica*. Other interior features not observed. Measurements given in table 26.

Discussion.—*Astartella newberryi* differs from other species of the genus by being produced both posteriorly and anteriorly and by having more numerous and heavier concentric ridges than does *A. concentrica*.

Occurrence.—Rare to abundant in the Lower Mercer and Putnam Hill units; rare in the Vanport and Columbiana units. Also reported from the Brush Creek and Portersville units by Mark (1912).

Repository.—Hypotypes, OSU-27381 to 27384.

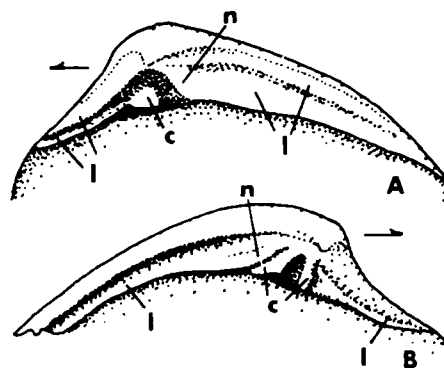


FIGURE 29.—Hinge line of *A*, right valve, and *B*, left valve, of *Astartella newberryi* Meek. Both figures X4. *c*, cardinal teeth; *l*, lateral teeth; *n*, nymph.

Astartella compacta Girty
Pl. 15, fig. 7

Astartella compacta Girty, 1915b, p. 354, pl. 28, figs. 4-5a;
Kelly, 1930, p. 148; Hoare, 1961, p. 127, pl. 15, fig. 5.

Small to medium-sized inequilateral equivalved shells. Beaks small, tightly incurved, prosogyrate; anterior and posterior margins truncate; ventral margin evenly convex; radiating ridge from umbonal area to posteroventral margin distinct, setting off a concave dorsoposterior area; lunule and escutcheon deeply impressed; surface marked by closely spaced concentric ridges with roughened edges separated by narrow flat interspaces; 8-12 ridges present in a space of 3 mm at a distance of 2 mm from the beak.

Hinge structure apparently the same as for *A. concentrica*. Interior ventral margin of valve crenulate. Other interior features not observed. Measurements given in table 26.

Discussion.—*Astartella compacta* is easily distinguished by the large number of closely spaced concentric ridges with roughened edges and by the truncate shape of the shell.

Occurrence.—Rare in the Lower Mercer, Upper Mercer, Putnam Hill, Vanport, Cambridge, and Portersville units; questionably present in the Columbiana unit.

Repository.—Hypotype, OSU-27385.

Genus *Cypricardinia* Hall, 1859
Cypricardinia carbonaria Meek
Pl. 15, figs. 15-17

Cypricardinia? carbonaria Meek, 1871d, p. 163; —, 1875, p. 342, pl. 19, figs. 8a, b; Herrick, 1887, p. 35, pl. 4, figs. 17, 18; Morningstar, 1922, p. 244, pl. 11, fig. 14; Sayre, 1930, p. 126, pl. 13, figs. 1-2a.

Small strongly inequilateral subovate modioliform shells with greatest height located posteriorly. Beaks small, incurved over hinge line, located very close to anterior extremity; anterior margin narrowly rounded into straight to slightly sinuate ventral margin; posterior margin broadly rounded, meeting dorsal margin at an obtuse angle; shell surface marked by several evenly spaced imbricating concentric lamellae with broad interspaces.

Hinge structure of right valve illustrated in figure 30. Pallial line complete; anterior adductor scar deep, subtriangular, and located at extremity; posterior scar indistinct.

Other internal features not observed. Measurements

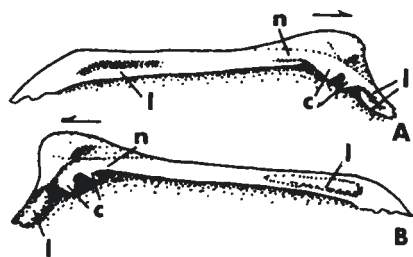


FIGURE 30.—Hinge line of A, left valve, and B, right valve, of *Cypricardinia carbonaria* Meek. Both figures X5. c, cardinal teeth; l, lateral teeth; n, nymph.

TABLE 27.—Measurements of *Cypricardinia carbonaria*

Locality	Specimen ¹	Length (mm)	Height (mm)	Hinge length (mm)
LIm-1	1 LV	12.6	7.7	7.0
	2 RV	13.0	5.8	8.2
	3 RV	12.1	7.0	
	4 RV	10.1	6.4	

¹ LV, left valve; RV, right valve.

given in table 27.

Discussion.—*Cypricardinia carbonaria*, a distinctive form in the Pennsylvanian of Ohio, is not likely to be mistaken for any other form. The dentition is shown on two partial internal molds, from which figure 30 was constructed. From the molds it is impossible to distinguish all hinge elements.

Occurrence.—Rare to abundant in the Lower Mercer unit; rare to common in the Putnam Hill and Columbiana units; rare in the Vanport unit. Also reported from the Brush Creek and Portersville units by Mark (1912).

Repository.—Hypotypes, OSU-27386 to 27388.

Genus *Edmondia* de Koninck, 1841
Edmondia ovata Meek & Worthen
Pl. 15, figs. 8, 9

Edmondia ovata Meek & Worthen, 1873, pl. 26, fig. 13; Meek, 1874, p. 580; Girty, 1915a, p. 106, pl. 14, fig. 13; Morningstar, 1922, p. 199, pl. 10, figs. 8, 9; Morse, 1931, p. 302; Hoare, 1961, p. 97, pl. 13, figs. 11, 12.

Medium-sized to large subequilateral equivalved ovate shells. Beaks small, prosogyrate, located about one-third distance behind anterior margin; anterior and posterior margins evenly rounded into ventral margin; lunule and escutcheon lacking; surface marked by numerous irregularly spaced and irregularly shaped concentric ridges and growth lines, the ridges being more pronounced anteriorly; no radial ornamentation.

Edentulous hinge line; an internal ridge paralleling the hinge plate and the ligament occupying a groove.

Other hinge features and interior features unknown. Measurements given in table 28.

Discussion.—*Edmondia ovata* differs from *E. gibbosa* (M'Coy) by having the beak located nearer the anterior margin and by having a larger length-height ratio. *E. aspinwallensis* Meek is similar, but has a pronounced marginal carina extending from the umbo to the posterior ventral margin, causing that margin to be more abruptly curved. *E. reflexa* Meek and *E. anodontoides* (Meek) are much more narrowly elongate species.

Occurrence.—Rare to abundant in the Brush Creek unit; rare to common in the Lower Mercer and Portersville units; rare in the Cambridge unit; questionably present in the Putnam Hill and Columbiana units. Also reported from the Upper Mercer unit by Morningstar (1922).

Repository.—Hypotypes, OSU-27389, 27390.

Edmondia gibbosa (M'Coy)
Pl. 16, figs. 3-5

Astarte gibbosa M'Coy, 1844, p. 55, pl. 8, fig. 11; Geinitz,

TABLE 28.—Measurements of species of *Edmondia*

Species	Locality	Specimen ¹	Length (mm)	Height (mm)	Thickness (mm)
<i>E. ovata</i>	MEco-1	1 LV	38.2	28.3	19.6
		2 LV	35.4	24.8	17.4
		3 LV	35.0	25.0	17.4
		4 RV	37.3	28.9	18.6
		5 RV	29.2	20.4	12.0
		6 LV	30.7	21.0	14.0
		7 RV	40.5	30.0	20.6
<i>E. gibbosa</i>	Ale-18	1	19.9	15.3	9.3
	MEco-1	2	14.4	11.2	7.2
<i>E. reflexa</i>	Aa-14	1 RV	20.1	11.7	3.8
<i>E. anodontoides</i>	MEco-1	1 RV	26.5	15.0	4.0
		2 LV	33.7	17.5	
		3 RV	33.2	17.8	
<i>E. meekiana</i>	LIho-1	1 RV	28.7	17.0	
		2 LV	30.6	19.3	
<i>E. nodulifera</i>	Ls-1	H LV	36.0+	43.2+	

¹ LV, left valve; RV, right valve; H, holotype.

1866, p. 16, pl. 1, figs. 23, 24.

Edmondia gibbosa Girty, 1903, p. 447, pl. 9, figs. 7-9; ———, 1909, p. 73; ———, 1915a, p. 107, pl. 14, fig. 12; Morningstar, 1922, p. 197, pl. 10, figs. 4, 5.

Small to medium-sized subequilateral equivalved ovate shells. Beaks small, incurved, prosogyrate, located one-fourth distance from anterior extremity; anterior margin more tightly curved than posterior margin; lunule and escutcheon lacking; surface marked by numerous irregularly spaced concentric ridges and growth lines; no radial ornamentation.

Edentulous hinge line; ligament occupying pronounced groove.

Other hinge structures and interior features unknown. Measurements given in table 28.

Discussion.—*Edmondia gibbosa* is distinguished from *E. ovata* Meek under the discussion of the latter species. Both *E. reflexa* Meek and *E. anodontoides* (Meek) are distinctly more elongate species. *E. aspinwallensis* Meek is more truncate posteriorly.

Occurrence.—Rare to abundant in the Lower Mercer and Putnam Hill units; rare to common in the Brush Creek unit; rare in the Columbiana, Washingtonville, and Ames units; questionably present in the Vanport unit.

Repository.—Hypotypes, OSU-27391, 27392.

Edmondia reflexa Meek
Pl. 15, figs. 10, 11

Edmondia reflexa Meek, 1872, p. 213, pl. 10, figs. 6a, b; pl. 4, fig. 7; Mark, 1912, p. 305, pl. 14, fig. 12; Price, 1918, p. 787; Morningstar, 1922, p. 199.

Small inequilateral equivalved narrowly elongate shells. Beaks small, incurved, prosogyrate, located one-third distance from anterior margin; anterior margin produced and more strongly curved dorsally; posterior margin evenly curved to more tightly curved ventrally; dorsal and ventral margins convergent anteriorly and posteriorly; lunule and

escutcheon lacking; surface marked by numerous concentric ridges and growth lines; faint radial markings on internal molds.

Dentition and interior features not observed. Measurements given in table 28.

Discussion.—*Edmondia reflexa* has been distinguished from other species under those discussions. It is most easily confused with *E. anodontoides* (Meek), but the consistently smaller size and radiating markings on the internal molds are distinguishing features.

Occurrence.—Rare in the Lower Mercer, Putnam Hill, Columbiana, Washingtonville, Portersville, and Ames units; questionably present in the Brush Creek and Skelley units. Also reported from the Cambridge unit by Mark (1912).

Repository.—Hypotypes, OSU-27393, 27394.

Edmondia anodontoides (Meek)
Pl. 15, figs. 12-14

Solenomya? anodontoides Meek, 1875, p. 339, pl. 14, fig. 11; Herrick, 1887, p. 29, pl. 4, fig. 10.

Edmondia anodontoides? Morningstar, 1922, p. 196.

Medium-sized subequilateral equivalved narrowly elongate subelliptical shells. Beaks small, incurved, prosogyrate, located one-third distance from anterior margin; anterior margin produced, more sharply rounded near dorsal margin, curving smoothly into ventral margin; posterior margin uniformly rounded; dorsal and ventral margins subparallel; lunule and escutcheon absent; surface marked by numerous concentric ridges and growth lines; no radial ornamentation.

Dentition and interior features not observed. Measurements given in table 28.

Discussion.—*Edmondia anodontoides* is easily distinguished from most other species of this genus by its elongate form and its much produced anterior margin. *E. reflexa* Meek is similar in height-length ratio, but differs in being consistently smaller in size, having less parallel dorsal and ventral margins, and having a faint radiating ornamentation on the internal molds.

Occurrence.—Common to abundant in the Brush Creek unit. Also questionably reported from the Lower Mercer unit by Morningstar (1922).

Repository.—Hypotypes, OSU-27395 to 27397.

Edmondia aspinwallensis? Meek
Pl. 16, figs. 1, 2

Edmondia aspinwallensis Meek, 1871a, p. 299; ———, 1872, p. 216, pl. 4, fig. 2-2c; White, 1884, p. 148, pl. 31, figs. 4, 5; Beede, 1900, p. 166, pl. 22, figs. 3-3b; Girty, 1903, p. 35; Mark, 1912, p. 305, pl. 14, fig. 11; Morningstar, 1922, p. 197, pl. 10, fig. 7; Sayre, 1930, p. 103, pl. 8, figs. 1, 1a; Hoare, 1961, p. 98, pl. 13, fig. 13.

Medium-sized subequilateral equivalved shells. Beaks small, incurved, prosogyrate; anterior margin uniformly curved; posterior margin slightly truncate; marginal carina extending from umbo to posterior ventral margin; escutcheon and lunule lacking; surface marked by numerous concentric arranged ridges and growth lines.

Dentition and interior features unknown. No worthwhile measurements possible.

Discussion.—Several incomplete specimens in the Por-

tersville unit are questionably referable to *Edmondia aspinwallensis*. The truncate posterior margin and marginal carina extending from the umbo are characteristic. Mark (1912) notes this species from the Cambridge, Portersville, and Ames units. The only extant specimen of hers in the OSU repository is a representative of *E. ovata* Meek from the Portersville. Morningstar (1922) reports *E. aspinwallensis* from the Lower Mercer and Putnam Hill units, but none of her specimens have been preserved in the collection.

Occurrence.—Rare in the Portersville unit; questionably present in the Cambridge unit. Also reported from the Lower Mercer and Putnam Hill units by Morningstar (1922) and from the Ames unit by Mark (1912).

Repository.—Hypotype, OSU-27398.

Edmondia meekiana (Herrick)

Pl. 16, figs. 6, 7

Solenomya(?) meekiana Herrick, 1887, p. 30, pl. 4, fig. 9.

Edmondia meekiana? Morningstar, 1922, p. 198, pl. 10, fig. 6.

Medium-sized inequilateral equivalved subrectangular shells. Beaks small, prosogyrate, located about one-third distance posterior to the anterior extremity; anterior margin more narrowly rounded than posterior; dorsal and ventral margins nearly parallel, though dorsal is straighter; lunule and escutcheon lacking; surface marked by numerous fine growth lines and more widely spaced coarser growth annulations.

Hinge structure and internal features not observed. Measurements given in table 28.

Discussion.—*Edmondia meekiana* differs from *E. anodontoides* (Meek) by being less elongate in shape and less produced anteriorly. Other species of *Edmondia* have a smaller length-height ratio.

Occurrence.—Rare in the Lower Mercer unit. Also questionably reported from the Putnam Hill unit by Morningstar (1922).

Repository.—Hypotypes, OSU-15259-1, 15259-2.

Edmondia nodulifera Hoare, Sturgeon & Kindt

Pl. 15, figs. 18-20

Edmondia nodulifera Hoare, Sturgeon & Kindt, 1978, p. 1032, pl. 2, figs. 14-16.

Large subequilateral equivalved ovate shells. Beaks small, prosogyrate, located one-third to one-fourth the distance behind the anterior margin; anterior and posterior margins smoothly rounded into convex ventral margin; lunule and escutcheon lacking; surface marked by numerous concentric ridges and growth lines; some ridges more prominent than others, with more gently sloping dorsal surfaces and scalloped into prominent closely spaced nodes, which are also arranged in regular radial lines.

Hinge unknown; pallial line entire. Other interior features not observed. Measurements given in table 28.

Discussion.—*Edmondia nodulifera* differs from other known species of this genus by the nodose sculpture of the larger concentric ridges. It also attains a larger size than previously described species, with a flattened specimen having a length of 81.0 mm and a height of 67.0 mm.

Occurrence.—Rare in the Cambridge unit.

Repository.—Holotype, OSU-27399; paratypes, OSU-27400, 28976.

Genus *Cardiomorpha* de Koninck, 1841

Cardiomorpha missouriensis Shumard

Pl. 16, fig. 8

Cardiomorpha missouriensis Shumard (*in* Shumard & Swallow, 1858), p. 207; Meek & Worthen, 1873, p. 588, pl. 27, fig. 8; Beede, 1900, p. 165, pl. 20, fig. 17; Hoare, 1961, p. 99, pl. 13, figs. 1-3.

Nucula cylindrica McChesney, 1859, p. 54.

Nucula mercerensis McChesney, 1867, p. 40, pl. 2, figs. 12a-c.

Small strongly inequilateral equivalved subrectangular inflated shells. Beaks small, strongly prosogyrate; umbones inflated; dorsal and ventral margins subparallel, diverging slightly towards the posterior; anterior margin narrowly rounded; posterior margin subtruncate, meeting dorsal margin in an obtuse angle and rounding sharply into ventral margin; surface smooth except for numerous fine growth lines.

Hinge similar to that of *Edmondia* with well-developed nymphs and hinge plate supported by a thin parallel internal ridge (fig. 31). Other internal features not observed. A specimen from the Putnam Hill unit 13.1 mm long and 8.1 mm high.

Discussion.—This is the only species of *Cardiomorpha* reported from the Pennsylvanian. Newell (*in* Moore, 1969) restricts the genus *Cardiomorpha* to the Lower Carboniferous and would presumably include these specimens in the genus *Edmondia*. The characteristics described above cause us to place them in *Cardiomorpha* and extend the genus into the Allegheny. The features upon which we have come to this conclusion are the more anterior location of the beaks, the inflated and strongly prosogyrate umbones and beaks, the subrectangular shape, and the lack of strong concentric ornamentation.

Occurrence.—Rare in the Putnam Hill and Columbiana units. Also reported from the Brush Creek, Cambridge, and Ames units by Mark (1912).

Repository.—Hypotype, OSU-28977.

Genus *Prothyris* Meek, 1871

Subgenus *Prothyris* Meek, 1871

Prothyris (Prothyris) elegans Meek

Pl. 16, figs. 9-11

Prothyris elegans Meek, 1871e, p. 5, pl. 1, fig. 3; —, 1872, p. 223, pl. 10, figs. 9a, b; Herrick, 1887, p. 32, pl. 4, fig. 3; Mark, 1912, p. 296; Price, 1918, p. 787; Morningstar, 1922, p. 195, pl. 14, fig. 12; Morse, 1931, p. 318, pl. 52, fig. 2.

Small strongly inequilateral equivalved elongate subrectangular shells with a small ovate anterior extension. Beaks small, low, with faint ridge running anteriorly to notch; escutcheon and lunule lacking; dorsal and ventral margins subparallel; posterior margin truncate, meeting ventral margin at slightly less than 90° and rounding abruptly into the dorsal margin at an obtuse angle; anterior margin with ovate extension anterodorsally producing a narrow notch below it and then curving into the ventral

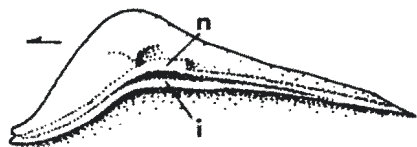


FIGURE 31.—Hinge line of right valve of *Cardiomorpha missouriensis* Shumard. X6. *i*, internal ridge; *n*, nymph.

margin; surface marked by fine closely spaced growth lines on the anterior and ventral portions of the valves, the dorsal and posterior portions smooth.

Other internal features not observed. Four specimens from the Putnam Hill unit averaging 17.4 mm in length and 6.0 mm in height.

Discussion.—*Prothyris* (*P.*) *elegans* is the only species yet recognized in the Pennsylvanian of North America. The shell form is diagnostic.

Occurrence.—Rare to abundant in the Putnam Hill unit; common in the Portersville unit; rare in the Columbiana and Brush Creek units. Also reported by Morningstar (1922) from the Lower and Upper Mercer units.

Repository.—Hypotypes, OSU-28978 to 28980.

Genus *Solenomorpha* Cockerell, 1903
Solenomorpha? *solenoides* (Geinitz)
Pl. 16, figs. 14, 15

Clidophorus solenoides Geinitz, 1866, p. 25, pl. 2, fig. 7.

Solenopsis solenoides Meek, 1872, p. 223, pl. 10, fig. 3.

Small strongly inequilateral equivalved elongate sub-cylindrical shells. Beaks very small, low, located about one-tenth distance from anterior extremity; lunule and escutcheon not observed; anterior margin extending slightly past beaks, sharply curved into ventral margin; dorsal margin nearly straight; ventral margin gently convex, converging slightly with dorsal margin, forming a narrowly rounded posterior margin; shell material thin; surface marked by numerous very faint growth lines.

Hinge unknown and internal features not observed. Two specimens from the Columbiana unit averaging 14.3 mm in length and 3.8 mm in height.

Discussion.—The specimens described above agree closely with those of Geinitz (1866) and Meek (1872). The species is questionably placed in the genus *Solenomorpha* because a lunule and escutcheon were not seen, and there is no radial umbonal carina extending to the posteroventral extremity.

Occurrence.—Rare to common in the Columbiana unit; rare in the Portersville unit.

Repository.—Hypotypes, OSU-28981, 28982.

Genus *Exochorhynchus* Meek & Hayden, 1864
Exochorhynchus altirostratus (Meek & Hayden)
Pl. 16, figs. 12, 13

Allorisma? *altirostrata* Meek & Hayden, 1858a, p. 76.

Allorisma altirostratus Meek & Hayden, 1864, p. 42.

Exochorhynchus altirostratus Newell (in Moore, 1969), p. N831, fig. F12.1.

Small to medium-sized strongly inequilateral equivalved

elongate oval shells. Beaks incurved over hinge line, orthogyrate, located at extreme anterior end; shell inflated anteriorly, possibly gaping posteriorly; surface marked by coarse broad concentric folds.

Other features not observed. No worthwhile measurements possible.

Discussion.—Specimens of this species may be confused with species of *Wilkingia* at first glance. The terminal beaks are diagnostic. The above description is based upon a few incomplete internal molds. All are partially crushed dorso-ventrally, possibly causing the apparent posterior gape.

Occurrence.—Rare in the Lower Mercer and Portersville units.

Repository.—Hypotypes, OSU-28983, 28984.

Genus *Wilkingia* Wilson, 1959
Wilkingia terminale (Hall)
Pl. 16, figs. 18-20

Allorisma terminalis Hall, 1852, p. 413, pl. 2, figs. 4a, b; Miller, 1889, p. 460; Girty, 1903, p. 437, pl. 9, figs. 4-6; —, 1909, p. 90; Mark, 1912, p. 298; Price, 1921, p. 784; Plummer & Moore, 1921, p. 218; Morningstar, 1922, p. 234, pl. 13, fig. 15; Morgan, 1924, pl. 46, figs. 3, 3a; Morse, 1931, p. 318, pl. 51, fig. 2; Chow, 1951, p. 31, pl. 3, figs. 17a-c; Burk, 1954, p. 14, pl. 1, figs. 38-40.

Allorisma ensiformis Swallow, 1860, p. 656.

Allorisma subcuneatum Meek & Hayden, 1858b, p. 263; —, 1864, p. 37, pl. 1, figs. 10a, b; Geinitz, 1866, p. 76; Meek, 1872, p. 221, pl. 2, figs. 10a, b; White, 1876, p. 91; —, 1884, p. 148, pl. 31, figs. 1-3; Heilprin, 1886, p. 276, figs. 10, 10a; Herrick, 1887, p. 34, pl. 4, figs. 1, 2; Miller, 1889, p. 460, fig. 769; Keyes, 1894, p. 129, pl. 47, figs. 5a-c; Beede, 1900, p. 169, pl. 20, figs. 1, 1b; Raymond, 1910, p. 155, pl. 27, figs. 5, 6; Plummer & Moore, 1921, p. 218, pl. 24, fig. 18.

Leptodomus granosus Shumard (in Shumard & Swallow, 1858), p. 207.

Allorisma (*Sedgwickia*) *granosa* Meek, 1872, p. 220, pl. 2, fig. 8.

Allorisma granosum Keyes, 1894, p. 128; Beede, 1900, p. 168, pl. 20, fig. 10.

Wilkingia terminale Hoare, 1961, p. 122, pl. 15, fig. 8, pl. 16, fig. 3.

Large very inequilateral equivalved elongate shells. Beaks tightly incurved, prosogyrate; anterior and posterior margins evenly rounded; dorsal and ventral margins sub-parallel; escutcheon and lunule present; umbonal ridge obsolete; posterior gape commonly present; surface marked by coarse concentric growth annulations; radial rows of small papillae on weathered specimens.

Hinge structure and interior features not observed. Two specimens averaging 44.8 mm in length, 23.2 mm in height, and 18.2 mm in thickness.

Discussion.—*Wilkingia terminale* is the only species of this genus recognized in our collections. *W. granosum* (Shumard, in Shumard and Swallow, 1858) is here considered a synonym of *W. terminale* in that the granules or papillae are characteristic of the genus and appear only under favorable modes of preservation. We can see no basis for differentiating other species in our collections.

Occurrence.—Abundant in the Skelley unit; rare to

common in the Lower Mercer, Putnam Hill, and Brush Creek units; rare in the Boggs, Zaleski, Vanport, Washingtonville, Cambridge, Portersville, and Ames units.

Repository.—Hypotypes, OSU-28985 to 28987.

Genus *Sanguinolites* M'Coy, 1844
Sanguinolites costata (Meek & Worthen)
Pl. 16, figs. 16, 17

Allorisma costata Meek & Worthen, 1869, p. 171; —, 1873, p. 585, pl. 26, fig. 15; Meek, 1875, p. 344, pl. 19, figs. 6a, b; Beede, 1900, p. 170, pl. 20, fig. 12; Mark, 1912, p. 298; Sayre, 1930, p. 123, pl. 12, fig. 10.

Medium-sized inequilateral equivalved elongate shells. Beaks small, incurved, prosogyrate; anterior margin narrowly rounded into gently convex ventral margin; posterior margin obliquely truncate; dorsal margin nearly straight; surface marked by prominent umbonal ridge running to posteroventral extremity; sharp concentric ridges separated by wider flat to slightly concave interspaces which terminate at umbonal ridge; a faint radial ridge present within the smooth posterodorsal area.

Hinge structure and interior features not observed. A specimen from the Vanport unit 41.7 mm long and 14.4 mm high.

Discussion.—*Sanguinolites costata* is the only species of this genus recognized in our collections. Although generally placed in the genus *Allorisma*, it is here placed in *Sanguinolites* because of its differentiated posterodorsal area. Neither the lunule or the escutcheon are preserved in our specimens.

Occurrence.—Rare in the Vanport, Brush Creek, Cambridge, and Ames units.

Repository.—Hypotype, OSU-28988.

Genus *Unklesbayella* Hoare, Sturgeon & Kindt, 1978
Unklesbayella geinitzi (Meek)
Pl. 18, figs. 8, 9

Allorisma elegans Geinitz, 1866, p. 13, pl. 1, fig. 21 [non] King, 1844.

Allorisma Geinitzii Meek, 1867, p. 170; Meek & Worthen, 1873, p. 586, pl. 26, fig. 23; Herrick, 1887, p. 53, pl. 4, fig. 27; Mark, 1912, p. 310, pl. 15, fig. 11.

Allorisma (Sedgwickia) Geinitzi Meek, 1872, p. 219, pl. 10, figs. 16a, b.

Pleurophorella geinitzi Morningstar, 1922, p. 235, pl. 13, figs. 18, 19.

Unklesbayella geinitzi Hoare, Sturgeon & Kindt, 1978, p. 1032, pl. 2, figs. 10, 11, text-fig. 3.

Small inequilateral equivalved subquadrate shells. Beaks small, incurved, prosogyrate; escutcheon present, lunule absent; anterior margin narrowly rounded into gently convex ventral margin; posterior margin truncate, forming right angle with dorsal margin and obtuse angle with ventral margin; umbo raised above dorsal margin; pronounced umbonal ridge extending to posteroventral extremity; concave posterodorsal area may have 2 or 3 faint radiating ridges; surface sculptured by fine closely spaced pustules arranged in radiating and concentric rows.

Hinge structure with short nymph posterior to beak; large blunt tooth under beak of right valve with small elongate socket just anterior to tooth; large socket under

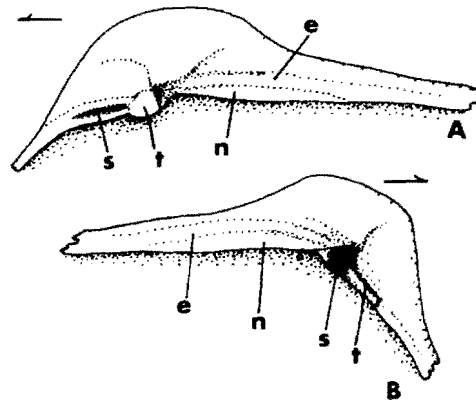


FIGURE 32.—Hinge line of A, right valve, and B, left valve, of *Unklesbayella geinitzi* (Meek). Both figures X5.5. e, escutcheon; n, nymph; s, socket; t, tooth.

beak of left valve, with narrowly elongate tooth on valve margin just anterior of socket (fig. 32). Other interior features not seen. Most specimens crushed and fragmentary. Two specimens averaging 5.9 mm in length and 3.7 mm in height.

Discussion.—*Unklesbayella geinitzi* is easily distinguished on the basis of its strong umbonal ridge, truncated posterior margin, and highly developed valve ornamentation. Specimens from the Lower Mercer unit have ornamentation that is more subdued, but of the same pattern as that of specimens higher in the section.

Occurrence.—Rare in the Putnam Hill, Vanport, and Brush Creek units; common in the Lower Mercer unit; abundant in the Ames unit. Also reported by Mark (1912) from the Portersville unit.

Repository.—Hypotypes, OSU-30354 to 30356.

Genus *Pseudoconocardium* Zavodowsky, 1960
Pseudoconocardium parrishi (Worthen)
Pl. 17, figs. 1-6; pl. 18, fig. 1

Conocardium parrishi Worthen, 1890, p. 112, pl. 20, fig. 7; Keyes, 1894, p. 124, pl. 46, figs. 6a, b; Beede, 1900, p. 164, pl. 20, fig. 9; Sayre, 1930, p. 109, pl. 9, figs. 20-20c.

Pseudoconocardium parrishi Hoare, Sturgeon & Kindt, 1978, p. 1033, pl. 2, figs. 1-7.

Very small inequilateral equivalved slightly longer-than-high shells. Beaks lacking; univalved larval shell located between umbones; anterior margin with pronounced gape; posterior margin with a small tubelike rostrum located near dorsal margin and a very small opening located at ventral margin; no hood structure evident; dorsal margin nearly straight; ventral margin strongly sloping and convex anteriorly and slightly concave and nearly vertical below the rostrum posteriorly; a strong umbonal ridge extending from the umbo to the ventral margin, separating the anterior and posterior valve areas; anterior valve surface marked by up to 15 radiating costae of differing widths and distinctness; posterior surface marked by up to 10 costae concentrically arranged ventral to the rostrum; outer shell material thin, generally missing, but where present anteriorly showing a

finely reticulated ornamentation which obscures the radial costae.

Musculature and other interior shell features not observed. All specimens crushed and worthwhile measurements not possible. Approximate length and height 2.6 mm and 2.2 mm, respectively.

Discussion.—*Pseudoconocardium parrishi* differs from *P. lanterna* (Branson, 1965) by being smaller and more strongly carinate. *P. obliquum* (Meek & Worthen, 1875) is less concave and more oblique in form than *P. parrishi*. *P. nicholasensis* (Price, 1921) is described from poorly preserved specimens, but is possibly a synonym of *P. parrishi*.

Occurrence.—Rare to abundant in the Lower Mercer, Putnam Hill, and Vanport units.

Repository.—Hypotypes, OSU-29269 to 29272, 30357.

Pseudoconocardium missouriensis (Girty)

Pl. 18, figs. 2, 3

Conocardium missouriensis Girty, 1915b, p. 353, pl. 28, figs. 3-3c.

Pseudoconocardium missouriensis Hoare, Sturgeon & Kindt, 1978, p. 1033, pl. 2, figs. 8, 9.

Small inequilateral equivalved shells. Beaks lacking; univalved larval shell located between umbones; anterior margin with pronounced gape; posterior margin with a small

tubelike rostrum located near dorsal margin; no hood structure evident; dorsal margin nearly straight; ventral margin strongly sloping and convex anteriorly and nearly vertical below rostrum posteriorly; a strong umbonal ridge extending from the umbo to the ventral margin, separating the anterior and posterior valve areas; umbonal ridge marked by several small evenly spaced ridges; posterior shell surface marked by 11 radiating rounded costae separated by interspaces wider than costae and marked by fine fila; costae increasing by intercalation and concentrically arranged ventral to the rostrum; anterior surface of outer shell material marked by a reticulated network of fine costae.

Musculature and other interior shell features not observed. Specimens crushed. Approximate length and height of a large specimen 6.0 mm and 8.0 mm, respectively.

Discussion.—*Pseudoconocardium missouriensis* differs from *P. parrishi* (Worthen) by having a distinctly coarser reticulate ornamentation on the anterior portion of the valve. The presence, as reported by Girty (1915b), of irregularly spaced nodes on the umbonal ridge was not observed. Sayre (1930) and Branson (1965) placed *P. missouriensis* in synonymy with *P. parrishi*, but the difference in ornamentation on the anterior portion of the valve distinguishes the two species. *P. obliquum* (Meek & Worthen, 1875) is less concave and more oblique in form.

Occurrence.—Rare in the Putnam Hill and Vanport units.

Repository.—Hypotypes, OSU-30352, 30353.

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APPENDIX—COLLECTING LOCALITIES

Specimens providing the basis for this report came from 21 stratigraphic units at 258 localities listed below in Athens, Carroll, Columbiana, Coshocton, Gallia, Guernsey, Hocking, Holmes, Jackson, Jefferson, Lawrence, Licking, Mahoning, Meigs, Morgan, Muskingum, Noble, Perry, Portage, Scioto, Stark, Summit, Tuscarawas, Vinton, and Wayne Counties (fig. 1). One locality from Preston County, West Virginia, also is included. The localities are listed in numerical order under the respective counties and civil townships, which are alphabetical according to the county and township names. The capitalized first letter(s) of the locality designation indicates the county, the small letter(s) the civil township, and the number following is our file number for that particular locality in the township. Exposures are located by sections or fractions thereof, by reference to various natural or cultural features, and/or by reference to elevation numbers on the pertinent 1:24,000 topographic maps, which are indicated in capital letters. This information is followed by the name of the stratigraphic unit(s) and, in parentheses, the number of collections made at the described locality; the Ohio Division of Geological Survey (OGS) file numbers of stratigraphic sections at or near the locality; and the names of the identified genera and species, with abundance indicated: A, abundant, 15 or more; C, common, 5-14; R, rare, 4 or fewer. It should be noted that almost all of the deep and strip mines are no longer active.

ATHENS COUNTY:

Alexander Township:

- Aal-11. Exposure in ravine, south of U.S. 50, directly south-southwest of road junction at elev. no. 677 and 0.2 mi. east of Snowden Cem., THE PLAINS. Portersville (5). OGS 11626. *Phestia bellistriata* (R).

Ames Township:

- Aam-5. Exposure along Mush Run, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, STEWART. Skelley (1). OGS 8970. *Aviculopecten* sp. (R), *Euchondria* sp. (R), *Astartella* sp. (R), *Edmondia reflexa*? (R), *E.* sp. (R).
- Aam-7. Exposure along ravine south of farm buildings, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, JACKSONVILLE. Ames and Skelley (3). OGS 8972. Ames: *Myalina* (*O.*) *subquadrata*? (R). Skelley: *Aviculopecten* sp. (R), *Wilkingia terminale* (A).

Athens Township¹:

- Aa-1. Exposure near hilltop, northeast side Ohio Rte. 13 (formerly U.S. 33), approx. 0.1 mi. northwest of junction of Ohio Rte. 13 and U.S. 33 at elev. no. 659, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, ATHENS. Ames, Lower and Upper Brush Creek (2). OGS 11484. Lower and Upper Brush Creek: *Euchondria ohioensis* (R).
- Aa-12. Exposure on east side of U.S. 33 and 50A, north of Athens and almost due east of Armitage, ATHENS. Portersville (2). OGS 11434. *Acanthopecten carboniferous* (R), *Exochorhynchus altirostratus* (R), *Edmondia* sp. (R).
- Aa-14. Exposure in ravine north of road, approx. 1.1 mi. west-southwest of road junction at elev. no. 742, west-northwest of The Plains, THE PLAINS. Ames (1). OGS 11226. *Edmondia reflexa* (R).
- Aa-15. Exposure along northwest side U.S. 50A, approx. 0.5 mi. south of Athens-Dover Twp. line, NW $\frac{1}{4}$ sec. 12, ATHENS. Upper Brush Creek (1). OGS 11227. *Edmondia* sp. (R).
- Aa-27. Exposure in ravine on south side of Hocking R., Athens State Hospital grounds, ATHENS. Ames (2). OGS 11235. *Acanthopecten meeki*? (R).
- Aa-41. Exposure at cliff, east side of Ohio Rtes. 56 and 682, THE PLAINS. Lower Brush Creek (numerous). OGS 12158. *Nuculopsis girtyi* (A), *N. anodontoides* (C), *Palaeoneilo oweni* (A), *Paleyoldia stvensoni* (C), *Phestia bellistriata* (R), *P. arata* (C), *P. attenuata* (R), *Pteronites americana* (R), *Septimyalina perattenuata* (R), *Dunbarella stri-*

ata (R), *Aviculopecten* sp. (R), *Acanthopecten carboniferous* (C), *Streblochondria tenuilineata* (R), *Euchondria ohioensis* (C), *E. levicula* (R), *Pernopecten prosseri* (R), *Palaeolima triplistriata* (C), *Schizodus wheeleri*? (R), *Astartella concentrica* (A), *Edmondia ovata* (A), *E. gibbosa*? (R), *E. anodontoides* (A), *Prothyris* (*P.*) *elegans* (R), *Wilkingia terminale* (R), *Sanguinolites costata* (R).

- Aa-49. Undescribed exposure southwest of the Athens State Hospital buildings (probably along valley of Dairy Run), ATHENS. Ames (1). *Pernopecten prosseri* (R).

- Aa-55. Exposure on east side of U.S. 33, north of Athens and in back of Athens Lake Motel, ATHENS. Portersville (2). *Parallelodon sangamonensis*? (R), *Acanthopecten carboniferous*? (R), *Streblopteria oklahomensis* (R), *Pernopecten attenuatus* (R), *Palaeolima triplistriata* (R), *Edmondia* sp. (C).

- Aa-57. Exposure on east side of U.S. 33, south of Athens and behind the College Apts., SE $\frac{1}{4}$ sec. 13, ATHENS. Portersville (1). *Edmondia* sp. (C).

Dover Township:

- Ad-11. Exposure along road west of elev. no. 717 road junction, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27, NELSONVILLE. Brush Creek? (1). OGS 11454. *Astartella concentrica* (R).

- Ad-12. Exposures in mine entrances, strip mine, and along Ohio Rte. 675 and Utah Ridge Rd., ctr. and NW $\frac{1}{4}$ sec. 36, NELSONVILLE. Ames and Portersville (1). OGS 11594. Ames: *Aviculopecten* sp. (R).

- Ad-23. Exposure north of east-west road and east of ravine, northeast of road junction at elev. no. 682, East Millfield, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, JACKSONVILLE. Ames (1). OGS 11298. *Nuculopsis girtyi* (R).

- Ad-37. Exposure along east side U.S. 50A just south of road junction at elev. no. 710, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 2, JACKSONVILLE. Cambridge (2). OGS 11310. *Septimyalina perattenuata* (R).

- Ad-49. Steep road cut north of junction of U.S. 33 and Ohio Rte. 682 at southeast edge of Beaumont, NELSONVILLE. Lower and Upper Brush Creek and Cambridge (1). OGS 15062. Upper Brush Creek: *Phestia* sp. (R), *Pernopecten prosseri*? (R), *Schizodus* sp. (R), *Astartella* sp. (R), *Prothyris* (*P.*) *elegans* (R).

Lee Township:

- Ale-4. Exposure along creek and road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, THE PLAINS. Undifferentiated Brush Creek (2). OGS 11545. *Euchondria ohioensis* (R).

¹ Athens Township is not divided into sections but in some cases it is desirable to indicate what the sections would be to facilitate designation of locations.

- Ale-18. Diamond Stone Quarries, Inc., Plant No. 2 (formerly Shamrock Quarries, Inc., and earlier Dickson Bros. Quarry), north side U.S. 50, NW $\frac{1}{4}$ sec. 13 and SW $\frac{1}{4}$ sec. 14, ALBANY. Lower and Upper Brush Creek (3). OGS 11559. *Nuculopsis girtyi* (A), *N. anodontoides* (R), *Paleyoldia stvensoni* (C), *Phestia arata* (A), *Pteronites americana* (R), *Aviculopecten arctisulcatus* (R), *Acanthopecten meeki* (R), *Palaeolima retifera* (R), *Schizodus wheeleri* (C), *Permophorus costatiformis* (A), *Astartella concentrica* (R), *Edmondia ovata* (A), *E. gibbosa* (R), *E. anodontoides* (C), *Wilkingia terminale* (C).
- Ale-19. Diamond Stone Quarries, Inc., Plant No. 1 (formerly Stinson Quarry), east of Columbia Rd. and south of U.S. 50 and along Leading Cr., N $\frac{1}{2}$ NE $\frac{1}{4}$ sec. 7, ALBANY. Lower and Upper Brush Creek (2). OGS 11560. *Phestia* sp. (R), *Aviculopecten occidentalis* (R), *Edmondia ovata* (R).
- Ale-35. Exposures along Appalachian Hwy. at Ohio Rte. 346, secs. 13 and 19, ALBANY and VALES MILLS. Brush Creek (2). *Nuculopsis girtyi* (A), *N. anodontoides* (A), *Paleyoldia stvensoni* (A), *Phestia arata* (A), *Pteronites americana* (R), *Schizodus wheeleri* (A), *Edmondia ovata* (C), *E. gibbosa* (C), *Wilkingia terminale* (R).
- Ale-36. Exposure in pipeline ditch (now covered), NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 10 and SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, ALBANY. Lower(?) Brush Creek (1). OGS 11548. *Edmondia* sp. (R), *Promytilus* sp. (R).
- Ale-37. Composite collection from locs. Ale-18 and Ale-19 (q.v.). Lower and Upper Brush Creek (1). *Nuculopsis girtyi* (R), *Phestia bellistriata* (R), *P. arata* (R), *Aviculopecten arctisulcatus* (R), *Palaeolima retifera* (R), *Schizodus wheeleri* (R), *Permophorus costatiformis* (R), *Astartella concentrica* (R), *Edmondia ovata* (R).
- Trimble Township:
- At-4. Exposure in abandoned NYC RR. cut (originally tunnel), northwest of Bishopville, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 4, CORNING. Portersville (4). OGS 6676. *Nuculopsis girtyi*? (R), *Phestia bellistriata* (R), *Edmondia* sp. (R), *Wilkingia terminale* (R).
- At-9. Exposure along southwest side of Ohio Rte. 13, 0.8 mi. north of Glouster, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 10, CORNING. Lower Brush Creek (3). OGS 6680. *Nuculopsis girtyi* (C), *N. croneisi* (R), *Phestia arata* (A), *P. attenuata* (R), *Myalina* (*O.*) *subquadrata*? (R), *Septimyalina perattenuata*? (R), *Leptodesma* (*L.*) *sulcata* (R), *Dunbarella striata* (R), *Acanthopecten carboniferous* (R), *Astartella concentrica* (C), *A. varica* (R), *Unklesbayella geinitzi* (R).
- At-64. Exposure along east-west stream and at abandoned drift mine, S $\frac{1}{2}$ sec. 1, JACKSONVILLE. Portersville (1). OGS 11648. *Permophorus oblongus* (R), *Edmondia ovata*? (R).
- Waterloo Township:
- Aw-7. Exposure along road, NE $\frac{1}{4}$ sec. 29, MINERAL. Brush Creek (1). OGS 7576. *Pteronites peracuta* (R).
- Aw-48. Exposure along ravine, N $\frac{1}{2}$ SW $\frac{1}{4}$ sec. 3, THE PLAINS. Shale over Mason coal, Upper Brush Creek, and Portersville (5). OGS 7618. Shale over Mason coal: *Phestia* sp. (R), *Solemya* (*J.*) *radiata* (R), *Dunbarella striatus* (R), *D. knighti* (A), Upper Brush Creek: *Dunbarella knighti*? (R), *Euchondria ohioensis* (R).
- Aw-49. Exposure along road, west of road junction at elev. no. 699, ctr. sec. 2, THE PLAINS. Lower Brush Creek (1). OGS 7619. *Clavicosta* sp. (R).
- Aw-51. Exposures in ravines, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1 and NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 7, THE PLAINS. Lower and Upper(?) Brush Creek and Ames (1). OGS 7621. Lower Brush Creek: *Nuculopsis girtyi* (R), *Paleyoldia stvensoni* (R), *Palaeolima retifera* (R), *P. triplistriata* (R), *Astartella concentrica* (R), *Edmondia ovata* (C), *E. reflexa*? (R). Ames: *Acanthopecten carboniferous* (R).
- York Township:
- Ay-9. Exposure along Mud Sock Rd. just north of road junction at elev. no. 783 on north side of Minkers Run, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, NELSONVILLE. Dorr Run (1). OGS 11576. *Solemya* (*J.*) *radiata* (R), *Dunbarella knighti* (A), *Euchondria levicula*? (R), *Posidonia fracta* (R), *Permophorus* sp. (R).
- Ay-11. Exposure along Mud Sock Rd. on south side of Hocking Valley, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, NELSONVILLE. Dorr Run (1). OGS 6733. *Dunbarella knighti* (C).
- Ay-21. Exposure along road just west of road junction at elev. no. 924, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 4, NELSONVILLE. Cambridge (2). OGS 6743. *Promytilus* sp. (R), *Myalina* (*O.*) *subquadrata*? (C), *Septimyalina perattenuata*? (C), *Aviculopecten bascilicus*? (C), *Fasciculiconcha knighti* (A), *Pseudomonotis* sp. (R), *Palaeolima retifera* (R), *Schizodus wheeleri*? (R), *Edmondia* sp. (R), *Wilkingia terminale* (R).
- Ay-48. Exposure in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 24, NELSONVILLE. Dorr Run (1). OGS 11080. *Solemya* (*J.*) *radiata* (R), *Dunbarella striata* (R), *D. knighti* (A), *Euchondria* sp. (R), *Permophorus* sp. (C).
- Ay-56. Exposure along northeast side U.S. 33, approx. 0.25 mi. east of Athens-Hocking County line, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, UNION FURNACE. Putnam Hill (1). OGS 14301. *Permophorus* sp. (R), *Astartella* sp. (R), *Edmondia* sp. (R).
- Uncertain locality:
- Auc-3. Undescribed and unknown locality (possibly Ames Twp.). Ames (1). *Pteronites peracuta* (R).
- CARROLL COUNTY:
- Brown Township:
- CAb-1. Strip mine, D & M Coal Co., NW $\frac{1}{4}$ sec. 14, MALVERN. Columbiana (1). OGS 11048. *Nuculopsis anodontoides* (R), *Palaeoneilo oweni* (C), *Paleyoldia* sp. (R), *Astartella concentrica* (R).
- Lee Township:
- CAL-5. Exposure on north side Ohio Rte. 43 at elev. no. 1248 road junction, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, CARROLLTON. Skelley (3). OGS 4906. *Dunbarella knighti* (A).
- Rose Township:
- CAr-2. James Bros. mine, secs. 32 and 33, MINERAL CITY. Washingtonville (3). OGS 15098. *Nuculopsis girtyi* (A), *N. anodontoides* (A), *N. croneisi* (A), *Palaeoneilo oweni* (A), *Phestia bellistriata* (R), *Paleyoldia stvensoni* (R), *Solemya* (*J.*) *trapezoides* (R), *Parallelodon carbonarius* (R), *P. obsoletus* (C), *Septimyalina* sp. (R), *Pseudomonotis millhorni* (R), *Euchondria levicula* (R), *Schizodus affinis* (C), *Permophorus oblongus* (R), *Astartella concentrica* (C), *A. varica* (R), *Edmondia reflexa* (R), *Wilkingia terminale* (R).
- CAr-3. Strip mine along Magnolia-Linden Tree Rds., NE $\frac{1}{4}$ sec. 34 and SE $\frac{1}{4}$ sec. 35, MINERAL CITY. Columbiana (1). OGS 15091. *Nuculopsis anodontoides* (R), *Astartella concentrica*? (R).
- COLUMBIANA COUNTY:
- Center Township:
- Cc-3. Exposure along stream south of east-west road near ctr. sec. 15, LISBON. Washingtonville (1). OGS 1694. *Palaeoneilo oweni* (C).
- Cc-4. Exposures in vicinity of Excelsior Clay Products Co. and along Ohio Rte. 164, E $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 23, LISBON. Washingtonville (2). OGS 5263. *Solemya* (*J.*) *radiata* (A), *S. (J.) trapezoides* (C), *Dunbarella knighti* (A), *D. retractararea*? (R).
- Cc-5. Exposure along lower part of ravine on west side Middle Fork Little Beaver Cr. west of Logtown, S $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 9, LISBON. Washingtonville (1). *Dunbarella knighti* (R), *Astartella concentrica* (R).

- Cc-6. Abandoned Dunn & Kirk mine along Middle Fork Little Beaver Cr., ctr. sec. 9, LISBON. Columbiana (1). *Palaeoneilo oweni* (R), *Phestia bellistriata* (R).
- Elk Run Township:
- Cer-3. Exposure along Middle Run, NW¼NE¼ sec. 20, ELKTON. Vanport (1). OGS 1681. *Nuculopsis croneisi* (R), *Dunbarella* sp. (R), *Palaeolima retifera* (R).
- Cer-5. Exposure along road relocation, N½NW¼ sec. 20, ELKTON. Washingtonville (2). *Palaeoneilo oweni* (R), *Solemya* (J.) *radiata* (R), *S.* (J.) *trapezoides* (A), *Dunbarella knighti*? (R), *Acanthopecten carboniferous* (R), *Pernopecten ohioensis* (R).
- Cer-6. Exposure along road relocation, SW¼ sec. 17 and SE¼ sec. 18, ELKTON. Washingtonville (1). *Clinopistha laevis*? (R), *Palaeoneilo oweni* (A), *Solemya* (J.) *radiata* (C), *S.* (J.) *trapezoides* (R), *Dunbarella striata* (R).
- Cer-7. Exposure in SE¼ sec. 21, ELKTON. Washingtonville (1). OGS 1684. *Palaeoneilo oweni* (R).
- Cer-8. Strip mine on west side of Elk Run, N½ sec. 21, ELKTON. Washingtonville (1). *Palaeoneilo oweni* (C).
- Fairfield Township:
- Cf-1. Strip mine, SE¼ sec. 7, COLUMBIANA. Washingtonville (2). *Solemya* (J.) *radiata* (R), *S.* (J.) *trapezoides* (C).
- Franklin Township:
- Cfr-1. Railroad cut at south edge of Summitville just east of Ohio Rte. 644, NW¼SE¼ sec. 23, KENSINGTON. Brush Creek (numerous). OGS 14776. *Nuculopsis girtyi* (A), *N. croneisi* (R), *Palaeoneilo oweni* (C), *Phestia bellistriata* (A), *Solemya* (J.) *radiata* (R), *Promytilus* sp. (R), *Leptodesma* (L.) *sulcata*? (R), *Dunbarella striata* (A), *D. knighti* (C), *Streblopteria oklahomensis* (A), *Euchondria ohioensis* (R), *Pernopecten prosseri* (R), *Palaeolima triplistriata* (A), *Permophorus tropidophorus* (R), *Astartella concentrica* (A), *Prothyris* (P.) *elegans* (R).
- Madison Township:
- Cma-3. Strip mine, NW¼ and E½ sec. 23, WEST POINT. Brush Creek (1). *Nuculopsis girtyi* (C), *N. anodontoides* (A), *Phestia arata* (A), *Solemya* (J.) *radiata* (R), *Myalina* (M.) *meekei*? (R), *Septimyalina perattenuata*? (R), *Aviculopecten* sp. (R), *Euchondria ohioensis* (R), *Permophorus tropidophorus* (R).
- Cma-7. Strip mine on Conger farm, north of township road 874, NE¼SW¼ sec. 19, WEST POINT. Cambridge (1). OGS 1985. *Septimyalina* sp. (R), *Aviculopecten basilicus*? (C), *Euchondria* sp. (R), *Permophorus tropidophorus*? (R), *Astartella* sp. (A).
- Cma-8. Road cut on U.S. 30 just west of junction with Ohio Rte. 7, NE¼SE¼ sec. 13, WEST POINT. Brush Creek (1). *Nuculopsis croneisi* (R).
- Perry Township:
- Cp-2. Abandoned Allison mine, just southwest of junction of Egypt and Pine Lake Rds., N ctr. sec. 29, SALEM. Columbiana (1). OGS 3777. *Solemya* (J.) *radiata* (C), *S.* (J.) *trapezoides* (R).
- Cp-3. Abandoned Brookwood mine (type locality for Columbiana), SE¼NW¼ sec. 29, SALEM. Columbiana (1). OGS 3778. *Clinopistha laevis* (R), *Nuculopsis girtyi*? (R), *N. anodontoides* (R), *N. croneisi* (R), *Palaeoneilo oweni* (R), *Phestia bellistriata* (C), *Solemya* (J.) *radiata* (C), *Parallelodon obsoletus* (R), myalinid sp. (R), *Aviculopecten columbianus* (R), *Fasciculiconcha knighti* (R), *Euchondria smithwickensis*? (R), *Pernopecten* sp. (R), *Permophorus* sp. (R), *Astartella concentrica* (C), *Edmondia ovata*? (R), *E. reflexa* (R), *E. gibbosa* (R).
- Cp-4. Exposure in ravine north of Pennsylvania RR., NW¼SW¼ sec. 26, DAMASCUS. Wash-
- ingtonville (1). OGS 3765. *Aviculopecten* sp. (R).
- Cp-5. Abandoned J. T. Reese & Sons mine, west side of Egypt Rd., NE¼NE¼ sec. 32, SALEM. Columbiana (1). OGS 1721. *Nuculopsis girtyi*? (R), *Euchondria levicula*? (R), *Edmondia reflexa* (R).
- Salem Township:
- Cs-3. Abandoned Delmore mine, Sterling Coal Co., east of Franklin Sq. and north of Ohio Rte. 344, NE¼SW¼ sec. 14, LISBON. Columbiana (1). OGS 1707. *Clinopistha laevis* (C), *Nuculopsis croneisi* (C), *Phestia attenuata* (C), *Solemya* (J.) *radiata* (C), *Aviculopecten columbianus* (R), *Euchondria smithwickensis*? (R), *Pernopecten attenuatus*? (C), *Schizodus cuneatus* (R), *Permophorus* sp. (R), *Astartella newberryi* (R), *Edmondia reflexa*? (R), *Cardiomorpha missouriensis* (R), *Prothyris* (P.) *elegans* (R), *Solenomorpha*? *solenoides* (C).
- Cs-5. Abandoned J. Fox & Howell Bros. mine, east side of Cherry Valley Run just east of abandoned Y & O RR. bridge, SE¼ sec. 1, SALEM. Washingtonville (1). OGS 3784. *Solemya* (J.) *radiata* (R), *Dunbarella knighti* (C).
- Cs-6. Akenhead Coal Co. mine, SE¼ sec. 3, SALEM. Columbiana (1). OGS 3787. *Solemya* (J.) *radiata* (R), *S.* (J.) *trapezoides*? (R).
- Cs-7. Abandoned mine (Bossart or Buzzard's Glory?), west side Middle Fork Little Beaver Cr., SW¼NE¼ sec. 3, SALEM. Columbiana (2). *Nuculopsis anodontoides* (R), *Palaeoneilo oweni* (R), *Phestia arata* (R), *Astartella newberryi*? (R).
- Cs-8. Abandoned McKeefry shaft, west side of Middle Fork Little Beaver Cr., N ctr. sec. 15, LISBON. Columbiana (1). OGS 1901? *Nuculopsis croneisi*? (R), *Streblochondria tenuilinea* (R), *Edmondia gibbosa* (R), *Solenomorpha*? *solenoides* (R).
- Cs-10. Abandoned Salem Mining Co. mine along abandoned Y & O RR., NW¼NW¼ sec. 3, SALEM. Columbiana (2). OGS 1717. *Solemya* sp. (R).
- Cs-11. Abandoned J. A. Sanders mine, east side of Lisbon Rd., NE¼SE¼ sec. 3, SALEM. Columbiana (1). OGS 3786. *Parallelodon carbonarius*? (R).
- Cs-15. F. A. Snyder shaft mine, NW¼ sec. 15, LISBON. Washingtonville (1). *Dunbarella knighti* (C).
- St. Clair Township:
- Csc-1. Exposures along Bieler Run, N½ sec. 12, EAST LIVERPOOL NORTH. Vanport (1). OGS 2021. *Clinopistha laevis* (R), *Nuculopsis girtyi* (R), *N. croneisi*? (R), *Phestia arata* (R), *Streblochondria* sp. (R), *Astartella concentrica*? (R).
- Csc-2. Exposures along Longs Run, NW¼ sec. 10, EAST LIVERPOOL NORTH. Vanport (1). OGS 2039. *Nuculopsis girtyi* (R), *Palaeoneilo oweni* (R), *Phestia bellistriata* (R), *Aviculopecten* sp. (R), *Astartella varica* (R).
- Washington Township:
- Cw-1. Exposure along Tidball's Run on Ohio Rte. 164 north of Salineville, NW¼NE¼ sec. 24, GAVERS. Brush Creek (3). *Nuculopsis girtyi* (A), *N. croneisi* (R), *Phestia arata* (R), ?*Solemya* (J.) sp. (R), pectinoid sp. (R), *Permophorus oblongus* (R), *Astartella concentrica* (R).
- Cw-2. Undescribed exposure at Salineville, SALINEVILLE. Cambridge (1). *Phestia arata* (R), *Astartella concentrica*? (R).
- Yellow Creek Township:
- Cyc-4. Abandoned strip mine on east and north sides of hill between Pennsylvania RR. on west and north-south road on east, approx. 500 yds. south of McClain Brick Plant, SW¼SE¼ sec. 33, WELLSVILLE. Washingtonville (1). OGS

1831. *Nuculopsis girtyi* (R).
- Uncertain localities:
- Cuc-1. Uncertain locality, LISBON. Columbiana (1). OGS 1909. *Solemya (J.) radiata* (R), *S. (J.) trapezoides* (R), *Fasciculiconcha* sp. (R), *Pernopecten* sp. (R), *Permophorus oblongus* (R), *Edmondia reflexa?* (R), *Cardiomorpha missouriensis* (R).
- Cuc-2. Uncertain locality south of East Palestine, EAST PALESTINE. Dorr Run or Washingtonville? (1). *Phestia arata* (R), *Solemya (J.) radiata* (R).
- COSHOCTON COUNTY:
- Bedford Township:
- CSb-1. Willowbrook mine pit, approximately 8.0 mi. west of Coshocton near Ohio Rte. 271, sec. 20, WARSAW. Washingtonville (1). *Nuculopsis girtyi* (R), *Solemya (J.)* sp. (R).
- Jackson Township:
- CSj-1. Abandoned borrow pit, approx. 200 ft. west of Ohio Rte. 16 and 0.5 mi. south of Ohio Rte. 271, RANDLE. Upper Mercer (1). *Astartella concentrica?* (R).
- Lafayette Township:
- CSI-1. Road cut on north side of U.S. 36, 1.6 mi. east of junction with Ohio Rte. 93, NW¼ sec. 1, FRESNO. Lower Mercer (2) and Upper Mercer. Lower Mercer: *Nuculopsis girtyi* (A), *N. croneisi* (A), *Phestia bellistriata* (C), *Parallelodon obsoletus* (A), *Leptodesma (L.) ohioense* (C), *Astartella concentrica* (A), *A. varica* (R), *A. compacta* (R), *Cypricardina carbonaria* (R), *Unklesbayella geinitzi* (C), *Pseudococardium parrishi* (A).
- Virginia Township:
- CSv-3. Strip mines, NE¼NW¼ sec. 17, CONESVILLE. Washingtonville (3). OGS 6775. *Nuculopsis girtyi* (R), *N. anodontoides* (R), *Phestia bellistriata* (R), *Astartella varica* (R).
- CSv-4. Abandoned strip mines of Simco-Peabody Coal Co., prospect pits and road cuts, S½ sec. 3, N½ sec. 8, and NW¼ sec. 9, CONESVILLE. Columbiana, Putnam Hill, Vanport, and Washingtonville (2). Columbiana: *Nuculopsis girtyi?* (R), *Solemya (J.) radiata* (R), *Parallelodon obsoletus* (R), *Acanthopecten carboniferous* (C), *Palaeolima retifera* (R), *Permophorus tropidophorus* (R). Washingtonville: *Nuculopsis girtyi?* (R), *Solemya (J.) radiata* (R).
- GALLIA COUNTY:
- Harrison Township:
- GAh-1. Exposure on west side of Smoky Row Rd. at junction with Rice Rd. and Fox Br., NW¼SE¼SE¼ sec. 30, RODNEY. Cambridge (1). *Parallelodon obsoletus* (R), *P. sangamonensis?* (R), *Promytilus* sp. (R), *Acanthopecten carboniferous* (R), *Permophorus tropidophorus* (R), *Pernopecten* sp. (R), *Palaeolima triplistriata* (R), *Schizodus affinis* (R), *S.* sp. (R), *Edmondia* sp. (R), *Sanguinolites costata* (R).
- Springfield Township:
- GAs-1. James Merry Stone Co. quarry, north side of U.S. 35, W½ sec. 25 and E½ sec. 31, RODNEY. Brush Creek (1). *Phestia bellistriata* (R).
- GAs-2. Abandoned Ray Glover quarry, sec. 21, VINTON. Cambridge (1). OGS 12930. *Acanthopecten meeki* (R).
- GUERNSEY COUNTY:
- Adams Township:
- Ga-1. Abandoned quarry approx. 1.0 mi. NE of New Concord, W½SE¼ sec. 25, BLOOMFIELD. Cambridge (3) and Portersville. Cambridge: *Nuculopsis girtyi* (A), *N. anodontoides* (A), *N. croneisi* (A), *Phestia arata* (A), *Parallelodon tenuistriatus* (R), *P. sangamonensis?* (R), *Myalina (O.) subquadrata?* (C), *Septimyalina perattenuata* (R), *Permophorus tropidophorus?* (R), *Schizodus* sp. (R), *Astartella concentrica* (C), *A. varica* (A).
- Cambridge Township:
- Gca-1. Exposure in road cut along Interstate 77, 1.0 mi. south of Cambridge, CAMBRIDGE. Brush Creek (1). *Dunbarella striata* (R).
- Gca-2. Exposure in road cut at Georgetown, CAMBRIDGE. Undifferentiated Brush Creek (1). *Pernopecten prosseri* (R).
- Center Township:
- Gce-1. Exposure along U.S. 40 approx. 4.0 mi. east of Cambridge, NW¼ sec. 17, CAMBRIDGE. Brush Creek (1). OGS 15063. *Astartella concentrica* (R).
- Spencer Township:
- Gs-1. Road cut along secondary road 1.0 mi. west of Interstate 77 (formerly U.S. 21), SW¼SE¼ sec. 25, CALDWELL NORTH. Portersville (1). *Palaeolima* sp. (R).
- Westland Township:
- Gwe-1. John Gress & Sons quarry, north of U.S. 40 and 0.25 mi. east of New Concord, NEW CONCORD. Cambridge and Portersville (2). Cambridge: *Clinopistha laevis?* (R), *Nuculopsis girtyi* (C), *N. anodontoides* (C), *N. croneisi* (R), *Palaeoneilo oweni* (C), *Phestia arata* (R), *Astartella concentrica* (C), *A. varica* (R), *A. compacta* (R), *Edmondia* sp. (R). Portersville: *Nuculopsis girtyi* (R), *N. anodontoides* (C), *Phestia bellistriata?* (R), *P. attenuata* (R), *Solemya (J.) radiata* (C), *Aviculopecten occidentalis?* (R), *Schizodus wheeleri* (R), *Edmondia* sp. (R).
- HOCKING COUNTY:
- Falls Gore Township:
- Hfg-5. Abandoned strip mines, Hocking Valley Brick Co., south of east-west road, SE¼ sec. 31, GORE. Lower Mercer (numerous). OGS 7070. *Solemya (J.) radiata* (R), *Dunbarella knighti?* (R), *Schizodus cuneatus* (C), *S. amplus* (A), *Astartella varica* (A), *A. newberryi* (R).
- Hfg-6. Abandoned strip mines, NE¼ sec. 31, GORE. Putnam Hill (1). OGS 6760. *Nuculopsis croneisi?* (C), *Phestia arata* (R), *Leptodesma (L.) ohioense* (R), *Dunbarella striata* (C), *Aviculopecten appalachianus* (R), *Aviculopecten* sp. (A), *Acanthopecten bellosum* (A), *Streblochondria tenuilineata* (A), *Pseudomonotis precursor* (R), *Palaeolima retifera* (C), *Astartella concentrica* (R), *A. compacta?* (R), *Edmondia* sp. (A).
- Starr Township:
- Hs-3. Slump behind county garage, 0.5 mi. south of Union Furnace Post Office, NW¼SW¼ sec. 23, UNION FURNACE. Lower Mercer (1). OGS 12876. *Phestia bellistriata?* (R), *Promytilus pottsvillensis* (R), *?Monopteria subalata* (R), *Schizodus cuneatus* (R), *S. amplus* (R).
- Hs-4. Exposures along relocated U.S. 33, SE¼NW¼ sec. 12, UNION FURNACE. Undifferentiated Pottsville (1). *Wilkingia terminale* (R).
- Hs-7. Exposure along east side of north-south road, W½NE¼NW¼ sec. 11, UNION FURNACE. Lower Mercer and Dorr Run (1). OGS 9297. Lower Mercer: *Exochorhynchus altirostratus* (R).
- Hs-8. Exposure in SW¼SE¼ sec. 16, UNION FURNACE. Zaleski (1). *Permophorus* sp. (R).
- Ward Township:
- Hw-12. Undescribed and uncertain exposure, SE¼NW¼ sec. 23, NEW STRAITSVILLE. Dorr Run (1). *Dunbarella* sp. (R).
- Hw-13. Abandoned strip mine, L. & M. (Liden) Coal Co. (type locality for Dorr Run), SW¼NW¼ sec. 31, UNION FURNACE. Dorr Run (1). *Dunbarella knighti* (C).
- HOLMES COUNTY:
- Clark Township:
- HOc-1. Shale pit west side Ohio Rte. 557, approx. 0.5 mi. north of Baltic, NE¼SW¼ sec. 25, BALTIC. Putnam Hill (1). *Nuculopsis girtyi* (C), *N.*

- anodontoides?* (R), *Palaeoneilo oweni* (C), *Phestia attenuata?* (R), *Astartella varica* (C).
- HOc-2. General Clay Products Co. shale pit, approx. 0.5 mi. northeast of Baltic, SE $\frac{1}{4}$ sec. 25, BALTIC. Putnam Hill and Columbiana (1). Columbiana: *Dunbarella knighti* (A).
- HOc-3. Abandoned strip mine along Ohio Rte. 93 on northeast corner at elev. no. 1014 road junction, approx. 1.0 mi. northeast of Baltic, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, BALTIC. Putnam Hill (1). *Astartella varica* (C), *Wilkingia terminale* (C).
- Hardy Township:
HOH-2. Uncertain locality near Millersburg, MILLERSBURG. Lower Mercer (1). *Promytilus pottsvillensis* (R).
- Richland Township:
HOR-1. Exposure on county line road, SW $\frac{1}{4}$ sec. 22, SPRING MOUNTAIN. Lower Mercer (1). *Phestia bellistriata* (R), *Parallelodon obsoletus* (R), *Pernopecten ohioensis* (R).
- Uncertain locality:
HOuc-1. Undescribed and uncertain exposure, northeast of Killbuck, MILLERSBURG. Washingtonville (1). *Nuculopsis girtyi* (R), *N. anodontoides* (R), *Palaeoneilo oweni* (R), *Solemya (J.) radiata* (R).
- JACKSON COUNTY:
Hamilton Township:
Jh-1. Exposure along stream bed below house of Phillip Meldick, ctr. sec. 14, PETERSBURG. Harrison (1). OGS 3580. *Septimyalina ortho-nota?* (R).
- Jefferson Township:
Jje-2. Exposure at Monroe Furnace, N $\frac{1}{2}$ sec. 29, PETERSBURG. Putnam Hill (1). *Schizodus sub-circularis* (R).
- Milton Township:
Jmi-2. Exposure along north side of road along Buffer Run, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, MULGA. Vanport (1). *Nuculopsis girtyi* (R), *N. croneisi* (A), *Phestia arata* (R), *P. bellistriata* (R), *Parallelodon carbonarius* (C), *P. obsoletus?* (R), *Aviculopecten* sp. (R), *Euchondria ohioensis?* (R), *Astartella concentrica* (A), *A. varica* (R), *A. compacta* (R), *Cypricardina carbonaria* (R), *Unklesbayella geinitzi* (R), *Pseudoconocardium parrishi* (C).
- JEFFERSON COUNTY:
Saline Township:
Jesa-2. Exposure at McClain Firebrick Co., 1.0 mi. southeast of Irondale, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 19 and SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, WELLSVILLE. Vanport (1). *Nuculopsis girtyi* (C), *Phestia bellistriata* (R), *Dunbarella knighti* (R), *Streblochondria hertzeri?* (C), *S. tenuilineata* (C), *Euchondria levicula* (C), *Astartella concentrica* (R).
- LAWRENCE COUNTY:
Aid Township:
La-1. Belville strip mine along Coffee Cr. and Tea Cr., N $\frac{1}{2}$ sec. 2, WATERLOO. Cambridge (1). OGS 14644. *Nuculopsis girtyi* (R), *Phestia arata* (R), *Parallelodon sangamonensis?* (R), *Acanthopecten meeki* (R), *Permophorus tropidophorus* (R), *P. costatiformis* (R), *Edmondia ovata* (R), *E. aspinwallensis?* (R), *E. nodulifera* (R).
- Lawrence Township:
Ll-1. Abandoned slope mine, east side of Ohio Rte. 141, ctr. sec. 10, KITTS HILL. Cambridge (1). OGS 4014. *Edmondia* sp. (A).
- Symmes Township:
Ls-1. Abandoned strip mines, Belville Mining Co., Inc., south side of Johns Cr., sec. 35, SHERRITTS. Cambridge (2). OGS 4706. *Nuculopsis girtyi* (R), *Parallelodon sangamonensis?* (R), *Pteronites peracuta* (R), *Acanthopecten meeki?* (R), *Limipecten* sp. (R), *Palaeolima retifera* (R), *Permophorus tropidophorus* (R), *Edmondia ovata* (R), *E. nodulifera* (R).
- LICKING COUNTY:
Bowling Green Township:
Llbg-1. Exposure on south side of Ohio Rte. 440, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 5, GLENFORD. Lower Mercer (1). OGS 8673. *Acanthopecten carboniferous* (R), *Streblochondria hertzeri* (R), *S. tenuilineata* (R).
- Franklin Township:
Llfr-1. Exposure along east-west road, ctr. SW $\frac{1}{4}$ sec. 19, GLENFORD. Lower Mercer (1). OGS 6295. *Parallelodon carbonarius* (R), *P. obsoletus* (R), *Promytilus pottsvillensis* (R), *Acanthopecten carboniferous* (C), *Fasciculiconcha* sp. (R), *Streblochondria* sp. (R), *Pernopecten attenuatus* (R), *Wilkingia terminale* (R).
- Llfr-2. Exposure along Flint Ridge Rd., NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, GLENFORD. Lower Mercer and Vanport (1). OGS 6293. Lower Mercer: *Permophorus tropidophorus* (R). Vanport: *Acanthopecten carboniferous* (R), *Palaeolima retifera* (R), *Pernopecten attenuatus* (C).
- Hopewell Township:
Llho-1. Abandoned cannel coal mine, west side of north-south road, approx. 0.2 mi. north of first road junction on Flint Ridge Rd. west of Flint Ridge Pk., GLENFORD. Lower Mercer (numerous). OGS 6294. *Nuculopsis girtyi* (R), *Phestia bellistriata* (R), *Solemya (J.) radiata* (R), *Parallelodon carbonarius* (C), *P. obsoletus* (C), *Promytilus pottsvillensis* (C), *Septimyalina perattenuata* (R), *Leptodesma (L.) ohioense* (R), *Dunbarella knighti?* (R), *Aviculopecten halensis?* (R), *A. germanus* (R), *A. coxanus* (R), *A. appalachianus* (R), *Acanthopecten carboniferous* (A), *Fasciculiconcha scalaris* (R), *F. knighti* (R), *F. providencensis?* (R), *Streblochondria hertzeri* (A), *S. tenuilineata* (A), *Euchondria levicula* (R), *Pseudomonotis carbonaria* (R), *Pernopecten ohioensis* (A), *P. attenuatus* (A), *Palaeolima retifera* (A), *Schizodus cuneatus* (C), *S. affinis?* (R), *Permophorus tropidophorus* (R), *P. immaturus* (A), *P. oblongus* (R), *Astartella concentrica* (A), *A. varica* (C), *A. newberryi* (A), *Cypricardina carbonaria* (C), *Edmondia ovata?* (C), *E. gibbosa* (A), *E. meekiana* (R), *E. sp.* (R), *Wilkingia terminale* (C).
- Llho-4. Exposure along north-south road approx. 0.5 mi. north of former Fairview School and south of BR 1085, GLENFORD. Lower Mercer (3). OGS 16041. *Nuculopsis anodontoides* (R), *Paleoyoldia stevensoni* (R), *Phestia bellistriata* (C), *P. bellistriata prolongata* (R), *Solemya (J.) radiata* (R), *Parallelodon carbonarius* (R), *Modiolus (M.) radiatus* (R), *Promytilus* sp. (R), *Leptodesma (L.) ohioense* (R), *Aviculopecten halensis?* (R), *A. coxanus* (R), *Acanthopecten carboniferous* (C), *Fasciculiconcha scalaris* (R), *Streblochondria hertzeri* (R), *S. tenuilineata* (A), *Euchondria levicula* (R), *Pernopecten ohioensis* (A), *P. attenuatus* (C), *Schizodus cuneatus* (R), *S. amplius?* (R), *S. acuminatus* (R), *Permophorus tropidophorus* (R), *P. immaturus* (C), *Astartella concentrica* (R), *A. newberryi* (A), *Cypricardina carbonaria* (R), *Edmondia ovata* (R), *E. sp.* (R), *Wilkingia terminale* (R).
- Llho-5. Exposure along N-S road approx. 0.1 mi. north of road junction that is approx. 0.1 mi. east of townhouse at BM 1143, west side sec. 13, GRATIOT. Lower Mercer and Putnam Hill (1). Lower Mercer: *Promytilus pottsvillensis* (R), *Pernopecten* sp. (C), *Palaeolima retifera* (R). Putnam Hill: *Aviculopecten halensis?* (R), *A. germanus* (R), *A. sorer* (R), *Streblochondria hertzeri* (R).
- Madison Township:
Llhm-1. Float exposed around radio tower on Bald Knob, HANOVER. Lower Mercer (1). *Phestia bellistriata* (R), *Solemya (J.) radiata* (R), *Parallelodon obsoletus* (C), *Promytilus pottsvillensis* (C), *Placopterna ohioensis* (R), *Leptodesma (L.) ohioense* (R), *Aviculopecten halensis?* (R),

- A. germanus* (R), *A. sorer* (R), *Acanthopecten carboniferous* (A), *Streblochondria hertzeri* (C), *S. tenuilineata* (A), *Pseudomonotis carbonaria* (R), *Pernopecten ohioensis?* (A), *P. sp.* (R), *Palaeolima retifera* (C), *Permophorus immaturus* (C), *P. spinulosa* (R), *Astartella concentrica* (C), *A. varica* (C), *Cypricardina carbonaria* (A), *Edmondia gibbosa* (R).
- Uncertain locality:
 Lluc-1. Undescribed and uncertain locality, Flint Ridge area. Lower Mercer (1). *Acanthopecten carboniferous* (R), *Streblochondria hertzeri* (R), *Edmondia reflexa?* (R), *Wilkingia terminale* (R).
- MAHONING COUNTY:
- Beaver Township:
 Mb-1. East Springfield Mining Co., SW¼ sec. 1, COLUMBIANA. Columbiana (2). OGS 15138. *Nuculopsis girtyi* (C), *N. anodontoides* (R), *Phestia attenuata* (R), *Astartella concentrica* (C).
- Canfield Township:
 Mc-1. Abandoned strip mine, north side of U.S. 224, approx. 2.0 mi. west of Canfield, CANFIELD. Putnam Hill (2). *Clinopistha laevis?* (R), *Nuculopsis girtyi* (C), *N. anodontoides* (R), *Solemya (J.) radiata* (R), *Parallelodon sp.* (R), *Chaenocardia ovata* (R), *Euchondria levicula* (R), *Astartella sp.* (R).
 Mc-2. Abandoned Leeb Coal Co. strip mine, east side of Croy Rd., 0.25 to 0.5 mi. south of U.S. 224, CANFIELD. Putnam Hill (2). *Clinopistha laevis* (R), *Nuculopsis girtyi* (A), *N. anodontoides* (C), *N. croneisi* (R), *Solemya (J.) radiata* (C), *Septimyalina sp.* (R), *Dunbarella striata* (R), *D. knighti* (A), *Astartella concentrica* (C), *A. compacta* (R), *Edmondia sp.* (R).
 Mc-3. Exposures along tributary on south side of Indian Run, between Christ's Mission Camp and Optimist Club Boys Camp, 0.5 mi. east of Raccoon Rd. and just north of Leffingwell Rd., YOUNGSTOWN. Putnam Hill (1). OGS 1911. *Solemya (J.) radiata* (R), *S. (J.) trapezoides?* (R).
 Mc-4. Exposure (abandoned quarry?) along Sawmill Cr. near County Home, CANFIELD. Lower Mercer (1). OGS 6908. *Nuculopsis girtyi* (C).
- Ellsworth Township:
 Me-1. Abandoned strip mines, east side of Ohio Rte. 45 north of Bowmans Corners and south of Leffingwell Rd., SALEM. Putnam Hill (1). OGS 6912. *Nuculopsis girtyi* (A), *N. anodontoides* (R), *Palaeoneilo oweni* (R), *Solemya (J.) radiata* (R), *Astartella concentrica* (R), *A. newberryi* (R).
 Me-2. Exposure on Wilson farm, east side of Ohio Rte. 45 just north of Ellsworth, CANFIELD. Lower Mercer (1). *Astartella varica* (R).
- Green Township:
 Mg-2. Abandoned shaft mine New Salem Coal Co. (J. Pascola), south side Ohio Rte. 14A, near head of ravine southwest of Millville, SW¼ sec. 33, SALEM. Columbiana (1). OGS 3776. *Nuculopsis girtyi* (A), *N. anodontoides* (C), *N. croneisi* (R), *Palaeoneilo oweni* (A), *Paleyoldia stevensoni* (C), *Phestia sp.* (R), *Solemya (J.) trapezoides* (R), *Dunbarella knighti* (C), *Streblochondria sp.* (R), *Euchondria smithwickensis?* (R), *Schizodus cuneatus?* (R), *Astartella concentrica* (C).
 Mg-3. Exposure along small stream on Ira Unger farm, approx. 100 yds. east of Knauf Rd., NW¼ sec. 4, SALEM. Putnam Hill (2). OGS 15068. *Nuculopsis girtyi* (A), *Phestia arata?* (R), *Solemya (J.) radiata* (R), *Dunbarella knighti?* (R), *Pernopecten ohioensis* (R), *Permophorus tropidophorus?* (R), *P. oblongus* (R), *Astartella concentrica* (A), *Edmondia sp.* (R), *Prothyris (P.) elegans* (C).
 Mg-4. Abandoned Nick Weingart mine, along northeast side of Middle Fork Little Beaver Cr., E ctr. sec. 7, SALEM. Putnam Hill (2). OGS 5608. *Clinopistha laevis* (C), *Nuculopsis girtyi* (C), *Palaeoneilo oweni?* (R), *Myalina (O.) sp.* (R), *Streblochondria tenuilineata* (R), *Chaenocardia ovata* (R), *Euchondria sp.* (R), *Astartella concentrica* (R), *Edmondia reflexa* (R).
- Mg-5. Exposure along stream and in two shallow pits on A. V. Kenreigh farm, NW¼ sec. 17 and NE¼ sec. 18, SALEM. Putnam Hill (1). OGS 15069. *Palaeolima retifera* (R), *Astartella concentrica?* (R).
 Mg-6. Abandoned New Albany Coal Co. (later Davis Coal Co.) strip mine, east side Ohio Rte. 45 and north of South Range Rd. (Ohio Rte. 165), SW¼ sec. 17 and S ctr. sec. 18, SALEM. Columbiana (2). OGS 15070. *Clinopistha laevis* (R), *Nuculopsis girtyi* (R), *N. anodontoides* (A), *Palaeoneilo oweni* (R), *Phestia bellistriata* (C), *P. arata* (R), *Astartella concentrica* (C), *Edmondia reflexa?* (R), *E. sp.* (R).
 Mg-7. Abandoned H. L. Daugherty slope mine, south side of South Range Rd. (Ohio Rte. 165), NE cor. sec. 19, SALEM. Columbiana (1). OGS 3770. *Clinopistha laevis* (R), *Nuculopsis girtyi* (A), *N. croneisi* (R), *Palaeoneilo oweni* (R), *Paleyoldia stevensoni* (R), *Phestia bellistriata* (R), *Aviculopecten columbianus* (R), *Pernopecten attenuatus* (R), *Astartella concentrica* (A), *Edmondia reflexa* (R), *Solenomorpha? solenoides* (R).
 Mg-10. Abandoned Ed Shepherd mine, east side of Middle Fork Little Beaver Cr., N ctr. sec. 33, SALEM. Columbiana (1). OGS 3775. *Clinopistha laevis* (R), *Nuculopsis girtyi* (R), *N. anodontoides* (R), *N. croneisi* (R), *Palaeoneilo oweni* (R), *Solemya (J.) radiata* (R), *S. (J.) trapezoides* (R), *Dunbarella knighti* (R), *Palaeolima sp.* (R), *Schizodus affinis?* (R), *Astartella concentrica* (A), *Edmondia reflexa* (R).
 Mg-11. Abandoned J. A. Stouffer mine (type locality for Washingtonville), east of reservoir on Cherry Valley Run and north of Ohio Rte. 14A, northeast edge of Washingtonville, SW¼ sec. 36, SALEM. Washingtonville (1). OGS 1710. *Nuculopsis girtyi* (R), *N. croneisi* (R), *N. sp.* (A), *Palaeoneilo oweni* (C), *Solemya (J.) radiata* (C), *S. (J.) trapezoides* (A), *Dunbarella striata?* (R), *D. knighti* (A).
 Mg-12. Abandoned mines formerly operated by A. L. Houts and Ed Zimmerman, west edge of New Albany and under present location of U.S. 62, NW¼ sec. 20, SALEM. Columbiana (1). *Clinopistha laevis* (R), *Phestia bellistriata* (C), *Solemya (J.) radiata* (A), *S. (J.) trapezoides* (R).
 Mg-16. Mellott mine, W ctr. sec. 33, SALEM. Columbiana (1). OGS 3779. *Nuculopsis girtyi* (R), *N. anodontoides* (C), *Astartella concentrica?* (R).
- Poland Township:
 Mp-1. Abandoned quarry with lake managed by Lowellville Rod and Gun Club, southwest of Lowellville, east of Quarry Rd. and north of U.S. 224, CAMPBELL. Vanport (4). OGS 5014. *Annuliconcha interlineata* (R).
- Smith Township:
 Ms-2. Alliance Stone Co. strip mine, southwest of junction of Martin and Middletown Rds., NE¼ sec. 18, ALLIANCE. Putnam Hill and Vanport (1). OGS 15124. Vanport: *Nuculopsis croneisi?* (R), *Solemya (J.) radiata* (R).
 Ms-3. Keller mine, northwest of junction of Martin and Middletown Rds., SE¼SE¼ sec. 7, ALLIANCE. Putnam Hill (numerous). *Clinopistha laevis* (R), *Nuculopsis girtyi* (A), *N. anodontoides* (C), *N. croneisi?* (R), *Phestia bellistriata* (R), *Solemya (J.) radiata* (A), *S. (J.) trapezoides* (C), *Parallelodon carbonarius* (C), *P. obsoletus?* (R), *Promytilus sp.* (R), *Septimyalina perattenuata* (R), *Dunbarella knighti* (A), *D. rectangularis?* (C), *Euchondria levicula* (C), *Pernopecten sp.* (C), *Palaeolima retifera* (C), *Schizodus affinis* (R), *Astartella concentrica* (C), *A. varica* (R), *A. compacta* (R), *Edmondia sp.* (C), *Cardiomorpha missouriensis* (R), *Wilkingia ter-*

- minale* (R).
 Ms-5. Abandoned Sunnyside Mining Co. strip mine, west of Westville and north of U.S. 62, SE¼ sec. 35, ALLIANCE. Columbiana (1). OGS 2160. *Nuculopsis girtyi*? (R). *Schizodus* sp. (R).
- Springfield Township:
 Msp-1. R & M Enterprise Mining Co., S ctr. sec. 28, COLUMBIANA. Columbiana (2). *Nuculopsis girtyi* (R), *Solemya (J.) trapezoides* (R), *Dunbarella knighti*? (R), *Astartella concentrica* (R), *Edmondia* sp. (R).
 Msp-2. Thompson Bros. Mining Co., south side of Garfield Rd., southeast of New Springfield, NW¼ sec. 33, NEW MIDDLETOWN. Columbiana (2). *Nuculopsis girtyi* (A), *Palaeoneilo oweni* (C), *Phestia bellistriata* (R), *Solemya (J.) radiata* (R), *Streblochondria* sp. (R).
 Msp-3. Abandoned strip mine on east side of Beard Rd., W ctr. sec. 4, NEW MIDDLETOWN. Columbiana (1). OGS 5540. *Schizodus affinis*? (R).
- MEIGS COUNTY:
 Columbiana Township:
 MEco-1. Exposure in roadbed and cut on Appalachian Hwy. at Ohio Rte. 346 just west of Mt. Blanco, NE¼SE¼SE¼ sec. 30, VALES MILLS. Brush Creek (2). *Nuculopsis girtyi* (A), *N. anodontoides* (C), *Paleyoldia stevensoni* (R), *Phestia arata* (A), *Pteronites americana* (A), *Aviculopecten occidentalis* (C), *A. arctisulcatus* (R), *Acanthopecten* sp. (R), *Pernopecten prosseri* (R), *Schizodus wheeleri* (A), *Astartella concentrica* (R), *Edmondia ovata* (R), *E. gibbosa* (R), *E. anodontoides* (C), *Wilkingia terminale* (R).
- MORGAN COUNTY:
 Bloom Township:
 MOb-1. Exposures along Opossum Hollow, SE¼ sec. 25, ROKEBY LOCK. Ames (1). OGS 10380. *Edmondia* sp. (R).
- MUSKINGUM COUNTY:
 Blue Rock Township:
 MUBr-1. Exposures along Coal Hollow, sec. 22, RURAL-DALE. Ames (1). *Acanthopecten meeki*? (R), *Pernopecten prosseri* (R), *Wilkingia terminale* (R).
 Cass Township:
 MUC-1. Exposure along Muskingum County Rte. 117, approx. 3.0 mi. southeast of Frazzysburg, DRESDEN. Lower Mercer (1). OGS 1658? *Streblochondria tenuilineata* (C), *Pernopecten ohioensis* (R), *Astartella concentrica* (C).
 MUC-2. Exposures along the Highlands and road between Dresden and Frazzysburg, DRESDEN. Putnam Hill and Vanport (1). OGS 770. Vanport: *Permophorus tropidophorus* (R).
 MUC-5. Exposure in ravine south side tributary to Big Run, southwest of elev. no. 826 and Headley farm buildings, sec. 3, DRESDEN. Lower Mercer (2). *Nuculopsis* sp. (R), *Phestia bellistriata* (R), *Parallelodon carbonarius* (C), *P. obsoletus* (A), *Promytilus potsvillensis* (R), *Septimyalina perattenuata* (C), *Aviculopecten germanus* (R), *A. sorer* (R), *Acanthopecten carboniferous* (A), *Fasciculiconcha* sp. (R), *Streblochondria hertzeri* (C), *S. tenuilineata* (R), *Pseudomonotis* sp. (R), *Pernopecten ohioensis*? (C), *P. attenuatus* (R), *Palaeolima retifera* (R), *Schizodus affinis* (R), *Permophorus tropidophorus* (C), *Astartella concentrica* (R), *A. compacta* (R).
 Falls Township:
 MUF-3. Exposure along Ohio Rte. 146 west of Bartlett Run, ZANESVILLE WEST. Lower Mercer (1). *Nuculopsis girtyi* (R), *Parallelodon carbonarius* (R), *P. obsoletus*? (R), *Septimyalina* sp. (R), *Acanthopecten carboniferous* (R), *Schizodus amplus* (R), *Astartella concentrica* (R), *A. varica* (R), *A. newberryi*? (R), *A. compacta* (R), *Edmondia* sp. (R).
- Harrison Township:
 MUha-1. Exposures along Cedar Run, secs. 31 and 32, PHILO. Portersville (1). *Schizodus wheeleri* (R), *Edmondia aspinwallensis*? (R).
- Hopewell Township:
 MUho-1. Exposure along ravine west-southwest of Glen Kiefer farm buildings near section line, N½ sec. 18, GRATIOT. Lowellville (Poverty Run) (1). *Euchondria levicula* (R).
 MUho-3. Abandoned Porter Bros. or G. L. Porter mine, south of Hopewell (Coaldale), GRATIOT. Vanport (1). OGS 433. *Nuculopsis anodontoides* (R), *Solemya (J.) radiata* (R), *Parallelodon obsoletus* (R), *Promytilus* cf. *P. annosus senex* (R), *Volsellina subelliptica* (R), *Septimyalina perattenuata*? (R), *Aviculopecten halensis*? (R), *A. sorer* (R), *A. sp.* (R), *Acanthopecten carboniferous* (A), *Streblochondria hertzeri* (C), *S. tenuilineata* (R), *Pernopecten attenuatus* (R), *Pseudomonotis* sp. (R), *Palaeolima retifera* (C), *Schizodus amplus* (A), *Permophorus tropidophorus* (C), *P. sp.* (R), *Astartella concentrica*? (R), *A. compacta*? (R), *Edmondia* sp. (R).
 MUho-4. Undescribed and uncertain exposure. Vanport (1). *Parallelodon carbonarius* (R), *P. obsoletus* (R), *Leptodesma (L.) ohioense* (R), *Dunbarella* sp. (R), *Acanthopecten carboniferous*? (R), *Palaeolima retifera* (C), *Schizodus* sp. (R), *Permophorus tropidophorus* (C), *Astartella compacta* (R), *A. sp.* (R), *Edmondia gibbosa*? (R).
 MUho-5. Exposure in stream bed (type locality for Poverty Run), SE¼SW¼ sec. 13, GRATIOT. Poverty Run (1). OGS 421. *Nuculopsis anodontoides* (R), *Astartella* sp. (R).
 MUho-6. Undescribed and uncertain exposure, NW¼NW¼ sec. 15, GRATIOT. Vanport (1). *Fasciculiconcha knighti*? (R).
 MUho-8. Exposure along limited-access road between Interstate 70 and Ohio Rte. 440 south of Gratiot, ctr. sec. 6, GRATIOT. Lower Mercer (1). OGS 14989. *Parallelodon obsoletus* (R), *Acanthopecten carboniferous*? (R), *Streblochondria* sp. (R), *Euchondria* sp. (R), *Pernopecten* sp. (R), *Palaeolima retifera* (R).
 MUho-9. Exposure along northeast-extending ravine on Fisher farm, SW¼ sec. 6, GRATIOT. Lower Mercer and Putnam Hill (1). Lower Mercer: *Parallelodon carbonarius* (R). Putnam Hill: *Pernopecten ohioensis* (A). ?*Edmondia* sp. (R).
 MUho-10. Exposure on northwest side at turn in road, NE¼NE¼ sec. 11, ZANESVILLE WEST. Lower Mercer (1). OGS 436. *Schizodus amplus* (R).
 MUho-11. Abandoned Maxville quarry on Bonifield farm, west side of north-south road, approx. 1.8 mi. northeast of Mt. Sterling, GRATIOT. Poverty Run (1). OGS 421. Myalinid sp. (R).
- Madison Township:
 MUma-2. Exposure at Ohio Rte. 666 bridge over small stream opposite Beech Run, ADAMSVILLE. Lower Mercer (1). OGS 522. *Edmondia ovata* (R).
- Muskingum Township:
 MUmu-1. Abandoned strip mines along north-south road, approx. 4.0 mi. south of Dresden, DRESDEN. Washingtonville (3). *Nuculopsis girtyi* (C), *N. anodontoides* (R), *N. croneisi*? (C), *Phestia bellistriata* (C), *Solemya (J.) trapezoides* (R), *Parallelodon obsoletus*? (R), *Aviculopecten* sp. (R), *Acanthopecten carboniferous* (R), *Streblochondria stantonensis*? (R), *S. tenuilineata*? (R), *Palaeolima retifera* (R), *Schizodus affinis* (R), *S. sp.* (R), *Astartella concentrica* (R), *Edmondia gibbosa* (R).
- Newton Township:
 MUN-3. Abandoned quarry, west side former Ohio Rte. 75 (now relocated approx. 0.1 mi. west of this location as Ohio Rte. 93), NE¼SE¼ sec. 33, CROOKSVILLE. Putnam Hill (1). *Streblochondria hertzeri* (R).

- Springfield Township:
- MUsp-1. Exposure at Dugway along Muskingum Ave. at Putnam Hill (type locality for Putnam Hill), west side of Muskingum R., Zanesville, NE¼ sec. 1, ZANESVILLE WEST. Putnam Hill (3). OGS 788. *Clavicosta echinata?* (R).
- MUsp-2. Exposures in channels of Licking R. and Muskingum R. at Y Bridge, Zanesville, NE¼ sec. 1, ZANESVILLE WEST. Lower Mercer (1). OGS 788. *Schizodus cuneatus* (R).
- Union Township:
- MUu-1. Undescribed and uncertain exposure, NE¼NW¼ sec. 7, NORWICH. Portersville (1). OGS 13600. *Phestia arata* (R), *Astartella compacta* (R).
- MUu-2. Exposure along tributary to Crooked Cr., west of Richard Rice (later Tony Fazekas) farm buildings, 1.5 mi. south of New Concord (Condit's locality 43), NEW CONCORD. Ames (1). *Nuculopsis girtyi?* (R), *Solemya* (*J.*) *trapezoides?* (C), *Parallelodon obsoletus* (R), *Pteronites peracuta* (R), *Myalina* (*O.*) *subquadrata?* (C), *M. (O.)* sp. (C), *Aviculopecten arctisulcatus* (C), *Acanthopecten carboniferous* (R), *Euchondria levicula* (C), *Pernopecten prosseri* (C), *Palaeolima retifera* (R), *Schizodus* sp. (C), *Permophorus* sp. (R), *Edmondia reflexa* (R), *E.* sp. (C), *Wilkingia terminale* (R), *Sanguinolites costata* (R).
- MUu-3. Abandoned mine on A. N. Daly farm, NE¼SE¼ sec. 5, NORWICH. Portersville (1). OGS 10385. *Nuculopsis girtyi?* (R).
- MUu-4. Exposure along road, approx. 1.0 mi. northwest of Norwich, NW¼SW¼ sec. 4, NORWICH. Ames (1). *Aviculopecten* sp. (R).
- Washington Township:
- MUwa-3. Pennsylvania RR. cut, east side Muskingum R., south of Gilbert, ADAMSVILLE. Putnam Hill (1). *Septimyalina perattenuata* (R), *Astartella varica* (R).
- Uncertain locality:
- MUuc-1. Uncertain locality in Cass Twp. Putnam Hill (1). *Aviculopecten halensis?* (R).
- NOBLE COUNTY:
- Noble Township:
- Nn-1. Exposure on west side of small creek behind the Belle Valley School, SW¼NE¼ sec. 20, CALDWELL NORTH. Portersville (1). OGS 12896. *Nuculopsis girtyi* (C), *N. anodontoides* (R), *N. croneisi* (R), *Palaeoneilo oweni* (R), *Phestia bellistriata* (R), *Parallelodon sangamonensis?* (R), *Astartella concentrica* (A).
- Olive Township:
- No-2. Exposures along old U.S. 21 (now Interstate 77), SW¼ sec. 11, CALDWELL SOUTH. Ames and Portersville (1). OGS 15055. Ames: *Wilkingia terminale?* (R). Portersville: *Nuculopsis girtyi* (R), *Astartella concentrica?* (R).
- No-3. Exposures along old U.S. 21 (now Interstate 77), 1.5 mi. north of Dudley (probably NE¼ sec. 15), CALDWELL SOUTH. Ames (1). *Astartella concentrica?* (R).
- No-4. Exposure on east side of old U.S. 21 (now Interstate 77), SE¼SE¼ sec. 10, CALDWELL SOUTH. Ames (1). OGS 15055. *Parallelodon obsoletus* (R), myalinid sp. (R), *Astartella concentrica* (R), *Edmondia ovata* (R).
- No-5. Exposure along Olive Rd. north of junction with county road 7, W ctr. sec. 15, CALDWELL SOUTH. Gaysport (1). OGS 15968. *Astartella* sp. (R).
- No-6. Exposure along north side of Ohio Rte. 78, W ctr. and SE¼ sec. 4, CALDWELL SOUTH. Ames (1). OGS 15971. *Solemya* (*J.*) *radiata?* (R), *Permophorus* sp. (R), *Edmondia gibbosa* (R).
- PERRY COUNTY:
- Bearfield Township:
- Pb-1. Abandoned Wabash RR. tunnel cut (railroad never built) (type locality for Portersville), N¼SW¼ sec. 24, DEAVERTOWN. Portersville (4). OGS 10375. *Nuculopsis girtyi* (R), *N. anodontoides?* (R), *N. croneisi* (R), *Palaeoneilo oweni* (R), *Phestia bellistriata?* (R), *Parallelodon tenuistriatus* (C), *Leptodesma* (*L.*) *longa* (R), *Acanthopecten carboniferous* (R), *Streblochondria stantonensis* (R), *Euchondria ohioensis* (R), *Palaeolima triplistriata?* (R), *Permophorus immaturus?* (R), *P. oblongus* (R), *Edmondia ovata* (C), *E. reflexa* (R), *E. aspinwallensis?* (R), *Prothyris* (*P.*) *elegans* (C), *Solenomorpha?* *solemoides* (R), *Wilkingia terminale* (R).
- Clayton Township:
- Pcl-1. Abandoned strip mine, NW¼SE¼ sec. 5, FULLTONHAM. Columbiana or Vanport(?), Upper Mercer (1). OGS 8583. Columbiana or Vanport(?): *Parallelodon carbonarius* (R), *P. obsoletus?* (R), *Acanthopecten carboniferous* (R), *Streblochondria tenuilineata* (R), *Astartella compacta?* (R), *Cypricardina carbonaria* (C), *Edmondia ovata?* (C).
- Coal Township:
- Pco-1. Exposure in ravine on northwest side of Ohio Rte. 216, SW¼SW¼ sec. 33, NEW STRAITSVILLE. Dorr Run (1). *Dunbarella* sp. (R).
- Harrison Township:
- Pha-3. Exposure along east-west road between abandoned strip mines and road junction at elev. no. 985, SW¼ sec. 33, DEAVERTOWN. Upper Freeport (2). OGS 8510. *Dunbarella* sp. (R).
- Hopewell Township:
- Pho-1. Exposures along road, approx. 2.0 mi. northwest of Somerset, NE¼SW¼ sec. 33, SOMERSET. Upper Mercer (1). *Astartella compacta* (R).
- Jackson Township:
- Pj-4. Rush Creek Clay Co. strip pit, SW¼ sec. 3, JUNCTION CITY. Lower Mercer (1). OGS 8375. *Schizodus amplus* (R).
- Monday Creek Township:
- Pmc-1. Exposure along ravine, southeast of northeast-extending road, ctr. sec. 9, JUNCTION CITY. Lower Mercer (1). OGS 12800. *Wilkingia terminale* (R).
- Pmc-2. Exposure along ravine west of road junction at elev. no. 817, NW¼NE¼ sec. 17, GORE. Lower Mercer (1). OGS 8325. *Septimyalina perattenuata* (R), *Schizodus cuneatus* (R), *S. amplus* (R), *Astartella newberryi?* (R).
- Pmc-3. Exposure along ravine or road, SE¼ sec. 19, GORE. Upper Mercer (1). *Promytilus* sp. (R).
- Pmc-4. Logan Clay Products pit, E ctr. sec. 19, GORE. Putnam Hill (1). *Astartella varica* (R).
- Reading Township:
- Pr-1. Undescribed and uncertain exposure on Mooter farm south of Somerset, sec. 22, SOMERSET. Lower Mercer (1). OGS 8401. *Parallelodon carbonarius* (R), *Schizodus amplus* (R), *Wilkingia terminale* (R).
- Pr-2. Exposure along road, 0.5 mi. south of St. Joseph's Priory, ctr. sec. 23, SOMERSET. Lower Mercer (1). OGS 8350. *Parallelodon carbonarius* (R), *P. obsoletus* (R), myalinid sp. (R), *Aviculopecten germanus* (R), *A. coxanus* (R), *Acanthopecten carboniferous* (R), *Streblochondria hertzeri* (R), *Pernopecten attenuatus* (R), *Palaeolima retifera* (R), *Astartella varica* (R), *Edmondia ovata* (R), *E. gibbosa* (R), *E. reflexa* (R).
- Pr-3. Exposures in B & O RR. cut at Somerset, NW¼ sec. 10, SOMERSET. Lower Mercer (1). OGS 8427. *Parallelodon carbonarius* (C), *P. obsoletus* (R), *Leptodesma* (*L.*) *ohioense* (R), *Acanthopecten carboniferous* (A), *Streblochondria hertzeri* (R), *Pseudomonotis carbonaria* (R), *Pernopecten attenuatus* (R), *Permophorus immaturus* (R), *Astartella varica* (R), *Edmondia* sp. (R).
- Pr-4. Exposure at pond on Swern farm, east edge, sec. 22, SOMERSET. Lower Mercer (1). *Astartella varica* (R).
- Pr-5. Exposure in road cut, NW¼(?) sec. 22, SOMERSET. Lower Mercer (1). *Parallelodon car-*

bonarius (R), *Aviculopecten sorer* (R), *Palaeolima retifera* (R).

PORTAGE COUNTY:

Atwater Township:

- POa-1. Strip mines in vicinity of junction of U.S. 224 and Ohio Rte. 225, approx. 2.3 mi. west of Deerfield and 2.2 mi. south of Yale, DEERFIELD. Lower Mercer (4). *Phestia bellistriata?* (R), *Dunbarella* sp. (R), *D. rectalaterarea?* (R).

Deerfield Township:

- POd-1. Combined with POa-1 (*q.v.*).

SCIOTO COUNTY:

Vernon Township:

- SCve-2. Exposure along northeast side of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 24, PEDRO. Boggs and Lower Mercer (1). OGS 4650. Boggs: *Leptodesma* (L.) sp. (R), *Dunbarella striata?* (R). Lower Mercer: *Acanthopecten* sp. (R), *Fasciculiconcha scalaris* (C), *Wilkingia terminale* (R).

STARK COUNTY:

Bethlehem Township:

- Sb-1. Undescribed and uncertain exposure, sec. 29, NAVARRE. Lower Mercer (1). *Astartella varica* (R).

- Sb-2. N & W RR. cut under Blough Ave. bridge, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 16, NAVARRE. Lower Mercer? (1). OGS 11417. *Streblochondria tenuilineata* (R), ?*Edmondia* sp. (R), *Wilkingia terminale* (R).

Lexington Township:

- Sle-28. Exposure along east side of small stream on W. A. Smyth farm, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 22, LIMAVILLE. Putnam Hill (1). OGS 6890. ?*Euchondria* sp. (R), *Pernopecten ohioensis?* (R).

Marlboro Township:

- Sm-1. Abandoned Clapsaddle quarry, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, LIMAVILLE. Putnam Hill (1). OGS 6891. *Nuculopsis anodontoides?* (R).

- Sm-2. Diamond Portland Cement Co. quarry, S $\frac{1}{2}$ SW $\frac{1}{4}$ sec. 32, HARTVILLE. Putnam Hill (2). OGS 12825. *Aviculopecten* sp. (R).

Osna burg Township:

- So-1. Undescribed and uncertain exposure, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, MALVERN. Washingtonville (1). *Nuculopsis girtyi* (R).

Pike Township:

- Spk-1. Abandoned strip mine, north side Gracemont St., NW $\frac{1}{4}$ sec. 30, BOLIVAR. Putnam Hill, Tuscarawas, and Vanport (2). OGS 13503. Tuscarawas: *Dunbarella knighti* (A).

Sandy Township:

- Ss-1. Abandoned strip mine, NE $\frac{1}{4}$ sec. 4, WAYNESBURG. Columbiana (1). OGS 14651. *Nuculopsis girtyi* (A), *N. anodontoides* (R), *N. croneisi?* (C), *Palaeoneilo oweni* (C), *Paleyoldia stevensoni* (R), *Phestia bellistriata* (R), *P. attenuata* (R), *Dunbarella striata* (R), *D. knighti* (R), *Euchondria levicula* (R), *Astartella* sp. (R), *Solenomorpha? solenoides* (R).

- Ss-4. D & M Coal Co. strip mine, SE $\frac{1}{4}$ sec. 10, MALVERN. Columbiana and Washingtonville? (1). Columbiana: *Nuculopsis croneisi* (A), *Palaeoneilo oweni* (R), *Phestia bellistriata* (R), *Solemya* (J.) *trapezoides* (R), *Parallelodon obsoletus* (A), *P. delicatus* (A), *P. carbonarius* (R), *Septimyalina perattenuata?* (R), *Streblochondria hertzeri* (R), *Astartella concentrica* (A).

- Ss-5. Magnolia Mining Co. strip mine, NW $\frac{1}{4}$ sec. 21, WAYNESBURG. Columbiana and Washingtonville? (2). OGS 14648. Columbiana: *Palaeoneilo oweni* (C), *Astartella concentrica?* (R).

SUMMIT COUNTY:

Green Township:

- SUg-1. Natco strip pit, southeast of junction of Aultman and Highland Park Rds., SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 36, NORTH CANTON. Lower Mercer (1). OGS 15122. *Schizodus cuneatus* (R).

TUSCARAWAS COUNTY:

Clay Township:

- Tc-2. Exposure on Ohio Rte. 416 (formerly Ohio Rte. 16), 1.5 mi. southwest of Gnadenhutten, GNADENHUTTEN. Washingtonville? (1). *Nuculopsis girtyi* (R), *N. anodontoides* (R), *Phestia arata* (R).

Dover Township:

- Td-1. Abandoned strip mines, north of Ohio Rte. 416 (formerly Ohio Rte. 16) and east of Ohio Rte. 800 (formerly Ohio Rte. 8) and Tuscarawas R., DOVER. Columbiana and Washingtonville (1). Columbiana: *Nuculopsis anodontoides* (R), *N. croneisi?* (R), *Parallelodon obsoletus* (R), *Palaeolima retifera* (R).

- Td-2. Beaver Fork Coal Co. mine, 0.5 mi. northeast of Oak Grove School, DOVER. Columbiana (1). OGS 6097. *Astartella concentrica?* (R).

- Td-4. Strip mine on southwest side of Ohio Rte. 39, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, DOVER. Putnam Hill and Vanport (3). Putnam Hill: *Nuculopsis girtyi* (A), *N. anodontoides* (R), *Dunbarella striata* (C), *Streblochondria hertzeri* (R), *Euchondria levicula* (R), *Palaeolima retifera* (R). Vanport: *Nuculopsis girtyi* (C).

- Td-7. Floyd Kimble strip mine west of New Philadelphia along county road 52, sec. 2, NEW PHILADELPHIA. Putnam Hill (2). *Nuculopsis girtyi* (C), *N. anodontoides?* (A), *N. croneisi* (A), *Phestia* sp. (R), *Parallelodon carbonarius?* (R), *Astartella concentrica* (R).

Franklin Township:

- Tfr-1. Exposure, south side of Sugar Cr. just below Beach City dam, W ctr. sec. 1(?), NAVARRE. Boggs? (4). OGS 13327. *Palaeoneilo* sp. (C), *Parallelodon obsoletus* (R), *Posidonia fracta* (A), *Astartella varica* (R), *A. newberryi?* (R), *Edmondia* sp. (R).

Goshen Township:

- Tg-1. High cut along U.S. 250 south of Dover and southwest of New Philadelphia, NEW PHILADELPHIA. Putnam Hill (2). *Nuculopsis girtyi* (A), *N. anodontoides* (R), *Phestia arata* (R), *P. attenuata* (R), *Dunbarella striata* (R), *Acanthopecten carboniferous* (R).

Jefferson Township:

- Tj-1. Stone Creek Brick Co. shale pit just north of plant and east of Stone Cr. and Pennsylvania RR., NW $\frac{1}{4}$ sec. 12, STONE CREEK. Putnam Hill (1). OGS 5492. *Nuculopsis girtyi* (C), *Parallelodon* sp. (R), *Dunbarella striata* (R), *Aviculopecten* sp. (R).

- Tj-2. Strip mine, 0.75 mi. west of Interstate 77 (formerly U.S. 21), 0.5 mi. north of Blackband, STONE CREEK. Washingtonville (1). *Edmondia* sp. (R).

Lawrence Township:

- TI-2. Abandoned strip mine, 0.5 mi. north of road junction at elev. no. 977, approx. 1.1 mi. east-northeast of Strasburg, NW $\frac{1}{4}$ sec. 16, STRASBURG. Putnam Hill (1). *Nuculopsis girtyi* (R), *Pernopecten ohioensis?* (R).

- TI-4. Abandoned strip mine, approx. 0.5 mi. north of Zoar between township road 57 and county road 82, DOVER. Putnam Hill (1). *Euchondria levicula* (R).

Sandy Township:

- Ts-1. Abandoned borrow pit, northwest side Ohio Rte. 800 (formerly Ohio Rte. 8) and Pennsylvania RR., approx. 1.0 mi. southwest of Mineral City and 0.7 mi. northeast of Valley Junction, DOVER. Putnam Hill, Vanport, and Columbiana (1). Columbiana: *Nuculopsis croneisi?* (R).

- Ts-2. Exposure in B & O RR. cut, approx. 0.75 mi. northwest of Mineral City, MINERAL CITY. Dorr Run (1). OGS 11344. *Parallelodon obsoletus* (R), *Dunbarella knighti* (A).

- Ts-3. Exposure along Ohio Rte. 183 (formerly Ohio Rte. 80), approx. 1.75 mi. east of Nimishillen Cr. and southwest of Farber Cem., WAYNES-

- Ts-4. BURG. Columbiana (1). *Schizodus affinis* (A). Zoar Mining Co., SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, BOLIVAR. Columbiana (1). OGS 16224. *Septimyalina sinuosa* (C), *Palaeolima retifera* (R).
- Ts-6. Fairfield Brick Co. pit, south of Zoarville, DOVER. Putnam Hill (1). *Nuculopsis girtyi* (R), *Astartella varica* (R), *A. sp.* (R).
- Ts-7. Exposure on Ohio Rte. 183, 0.5 mi. east of road junction at elev. no. 989, WAYNESBURG. Columbiana (1). *Schizodus affinis?* (A).
- Ts-8. Cut (partly in Fairfield Twp.) on W & LE RR. at Zoar Station, DOVER. Vanport (1). OGS 10943. *Solemya (J.) trapezoides* (R).
- Sugar Creek Township:
- Tsc-1. Belden Brick Co. (formerly Finzer Bros.?) strip mine, northeast of Shanesville, NW $\frac{1}{4}$ sec. 2 and NE $\frac{1}{4}$ sec. 3, SUGARCREEK. Putnam Hill and Vanport (2). OGS 13316. Putnam Hill: *Nuculopsis girtyi* (R), *N. anodontoides* (R), *N. croneisi* (A), *Phestia bellistriata* (R), *Schizodus sp.* (R), *Astartella concentrica* (A). Vanport: *Nuculopsis girtyi* (C), *Astartella varica* (R), *Wilkingia terminale* (R).
- Warwick Township:
- Twa-1. Abandoned strip mines, southwest side of Fox Valley and extending northwest into Clay Twp., SW $\frac{1}{4}$ sec. 4, NEW PHILADELPHIA. Columbiana, Washingtonville, and Dorr Run (2). Columbiana: *Parallelodon obsoletus* (R), *Acanthopecten carboniferous* (R), *Permophorus tropidophorus?* (C). Washingtonville: *Nuculopsis anodontoides* (R), *N. croneisi* (C), *Phestia bellistriata* (R), *Parallelodon obsoletus* (R). Dorr Run: *Solemya (J.) radiata* (R), *Dunbarella knighti* (R).
- Wayne Township:
- Twy-2. Abandoned strip mines approx. 2.65 mi. south of junction of Holmes, Stark, and Tuscarawas Counties and east of road junction at elev. no. 1300, WILMOT. Upper Mercer (1). *Nuculopsis girtyi* (R), *N. anodontoides?* (R), *N. croneisi* (R), *Parallelodon carbonarius* (R), *Palaeolima retifera* (R), *Astartella varica* (R), *Wilkingia sp.* (R).
- Twy-3. Belden Brick Co. Wallick mine, NE $\frac{1}{4}$ sec. 25, STRASBURG. Putnam Hill and Vanport (1). Vanport: *Astartella compacta* (R).
- York Township:
- Ty-1. Howe Coal Co. strip mine, south of county road 55, NW $\frac{1}{4}$ sec. 24, NEW PHILADELPHIA. Washingtonville (1). *Nuculopsis girtyi* (R), *Palaeoneilo oweni* (R), *Solemya (J.) radiata* (R), *S. (J.) sp.* (R), *Dunbarella knighti* (A), *Streblochondria sp.* (R), *Pernopecten attenuatus* (C).
- Ty-3. Zoar Mining Co. borrow pit, NW $\frac{1}{4}$ sec. 17, NEW PHILADELPHIA. Putnam Hill (5). *Nuculopsis girtyi* (A), *N. croneisi* (A), *Phestia bellistriata* (A), *Solemya (J.) radiata* (R), *Parallelodon obsoletus* (R), *P. carbonarius* (R), myalinid sp. (R), *Dunbarella knighti* (R), *Acanthopecten carboniferous* (R), *Streblochondria tenuilineata* (R), *Euchondria levicula* (R), *Posidonia fracta* (R), *Pernopecten attenuatus* (A), *Schizodus amplus* (R), *Permophorus tropidophorus* (R), *Astartella concentrica* (R), *A. varica* (C), *Edmondia ovata?* (R), *E. gibbosa* (R), *E. sp.* (R), *Pseudoconocardium parishi* (R).
- Ty-6. Strip mine, W $\frac{1}{2}$ sec. 5, STONE CREEK. Washingtonville (1). *Palaeoneilo oweni* (C).
- VINTON COUNTY:
- Brown Township:
- Vb-1. Exposures along Ohio Rte. 328, SW $\frac{1}{4}$ sec. 36, NEW PLYMOUTH. Boggs (1). OGS 1588. *Wilkingia terminale* (R).
- Vb-3. Exposure on Ohio Rte. 328 southeast of second bridge over Raccoon Cr. south of New Plymouth, N ctr. sec. 35, NEW PLYMOUTH. Boggs (1). OGS 275. *Septimyalina perattenuata* (R), *Acanthopecten sp.* (R).
- Clinton Township:
- Vc-6. Exposures along tributary valley to Sugar Run, NW $\frac{1}{4}$ sec. 27, MCARTHUR. Vanport (3). OGS 5388. *Dunbarella striata* (C), *Aviculopecten appalachianus* (R).
- Vc-7. Exposure along east-west road approx. 0.5 mi. west of road junction at elev. no. 761, W ctr. sec. 18, HAMDEN. Lower Mercer (1). OGS 4281. *Streblochondria hertzeri* (R).
- Elk Township:
- Vel-6. Exposures along road, N ctr. sec. 17, ALLENSVILLE and ZALESKI. Lower Mercer (4). OGS 153. *Septimyalina perattenuata* (R), *Acanthopecten carboniferous* (R), *Fasciculiconcha scalaris* (C), *Posidonia fracta* (R), *Astartella concentrica* (A), *Wilkingia terminale* (R).
- Vel-7. Exposure at tipple of Vinton Coal Co., north side U.S. 50, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 18, ALLENSVILLE. Lower Mercer (2). OGS 153. *Phestia bellistriata* (R), *Leptodesma (L.) ohioense* (R), *Aviculopecten germanus* (R), *Fasciculiconcha sp.* (C), *Streblochondria sp.* (R), *Pernopecten ohioensis?* (R), *Palaeolima retifera* (R), *Astartella concentrica* (C).
- Vel-8. Exposure on southeast side of ravine, north side east-west road, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 33, MCARTHUR. Lower Mercer (2). OGS 13276. *Aviculopecten sp.* (R), *Posidonia fracta* (C), *Edmondia sp.* (A).
- Vel-10. Abandoned strip mine, NW $\frac{1}{4}$ sec. 11, ZALESKI. Putnam Hill (3). *Phestia sp.* (R), *Parallelodon obsoletus* (R), *Schizodus amplus* (R), *Astartella concentrica* (C), *A. varica* (C), *A. newberryi* (A).
- Vel-11. Abandoned strip mine, south side abandoned road, N $\frac{1}{2}$ NE $\frac{1}{4}$ sec. 17, ZALESKI. Putnam Hill (2). OGS 1438. *Nuculopsis girtyi* (C), *Phestia bellistriata* (C), *Parallelodon obsoletus* (R), *Septimyalina perattenuata* (R), *Schizodus cuneatus* (R), *S. amplus* (C), *Astartella concentrica* (C), *A. varica* (A), *A. newberryi* (A), *Wilkingia terminale* (R).
- Vel-12. Vinton Coal Co. abandoned strip mine on northeast side of road 1.1 mi. north-northwest of road junction at elev. no. 799, ctr. sec. 20 and NW $\frac{1}{4}$ sec. 17, ALLENSVILLE and ZALESKI. Putnam Hill and Vanport (2). OGS 238. Putnam Hill: *Nuculopsis girtyi* (C), *N. anodontoides* (R), *Phestia bellistriata* (C), *Parallelodon sp.* (R), *Promytilus sp.* (R), *Septimyalina perattenuata* (R), *Aviculopecten halensis?* (R), *A. sp.* (R), *Acanthopecten carboniferous* (R), *Fasciculiconcha providencensis* (R), *Streblochondria hertzeri* (R), *S. tenuilineata* (A), *Schizodus cuneatus* (C), *S. amplus* (A), *Permophorus sp.* (R), *Astartella concentrica* (C), *A. varica* (A), *A. newberryi* (A), *A. compacta* (R), *Edmondia sp.* (R), *Prothyris (P.) elegans* (R). Vanport: *Solemya (J.) radiata?* (R).
- Vel-13. Uncertain exposure, probably small abandoned mine on property formerly owned by Wm. Jacobs, NE $\frac{1}{4}$ sec. 25, MCARTHUR. Putnam Hill and Zaleski (1). OGS 142. Putnam Hill: *Nuculopsis girtyi* (R). Zaleski: *Acanthopecten carboniferous* (R).
- Vel-14. Abandoned borrow pit, west of deep road cut and north of U.S. 50, NE $\frac{1}{4}$ sec. 25, MCARTHUR. Putnam Hill and Zaleski (2). OGS 142. Putnam Hill: *Parallelodon carbonarius?* (R), *Aviculopecten sp.* (R), *Pernopecten sp.* (R), *Astartella concentrica?* (R). Zaleski: *Promytilus pottsvillensis?* (R), *Septimyalina sinuosa* (R).
- Vel-15. Abandoned J. A. Crow (on former Truman Dixon property) strip mine, south side U.S. 50, NW $\frac{1}{4}$ sec. 27, MCARTHUR. Putnam Hill (4). OGS 11819. *Nuculopsis girtyi* (C), *N. anodontoides?* (R), *Palaeoneilo oweni* (R), *Phestia bellistriata* (R), *P. arata* (C), *Solemya (J.) radiata* (R), *S. (J.) trapezoides* (R), *Parallelodon carbonarius* (R), *Promytilus sp.* (R), *Dunbarella striata* (A), *Aviculopecten appalachianus* (C), *A. sp.* (R), *Fasciculiconcha knighti* (R), *Streblochon-*

- dria hertzeri* (R), *S. tenuilineata* (C), *Pseudomonotis precursor* (R), *Pernopecten ohioensis* (R), *P. attenuatus* (R), *Palaeolima retifera* (R), *Schizodus affinis* (R), *Permophorus* sp. (R), *Astartella varica* (R), *A. newberryi* (R), *Astartella* sp. (R), *Cypricardina carbonaria* (R), *Edmondia gibbosa* (A), *E. sp.* (R), *Prothyris (P.) elegans* (A), *Wilkingia terminale* (C).
- Vel-16. Exposure along road (type locality for Zaleski), SW $\frac{1}{4}$ sec. 12, ZALESKI. Zaleski (1). OGS 60. *Acanthopecten* sp. (R), *Streblochondria tenuilineata?* (R) *Wilkingia terminale* (R).
- Vel-17. Exposure on Miles Ogan farm, SE $\frac{1}{4}$ sec. 14, ZALESKI. Zaleski (1). OGS 64. *Astartella concentrica* (R), *Wilkingia terminale* (R).
- Vel-19. Vinton Coal Co. abandoned strip mine, SE $\frac{1}{4}$ sec. 7, ALLENSVILLE. Vanport and Putnam Hill (4). Putnam Hill: *Nuculopsis anodontoides* (R), *N. croneisi* (A), *Phestia bellistriata* (A), *Parallelodon obsoletus* (A), *Promytilus* sp. (R), *Septimyalina perattenuata* (R), *Aviculopecten halensis?* (R), *Schizodus cuneatus* (A), *S. amplus* (C), *Permophorus tropidophorus* (R), *Astartella concentrica* (A), *A. varica* (A), *A. compacta* (R), *Cypricardina carbonaria* (C), *Unklesbayella geinitzi* (R), *Pseudoconocardium parrishi* (A), *P. missouriensis* (R).
- Vel-20. Abandoned strip mines, E ctr. and NE $\frac{1}{4}$ sec. 15, ZALESKI. Vanport (3). *Parallelodon obsoletus* (R), *Promytilus* cf. *P. annosus senex* (R), *Dunbarella striata* (R), *Acanthopecten carboniferous* (R), *Pernopecten ohioensis* (R), *P. attenuatus* (R), *Edmondia* sp. (C).
- Vel-22. Abandoned strip mine, SW $\frac{1}{4}$ sec. 26, MCARTHUR. Vanport (1). *Dunbarella striata* (R), *Aviculopecten halensis?* (R), *A. appalachianus* (R).
- Vel-23. Abandoned strip mine, SW $\frac{1}{4}$ sec. 23 and NW $\frac{1}{4}$ sec. 26, MCARTHUR. Vanport (1). OGS 78, 79. *Phestia arata* (R), *Dunbarella striata* (R), *Schizodus affinis?* (R).
- Vel-25. Benedict mine pit, location unknown except for township and county. Putnam Hill (1). *Parallelodon carbonarius* (R), *Septimyalina* sp. (R).
- Vel-26. Exposure in North Fork of Rock Hollow on Goodwin farm, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, MCARTHUR. Lower Mercer (1). OGS 13276. *Posidonia fracta* (A), *?Pleurophorella sesquiplicata* (A).
- Vel-27. Exposure along abandoned road, SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, ZALESKI. Zaleski (1). OGS 295. *Streblochondria* sp. (R), *Pernopecten ohioensis* (C).
- Jackson Township:
Vj-1. Exposure along Columbia Gas Co. line, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 24, ALLENSVILLE. Lower Mercer (1). *Parallelodon obsoletus* (A), *Aviculopecten halensis?* (R), *A. germanus* (R), *Acanthopecten carboniferous* (R), *Euchondria* sp. (R), *Pernopecten ohioensis* (R), *Permophorus immaturus* (R), *Astartella* sp. (R).
- Madison Township:
Vm-1. Exposure in deep road cut along U.S. 50, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 32, MCARTHUR. Vanport (?) and Zaleski (1). OGS 15066. Vanport (?): *Aviculopecten germanus* (R).
- Richland Township:
Vr-1. Exposure on north side of road, SE $\frac{1}{4}$ sec. 13, HAMDEN. Lower Mercer (2). OGS 215. *Astartella concentrica* (R), *A. newberryi* (C).
Vr-2. Abandoned strip mine on north side of U.S. 50, W $\frac{1}{2}$ sec. 1, ALLENSVILLE. Vanport (1). OGS 187. *Leptodesma* sp. (R), *Pseudoconocardium parrishi* (A), *P. missouriensis* (R).
Vr-3. Exposure along east-west road, E ctr. sec. 11, ALLENSVILLE. Lower Mercer (1). OGS 1583. *Aviculopecten* sp. (R).
- Swan Township:
Vs-1. Central States Coal Co. abandoned strip mine, approx. 0.5 mi. south of Orland, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 12, ZALESKI. Vanport (2). OGS 6919. *Phestia bellistriata* (R), *Aviculopecten* sp. (C), *Schizodus* sp. (R).
Vs-3. Central States Coal Co. abandoned strip mine on Merz farm, ctr. sec. 10, ZALESKI. Vanport (2). OGS 1560. *Phestia arata* (R), *Parallelodon obsoletus* (R), *Schizodus* sp. (R), *Permophorus* sp. (R), *Astartella varica* (C), *A. newberryi* (R), *A. compacta* (R), *Sanguinolites costata* (R).
- WAYNE COUNTY:
Paint Township:
WApA-2. Uncertain exposure along U.S. 250, sec. 24, WILMOT. Putnam Hill (1). *Nuculopsis girtyi* (R), *Astartella concentrica* (R).
- WEST VIRGINIA
- PRESTON COUNTY:
Reno Township:
WVA:Pr-1. Abandoned quarry on east side of West Virginia Rte. 92 approx. 0.7 mi. NE of the Barbour-Preston County line at Dent, FELLOWSHIP. Ames (2). *Nuculopsis girtyi* (R), *N. croneisi* (A), *Phestia bellistriata* (A), *Parallelodon tenuistriatus* (A), *Septimyalina* sp. (R), *Aviculopecten occidentalis* (A), *Acanthopecten carbonarius* (R), *Streblochondria stantonensis?* (C), *Permophorus oblongus* (R), *P. occidentalis* (C), *Astartella concentrica* (A), *A. varica* (C), *Unklesbayella geinitzi* (A).

INDEX

- Acanthopecten*, 21, 22, 40
bellosun, 11, 14, 21, 41; pl. 8, figs. 15-19
carboniferous, 14, 18, 21, 40; pl. 8, figs. 8-12
meeki, 11, 14, 18, 21, 41; pl. 8, figs. 13, 14
- Allegheny faunas, 2
 Allegheny Group, 1, 2, 3, 5, 6, 11, 12, 14, 16, 18
- Ames cyclothem, 5
 Ames unit, 2, 5, 12, 14, 16
 Anderson cyclothem, 5
 Anderson unit, 5
Annuliconcha, 21, 41
interlineata, 14, 18, 44; pl. 8, fig. 22
- Anthony cyclothem, 9
 Anthony unit, 9, 12, 14, 16
 Appalachian Basin, 1, 2, 18
 Appalachian Mountains, 1
 Appalachian Plateaus, 1
 Arcoids, 19
Astarte, 22
Astartella, 22, 23, 54
compacta, 16, 56; pl. 15, fig. 7
concentrica, 15, 54; pl. 14, figs. 18-23
newberryi, 16, 55; pl. 15, figs. 3-6
varica, 15, 55; pl. 14, figs. 24, 25; pl. 15, figs. 1, 2
- Athens County, 3, 65
 Atokan Series, 18
- Aviculopecten*, 21, 22, 37
appalachianus, 11, 14, 40; pl. 8, figs. 1-3
arcisulcatus, 11, 13, 18, 39; pl. 7, figs. 16-19
basilicus?, 11, 13, 18, 39; pl. 7, figs. 20-22
columbianus, 11, 14, 39; pl. 8, figs. 4-7
coxanus, 11, 13, 18, 39; pl. 7, figs. 9, 11, 12
germanus, 11, 13, 18, 37; pl. 7, figs. 3-6
halensis?, 11, 13, 18, 37; pl. 7, figs. 1, 2
occidentalis, 11, 13, 18, 38; pl. 7, figs. 13-15
sorer, 11, 13, 38; pl. 7, figs. 7, 8, 10
- Bakerstown unit, 5
 Bear Run cyclothem, 9
 Bear Run unit, 9, 12, 14, 16
 Bedford cyclothem, 8
 Bedford unit, 8
 Big Red Block unit, 8
 Bivalves, 1, 11, 18
 Bloomfield unit, 5
 Boggs unit, 9, 12, 14, 16
 Bolivar cyclothem, 3, 6
 Bolivar unit, 6
 Bowling Green State University, 1, 2
 Brachiopods, 18
 Brookville cyclothem, 8
 Brookville unit, 8
 Brush Creek cyclothem, 6
 Brush Creek unit, 1, 2, 6
 Buffalo unit, 6
- Cambridge unit, 6, 12, 14, 16
 Canary unit, 7
Cardiomorpha, 22, 23, 58
missouriensis, 11, 16, 58; pl. 16, fig. 8
- Carroll County, 65, 66
Chaenocardia, 21, 45
ovata, 11, 15, 45; pl. 10, figs. 9, 10
- Clarion cyclothem, 7
 Clarion unit, 7
Clavicosta, 21, 41
echinata?, 14, 41; pl. 8, fig. 20
 sp., 14, 42; pl. 8, fig. 21
Clinopistha, 19, 24
laevis, 12, 24; pl. 1, figs. 1-3
- Columbiana County, 65, 66
 Columbiana unit, 7, 12, 14, 16
 Conemaugh faunas, 1, 2
 Conemaugh Group, 1, 2, 3, 4, 5, 6, 11, 12, 14, 16, 18
- Coshocton County, 65, 68
 Cow Run unit, 5
Crania modesta, 18
 Cyclothem, 3, 4
Cypriocardinia, 22, 23, 56
carbonaria, 16, 56; pl. 15, figs. 15-17
- Des Moines Series, 18
 Dorr Run unit, 7, 12, 14, 16
Dunbarella, 21, 36
knighti, 13, 18, 19, 21, 37; pl. 6, figs. 15-23
rectalaterarea?, 13, 18, 21, 37; pl. 6, fig. 24
striata, 13, 18, 21, 36; pl. 6, figs. 11-14
- Dunkard, 3
 Duquesne cyclothem, 5
 Duquesne unit, 5
- Eastern Interior Basin, 18
Edmondia, 22, 23, 56
anodontooides, 11, 16, 57; pl. 15, figs. 12-14
aspinwallensis?, 11, 16, 57; pl. 16, figs. 1, 2
gibbosa, 16, 56; pl. 16, figs. 3-5
meekiana, 11, 16, 58; pl. 16, figs. 6, 7
nodulifera, 11, 16, 58; pl. 15, figs. 18-20
ovata, 16, 56; pl. 15, figs. 8, 9
reflexa, 16, 57; pl. 15, figs. 10, 11
- Epibionts, 18
Euchondria, 21, 45
levicula, 15, 18, 46; pl. 10, figs. 16-20
ohioensis, 11, 15, 45; pl. 10, figs. 11-15
smithwickensis?, 11, 15, 46; pl. 10, figs. 21, 22
- Ewing unit, 5
Exochorhynchus, 22, 23, 59
altirostratus, 16, 59; pl. 16, figs. 12-13
- Fasciculiconcha*, 21, 42
knighti, 14, 18, 42; pl. 9, figs. 5, 6
providencensis, 11, 14, 18, 43; pl. 9, figs. 7-9
scalaris, 11, 14, 42; pl. 9, figs. 1-4
- Ferriferous unit, 7
 Flint Ridge cyclothem, 9
 Flint Ridge unit, 9
- Gallia County, 65, 68
 Gaysport cyclothem, 5
 Gaysport unit, 5, 12, 14, 16
 Guernsey County, 65, 68
 Guinea Fowl unit, 9
- Harlem cyclothem, 5
 Harlem unit, 5
 Harrison cyclothem, 10
 Harrison unit, 4, 10, 12, 14, 16
 Hocking County, 65, 68
- Holmes County, 65, 68
 Homewood unit, 8
- Jackson County, 65, 69
 Jefferson County, 65, 69
- Kentucky, 2
 Kewanee Group, 18
- Lake County, 1
 Lamellibranchs, 1
 Lawrence County, 1, 65, 69
 Lawrence cyclothem, 7
 Lawrence unit, 7
 Leetonia unit, 7
Leptodesma (Leptodesma), 20, 21, 35
longa, 11, 13, 36
ohioense, 11, 13, 35
sulcata?, 11, 13, 35
- Licking County, 1, 65, 69
Lingula, 18
Limipecten, 43
 sp., 11, 14, 43; pl. 9, fig. 10
- Little Red Block unit, 8
 Lowellville unit, 9, 12, 14, 16
 Lower Brush Creek unit, 12, 14, 16
 Lower Coal Measures, 1
 Lower Freeport cyclothem, 3, 7
 Lower Freeport unit, 7
 Lower Grafton unit, 5
 Lower Kittanning cyclothem, 7
 Lower Kittanning unit, 7
 Lower Mahoning unit, 6
 Lower Mercer cyclothem, 9
 Lower Mercer unit, 8, 9, 12, 14, 16
- Mahoning County, 65, 70
 Mahoning cyclothem, 6
 Mahoning unit, 6
 Maryland, 2
 Mason cyclothem, 6
 Mason unit, 6, 12, 14, 16
 Massillon unit, 9
 Meigs County, 65, 71
 Middle Kittanning coal, 4
 Middle Kittanning cyclothem, 3, 7
 Middle Kittanning unit, 7
 Middle Mercer cyclothem, 8
 Middle Mercer unit, 8
 Missourian Series, 18
Modiolus (Modiolus), 19, 20, 32
radiatus, 11, 13, 32; pl. 3, fig. 14
- Monongahela Group, 3, 12, 14, 16
 ?*Monopteria*, 20, 21, 35
subalata, 11, 13, 35; pl. 6, fig. 1
- Monopterids, 20
 Morgan County, 65, 71
 Morrow Series, 18
 Muskingum County, 2, 65, 71
Myalina (Myalinella), 20, 33
meeki?, 11, 13, 18, 33; pl. 5, fig. 3
Myalina (Orthomyalina), 20, 33
subquadrata?, 11, 13, 18, 20, 33; pl. 4, fig. 7; pl. 5, figs. 1, 2
- Mytilacea, 18
 Mytilids, 20
- Neospirifer*, 22
 Noble County, 65, 72
 Nuculoids, 19
Nuculopsis, 19, 24

- anodontoides*, 12, 25, 26; pl. 1, figs. 9-14
croneisi, 12, 25; pl. 1, figs. 15-17
girnyi, 12, 24, 25; pl. 1, figs. 4-8
- Oak Hill unit, 7
 Ogan cyclothem, 8
 Ogan unit, 8
 Ohio, 1, 2, 3, 4, 11, 24, 19, 22, 65
 Ohio Division of Geological Survey, 65
 Ohio State University, 1
 Ohio University, 1, 2
 Ohio Valley, 1
- Palaeolima*, 21, 49
retifera, 15, 49; pl. 12, figs. 1-3
triplistriata, 11, 15, 50; pl. 11, figs. 20-22
Palaeoneilo, 19, 26
oweni, 17, 26; pl. 1, figs. 22-28
 Paleogeology, 18
Paleyoldia, 19, 26
stevensoni, 12, 26; pl. 1, figs. 18-21
Parallelodon, 19, 30
carbonarius, 12, 30; pl. 3, figs. 4-8
delicatus, 11, 13, 31; pl. 18, figs. 4, 5
obsoletus, 12, 30; pl. 2, fig. 18; pl. 3, figs. 1-3
sangamonensis?, 11, 12, 31; pl. 3, figs. 9, 10
tenuistriatus, 11, 13, 31; pl. 3, figs. 11-13
 Pectinacea, 18
 Pectinids, 21
 Pelecypods, 1
 Pennsylvania, 2, 3
 Pennsylvanian strata, 1, 2, 3
 Pennsylvanian System, 1, 2, 3, 4, 11, 18
 Permian strata, 3
Permophorus, 22, 23, 52
costatiformis, 11, 15, 53; pl. 14, figs. 12-14
immaturus, 15, 52; pl. 14, figs. 5-8
oblongus, 15, 53; pl. 14, figs. 9-11
occidentalis, 11, 15, 53; pl. 18, figs. 6, 7
spinulosa, 11, 15, 53; pl. 14, figs. 3, 4
tropidophorus, 15, 52; pl. 13, figs. 3, 4; pl. 14, figs. 1, 2
Pernopecten, 21, 22, 48
attenuatus, 15, 18, 48; pl. 11, figs. 11-13, 15
ohioensis, 15, 18, 48; pl. 11, figs. 14, 16-18
prosseri, 11, 15, 18; pl. 11, fig. 19
 Perry County, 65, 72
Phestia, 19, 27
arata, 12, 28; pl. 2, figs. 4-9
attenuata, 12, 28; pl. 2, figs. 10, 11
bellistriata, 12, 27; pl. 2, figs. 1, 2
bellistriata prolongata, 11, 12, 28; pl. 2, fig. 3
 Pholadomyoids, 22
 Pinnids, 20
Placoptera, 20, 35
ohioensis, 11, 13, 35; pl. 6, figs. 2-5
?Pleurophorella, 22, 54
sesquiplicata, 11, 15, 21, 54; pl. 14, figs. 15-17
 Portage County, 65, 73
 Portersville unit, 2, 4, 5, 12, 14, 16
- Posidonia*, 21, 22, 48
fracta, 15, 18, 48; pl. 11, figs. 7-10
 Pottsville fauna, 1
 Pottsville Group, 1, 2, 3, 8, 9, 10, 11, 12, 14, 16, 18
 Poverty Run unit, 9, 12, 14, 16
 Preston County, West Virginia, 65, 75
Promytilus
cf. annosus senex, 13, 19, 20, 32
pottsvillensis, 11, 13, 32
Prothyris (Prothyris), 22, 23, 58
elegans, 16, 58; pl. 16, figs. 9-11
Pseudoconocardium, 23, 60
missouriensis, 11, 17, 61; pl. 18, figs. 2, 3
parrishi, 11, 17, 60; pl. 17, figs. 1-6; pl. 18, fig. 1
Pseudomonotis, 18, 21, 22, 46
carbonaria, 11, 15, 46; pl. 10, figs. 23, 24
millhorni, 11, 15, 47; pl. 11, figs. 5, 6
precursor, 11, 15, 46; pl. 11, figs. 1-4 spp., 15, 48; pl. 10, figs. 25-27
Pteria, 20
 Pteriids, 20
 Pteroids, 20
Pteronites, 20, 33
americana, 11, 13, 20, 33; pl. 4, figs. 1-4; pl. 17, fig. 7
peracuta, 11, 13, 20, 33; pl. 4, figs. 5, 6
 Putnam Hill unit, 8
- Quakertown cyclothem, 9
 Quakertown unit, 9, 12, 14, 16
- Rock Riffle unit, 5
 Rostroconchids, 1, 11, 23
 Round Knob unit, 5
- Sand Block unit, 8, 12, 14, 16
Sanguinolites, 22, 23, 60
costata, 16, 60; pl. 16, figs. 16, 17
 Saltsburg unit, 5
Schizodus, 18, 22, 50
affinis, 15, 51; pl. 13, figs. 1, 2
acuminatus, 11, 15, 51; pl. 13, figs. 5, 6
amplus, 11, 15, 51; pl. 13, figs. 7-11
cuneatus, 11, 15, 50; pl. 12, figs. 10-14
subcircularis, 15, 51; pl. 12, figs. 4, 5
wheeleri, 11, 15, 51; pl. 12, figs. 6-9
 Scioto County, 65, 73
 Sciotoville unit, 9
 Scrubgrass cyclothem, 7
 Scrubgrass unit, 7
Septimyalina, 20, 34
perattenuata, 13, 18, 20, 34; pl. 5, figs. 4-11
orthonota?, 11, 13, 18, 34; pl. 5, figs. 12, 13
sinuosa, 13, 18, 34; pl. 5, figs. 14, 15
Serpulopsis, 18
 Sharon cyclothem, 10
 Sharon unit, 10, 12, 14, 16
 Shawnee unit, 6
 Skelley unit, 3, 4, 5, 12, 14, 16
Solemya (Janeia), 19, 29
radiata, 12, 29; pl. 2, figs. 12, 13
trapezoides, 12, 30; pl. 2, figs. 14-17
- Solemyoids, 19
Solenomorpha?, 22, 23, 59
solenoides, 16, 59; pl. 16, figs. 14, 15
Spirorbis, 19
 Stark County, 65, 73
 Strasburg cyclothem, 7
 Strasburg unit, 7
 Stratigraphy, 3
Streblochondria, 21, 22, 43
hertzeri, 11, 14, 18, 43; pl. 9, figs. 11-15
stantonensis, 11, 14, 18, 43; pl. 9, figs. 16, 17
tenuilineata, 14, 18, 44; pl. 10, figs. 1-5
Streblopteria, 21, 44
oklahomensis, 11, 14, 18, 44; pl. 10, figs. 6-8
 Summit County, 65, 73
- Thanatocoenose, 18
 Thornton unit, 6
 Tionesta cyclothem, 8
 Tionesta unit, 8
 Trigonoids, 22
 Tuscarawas County, 65, 73
 Tuscarawas unit, 7, 12, 14, 16
- Unklesbayella*, 22, 23, 60
geinitzi, 16, 60; pl. 18, figs. 8, 9
 Upper Bakerstown cyclothem, 5
 Upper Bakerstown unit, 5
 Upper Brush Creek unit, 12, 14, 16
 Upper Freeport cyclothem, 6
 Upper Freeport unit, 6
 Upper Kittanning cyclothem, 7
 Upper Kittanning unit, 7
 Upper Mahoning unit, 6
 Upper Mercer cyclothem, 8
 Upper Mercer unit, 8, 12, 14, 16
- Vandusen cyclothem, 9
 Vandusen unit, 9
 Vanport unit, 4, 11, 12, 14, 16
 Veneroids, 22
 Vinton County, 65, 74
 Virgilian Series, 18
VolSELLina, 19, 20, 32
subelliprica, 11, 13, 18, 32; pl. 3, fig. 22
- Washington Group, 12, 14, 16
 Washington shale, 12, 14, 16
 Washingtonville unit, 7, 12, 14, 16
 Wayne County, 65, 75
 West Virginia, 65, 75
 Western Interior Basin, 18
 Wilgus cyclothem, 6
 Wilgus unit, 6
Wilkingia, 22, 23, 59
terminale, 16, 59; pl. 16, figs. 18-20
 Winters cyclothem, 8
 Winters unit, 8
 Wolfcampian Series, 18
- Zaleski unit, 8, 12, 14, 16

PLATE 1

(All figures X2 except where noted)

- FIGURES 1-3. *Clinopistha laevis* Meek & Worthen.
1, 2. Right valve and posterior views; Tebo Formation, near Lewis, Henry County, Missouri; OSU-28993.
3. Right valve; Columbiana limestone, Mg-7; OSU-27143.
- 4-8. *Nuculopsis girtyi* Schenck.
4, 5. Dorsal and right valve views of internal mold; Brush Creek shale, Ale-18; OSU-27169.
6, 7. Left and right valves; Brush Creek shale, Ale-35; OSU-27167, 27166.
8. Dentition of right valve; Brush Creek shale, Cw-1; OSU-27168.
- 9-14. *Nuculopsis anodontoides* (Meek).
9-11. Right valve and dorsal views and right valve view of internal mold; Brush Creek shale, Ale-35; OSU-27170, 27171.
12, 13. Dorsal and right valve views of internal mold; Washingtonville shale, CAr-3; OSU-27172.
14. Right valve; Columbiana shale, Mg-2; OSU-27173.
- 15-17. *Nuculopsis croneisi* Schenck.
15. Left valve, X3; Brush Creek shale, Cfr-1; OSU-28989.
16. Right valve; Columbiana shale, Mg-2; OSU-27174.
17. Right valve, X3; Washingtonville shale, Mg-11; OSU-27251.
- 18-21. *Paleyoldia stevensoni* (Meek).
18. Left valve with shell partly missing; Brush Creek shale, Ale-35; OSU-27180.
19, 20. Left valve and dorsal views of internal mold; Brush Creek shale, Ale-18; OSU-27182.
21. Right valve with shell partly missing; Washingtonville shale, CAr-2; OSU-27181.
- 22-28. *Palaeoneilo oweni* (McChesney).
22. Right valve; Washingtonville shale, HOuc-1; OSU-27176 (Murphy, 1966, pl. 101, fig. 18).
23. Left valve; Washingtonville shale, Ty-1; OSU-27178 (Murphy, 1966, pl. 101, fig. 20).
24, 25. Left valve and dorsal views of internal mold; Columbiana shale, Mg-2; OSU-27177 (Murphy, 1966, pl. 101, fig. 19).
26. Left valve of immature individual; Brush Creek shale, Cfr-1; OSU-27179 (Murphy, 1966, pl. 101, fig. 15).
27, 28. Left valve and dorsal views; Columbiana shale, Ss-5; OSU-27175.



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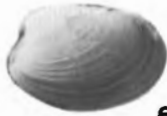
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PLATE 2

(All figures X2 except where noted)

- FIGURES 1, 2. *Phestia bellistriata* (Stevens). Right valve and dorsal views; Washingtonville shale, MUmu-1; OSU-27183.
3. *Phestia bellistriata prolongata* (Morningstar). Right valve view of badly weathered specimen, X1; Lower Mercer limestone, LLho-4; holotype, OSU-15254 (Morningstar, 1922, pl. 10, fig. 28).
- 4-9. *Phestia arata* (Hall). Dorsal, left valve, right valve interior, and hinge line interior views and left valve and dorsal views of internal mold; Brush Creek shale, Ale-35; OSU-27186, 27185, 27187, 27189, 27188.
- 10, 11. *Phestia attenuata* (Meek).
10. Left valve, crushed, X4; Portersville shale, Gwe-1; OSU-27190.
11. Two specimens and external molds, X3; Lower Brush Creek shale, Aa-41; OSU-27191.
- 12, 13. *Solemya (Janeia) radiata* Meek & Worthen. Internal mold of right valve, X1, and left valve; Putnam Hill shale, Ms-3; OSU-27192, 27193.
- 14-17. *Solemya (Janeia) trapezoides* (Meek).
- 14, 15. Interior views of hinge line near beaks of right valve, X1, and left valve; Putnam Hill shale, Vel-15; OSU-27195, 27196.
16. Right valve, X1; Washingtonville shale, CAr-2; OSU-28990.
17. Right valve, crushed, X1; Columbiana shale, Cuc-1; OSU-27194.
18. *Parallelodon obsoletus* (Meek). Right valve, shell partially missing, X1; Ames limestone, MUu-2; OSU-27200.

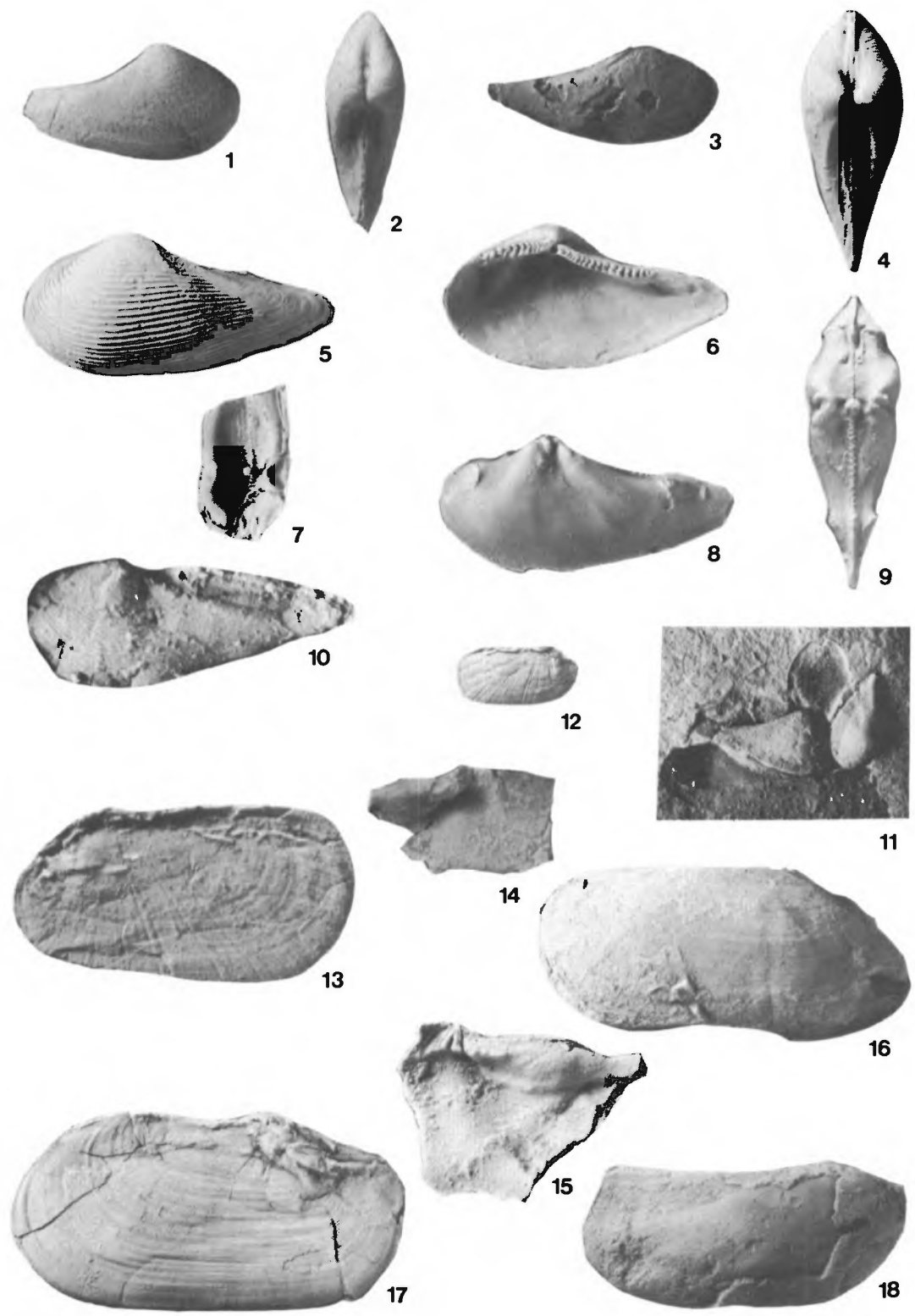


PLATE 3

(All figures X2 except where noted)

- FIGURES 1-3. *Parallelodon obsoletus* (Meek).
1, 2. Right and left valves, X1; Vanport shale, Vs-3; OSU-27197, 27198.
3. Hinge line of left valve; Putnam Hill shale, Vel-11; OSU-27199.
- 4-8. *Parallelodon carbonarius* (Cox).
4, 5. Dorsal view and left valve; Washingtonville shale, CAR-2; OSU-28991.
6. Right valve, X1; Putnam Hill shale, Ms-3; OSU-27202.
7. Left valve, X1; Lower Mercer limestone, LIho-4; OSU-27201.
8. Interior view of left valve; Lower Mercer limestone, Pr-1; OSU-27203.
- 9, 10. *Parallelodon sangamonensis?* (Worthen).
9. Internal mold, X1; Cambridge limestone, Ls-1; OSU-27204.
10. Left valve with most of shell missing, X1; Portersville shale, Aa-55; OSU-27205.
- 11-13. *Parallelodon tenuistriatus* (Meek & Worthen). Cast and external mold of left valve and internal mold of left valve; Portersville limestone, Pb-1; OSU-14032 (Mark, 1912, pl. 15, fig. 2; Morningstar, 1922, pl. 10, fig. 30), 27206.
14. *Modiolus (Modiolus) radiatus* Hoare, Sturgeon & Kindt. Left valve, X3; Lower Mercer limestone, LIho-4; holotype, OSU-27207.
- 15-19. *Promytilus pottsvillensis* Hoare, Sturgeon & Kindt.
15. Right valve; Lower Mercer limestone, LIho-1; paratype, OSU-27210.
16, 17. Internal molds of left valves; Lower Mercer limestone, LIm-1; paratypes, OSU-27209, 27208.
18, 19. Left valves; Lower Mercer limestone, HOH-2; paratype, OSU-4587-2, holotype, OSU-4587-1 (Morningstar, 1922, pl. 11, fig. 13).
- 20, 21. *Promytilus* cf. *P. annosus senex* Newell.
20. Left valve, X1; Vanport limestone, MUho-3; OSU-27212.
21. Right valve, distorted; Vanport limestone, Vel-20; OSU-27211.
22. *VolSELLina subelliptica* (Meek). Right valve with shell partially missing; Vanport limestone, MUho-3; OSU-27213.



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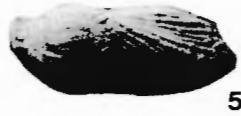
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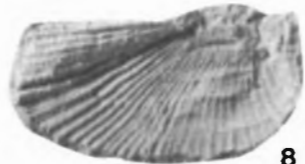
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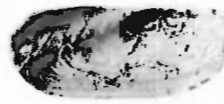
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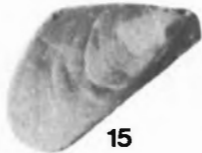
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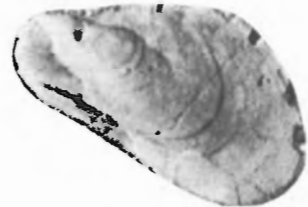
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PLATE 4
(All figures X1)

- FIGURES 1-4. *Pteronites americana* (Meek). Right valve, right valve, dorsal, and spread dorsal views of distorted specimens; Brush Creek shale, MEco-1; OSU-27216, 27215, 27214.
- 5, 6. *Pteronites peracuta* (Shumard).
5. Dorsal view of internal mold; Ames limestone, Auc-3; OSU-27218.
 6. Left valve with shell partially missing; Ames limestone, MUu-2; OSU-27217.
7. *Myalina (Orthomyalina) subquadrata?* Shumard. Internal mold of left valve with some adhering shell material; Ames limestone, Aam-7; OSU-27221.



PLATE 5

(All figures X1 except where noted)

- FIGURES 1, 2. *Myalina (Orthomyalina) subquadrata?* Shumard.
1. Fragment of left valve; Ames limestone, MUu-2, OSU-27219.
 2. Fragment of left valve; Cambridge limestone, Ay-21; OSU-27220.
3. *Myalina (Myalinella) meeki?* Dunbar. Left valve, X3; Brush Creek shale, Cma-3; OSU-27222.
- 4-11. *Septimyalina perattenuata* (Meek & Hayden).
4. Internal mold of right valve; Columbiana limestone, Ss-4; OSU-27228.
 5. Right valve, X2; Putnam Hill shale, Ms-3; OSU-27229.
 6. Internal mold of right valve; Cambridge limestone, Ad-37; OSU-27227.
 - 7, 8. Fragmentary left valve and right valve; Lower Mercer limestone, Vel-6; OSU-27224, 27223.
 - 9, 10. Exterior and interior views of fragmentary right valve; Lower Mercer limestone, Pmc-2; OSU-27225.
 11. Internal mold of left valve with some adhering shell material; Lower Mercer limestone, MUc-5; OSU-27226.
- 12, 13. *Septimyalina orthonota?* (Mather). Internal molds of right and left valves; Harrison ironstone, Jh-1; OSU-15268, 15267 (Morningstar, 1922, pl. 11, figs. 6, 5).
- 14, 15. *Septimyalina sinuosa* (Morningstar).
14. External mold of left valve; Zaleski flint, Vel-14; OSU-27230.
 15. Crushed left valve; Columbiana shale, Ts-4; OSU-27231.

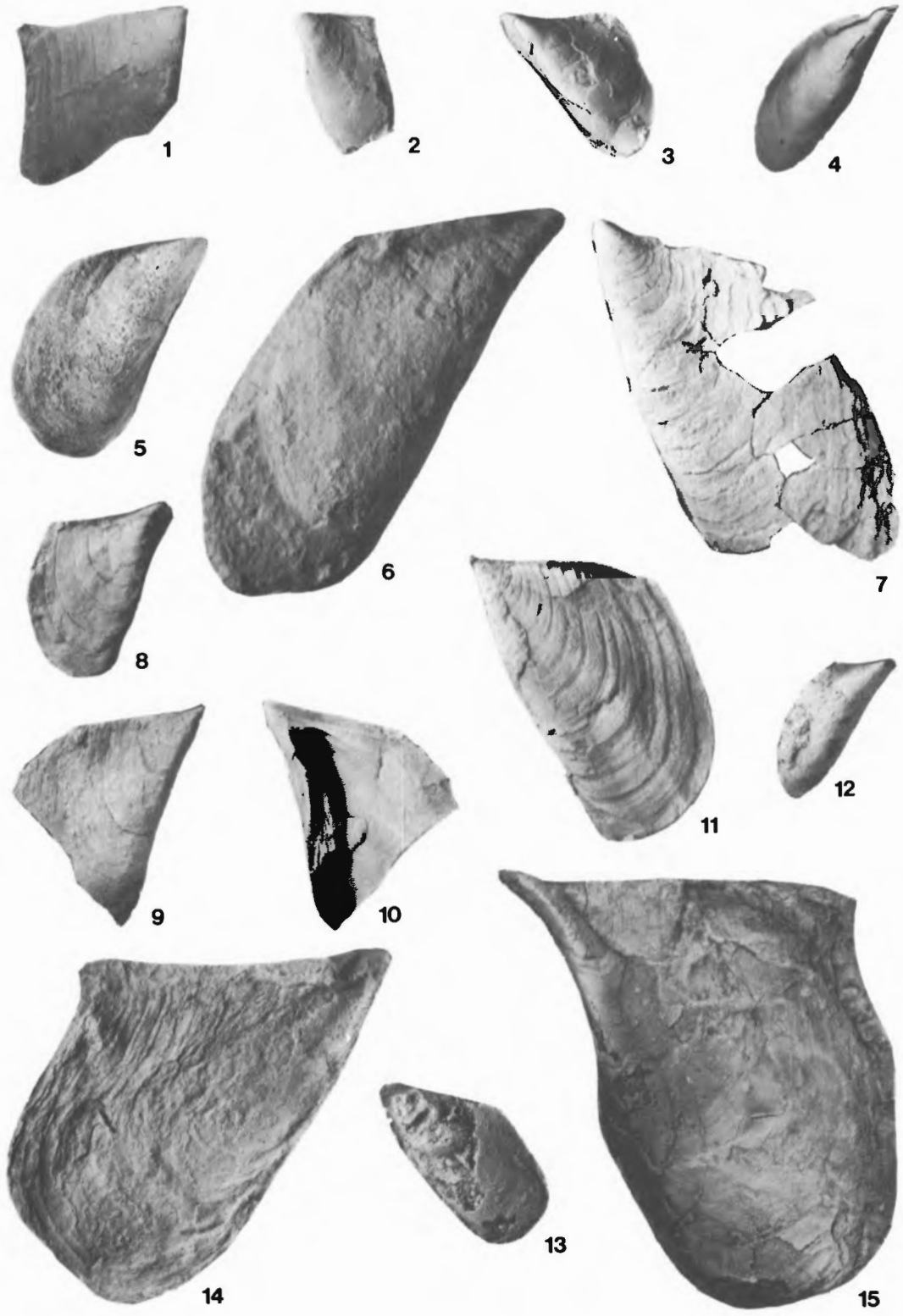


PLATE 6
(All figures X1 except where noted)

- FIGURE 1. *?Monopteria subalata* Beede & Rogers. Internal mold of right valve with anterodorsal portion missing; Lower Mercer shale, Hs-3; OSU-27232.
- 2-5. *Placopterina ohioensis* Hoare, Sturgeon & Kindt. Internal and external molds of right valve, and external and internal molds of left valve, X3; Lower Mercer limestone, LIm-1; holotype, OSU-27233.
- 6, 7. *Leptodesma (Leptodesma) ohioense* (Herrick).
6. Interior view of left valve, X2; Lower Mercer limestone, Lho-4; OSU-27234.
7. Internal mold of left valve, X2; Lower Mercer limestone, Vel-7; OSU-27235.
- 8, 9. *Leptodesma (Leptodesma) sulcata?* (Geinitz). Left and right valves, X2; Brush Creek shale, Cfr-1; OSU-27236, 27238.
10. *Leptodesma (Leptodesma) longa* (Geinitz). Left valve, X2; Portersville limestone, Pb-1; OSU-27237.
- 11-14. *Dunbarella striata* (Stevens).
11. Interior view of left valve, distorted, X2; Lower Brush Creek limestone, At-9; OSU-27240.
12. Left valve, X2; Brush Creek shale, Gca-1; OSU-27239.
13. Left valve, X2; Vanport shale, Vc-6; OSU-27242.
14. Internal mold of left valve, X2; Brush Creek shale, Cfr-1; topotype, OSU-27241.
- 15-23. *Dunbarella knighti* Newell.
15. Left valve, X2; Putnam Hill shale, Ty-3; OSU-27245.
- 16-18. Interior view of left valve, and internal molds of left and right valves; Putnam Hill shale, Ms-3; OSU-27247, 27246.
19. External mold of left valve; Skelley shale, CAI-5; OSU-27243.
- 20-22. Interior view of left valve showing *Spirorbis* tubes pressed through valve, and external and internal molds of a left valve showing hinge line area of attached corresponding right valve; Putnam Hill shale, Ms-3; OSU-27249, 27248.
23. External mold of left valve; Dorr Run shale; Ay-48; OSU-27244.
24. *Dunbarella rectalaterarea?* (Cox). Left valve, poorly preserved; Washingtonville shale, Cc-4; OSU-27250.



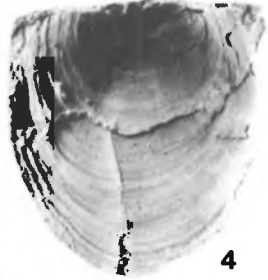
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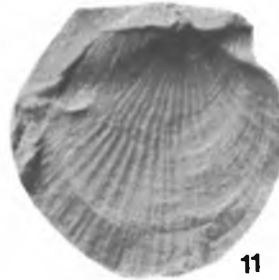
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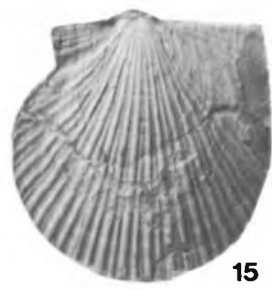
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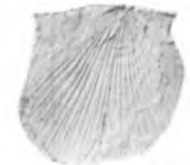
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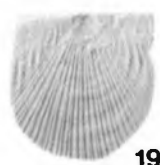
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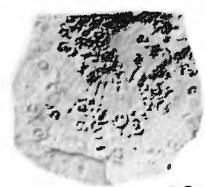
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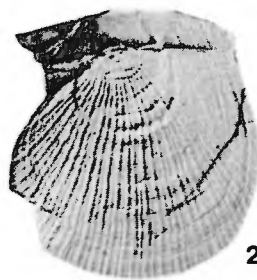
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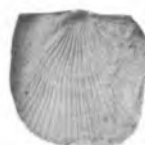
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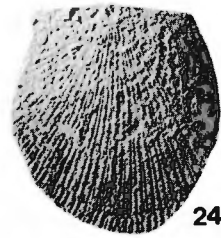
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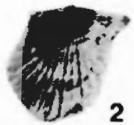
PLATE 7

(All figures X1 except where noted)

- FIGURES 1, 2. *Aviculopecten halensis?* Mather.
1. External mold of left valve, X2; Lower Mercer limestone, LIm-1; OSU-27253.
 2. External mold of left valve, X2; Lower Mercer limestone, Lho-1; OSU-27252.
- 3-6. *Aviculopecten germanus* Miller & Faber.
3. Internal mold of left valve, X3; Lower Mercer limestone, Pr-2; OSU-27257.
 4. Internal mold of left valve, X2; Lower Mercer limestone, MUc-5; OSU-27255.
 5. Partially exfoliated left valve, X3; Lower Mercer limestone, Vel-7; OSU-27254.
 6. Internal mold of left valve, X3; Putnam Hill limestone, Lho-5; OSU-27256.
- 7, 8, 10. *Aviculopecten sorer* Herrick.
7. Internal mold of left valve, X2; Lower Mercer limestone, Pr-5; OSU-27258.
 - 8, 10. Internal molds of left valves, X2; Lower Mercer limestone, MUc-5; OSU-27259, 27260.
- 9, 11, 12. *Aviculopecten coxanus* Meek & Worthen.
- 9, 12. Interior view and internal mold of left valves, X2; Lower Mercer limestone, Pr-2; OSU-27264, 27265.
 11. External mold of left valve, X2; Lower Mercer limestone, Lho-4; OSU-27263.
- 13-15. *Aviculopecten occidentalis* (Shumard). Left valve, X2, and interior view and internal mold of left valve; Brush Creek shale, MEco-1; OSU-27262, 27261.
- 16-19. *Aviculopecten arctisulcatus* Newell.
- 16-18. Left valve and associated left and right valves; Brush Creek shale, MEco-1; OSU-27266, 27267.
 19. Left valve; Brush Creek limestone, Ale-37; OSU-28992.
- 20-22. *Aviculopecten bascilicus?* Newell.
- 20, 22. External and internal molds of left valves; Cambridge limestone, Ay-21; OSU-27269, 27270.
 21. Internal mold of left valve; Cambridge limestone, Cma-7; OSU-27268.



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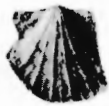
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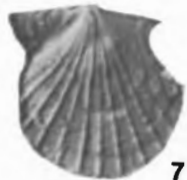
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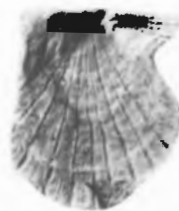
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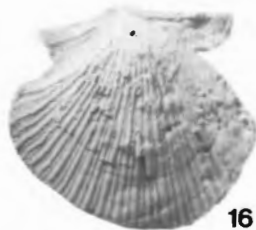
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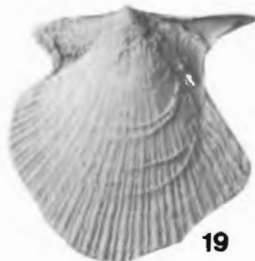
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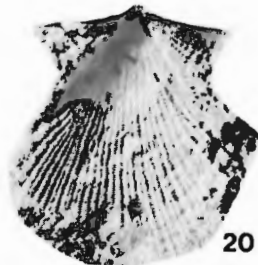
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PLATE 8

(All figures X2 except where noted)

- FIGURES 1-3. *Aviculopecten appalachianus* Hoare, Sturgeon & Kindt.
1, 2. Left valve, X1, and left valve, X3; Vanport shale, Vel-22; holotype, OSU-27275; paratype, OSU-27276.
3. Left valve; Putnam Hill shale, Hfg-6; paratype, OSU-27277.
- 4-7. *Aviculopecten columbianus* Hoare, Sturgeon & Kindt.
4. Internal mold of left valve, X3; Columbiana limestone, Cp-3; paratype, OSU-27273.
5. Interior view of left valve; Columbiana limestone, Cs-3; holotype, OSU-27271.
6. Interior view of left valve; Columbiana limestone, Mg-7; paratype, OSU-27274.
7. Internal mold of right valve with some adhering shell near hinge line, X4; Columbiana limestone, Cs-3; paratype, OSU-27272.
- 8-12. *Acanthopecten carboniferous* (Stevens).
8, 9. Internal and external molds of left valves; Vanport limestone, Lifr-2; OSU-27278, 27279.
10, 11. External and internal molds of left valve; Lower Mercer limestone, LIm-1; OSU-27280.
12. Left valve; Washingtonville shale, MUmu-1; OSU-27281.
- 13, 14. *Acanthopecten meeki* Newell.
13. Fragmentary left valve; Cambridge limestone, La-1; OSU-27283.
14. Fragmentary left valve; Cambridge limestone, Ls-1; OSU-27282.
- 15-19. *Acanthopecten bellosum* Hoare, Sturgeon & Kindt. External and internal molds of associated left and right valves, external mold of right valve, external mold of left valve, and internal mold of left valve, X1; Putnam Hill shale, Hfg-6; holotype, OSU-27284; paratypes, OSU-27287, 27286, 27285.
20. *Clavicosta echinata?* Newell. Fragmentary right valve, X1; Putnam Hill limestone, MUsp-1; OSU-27289.
21. *Clavicosta* sp. Internal mold of right valve, X3; Brush Creek limestone, Aw-49; OSU-27290.
22. *Annuliconcha interlineata* (Meek & Worthen). Fragmentary left valve, X3; Vanport limestone, Mp-1; OSU-27288.

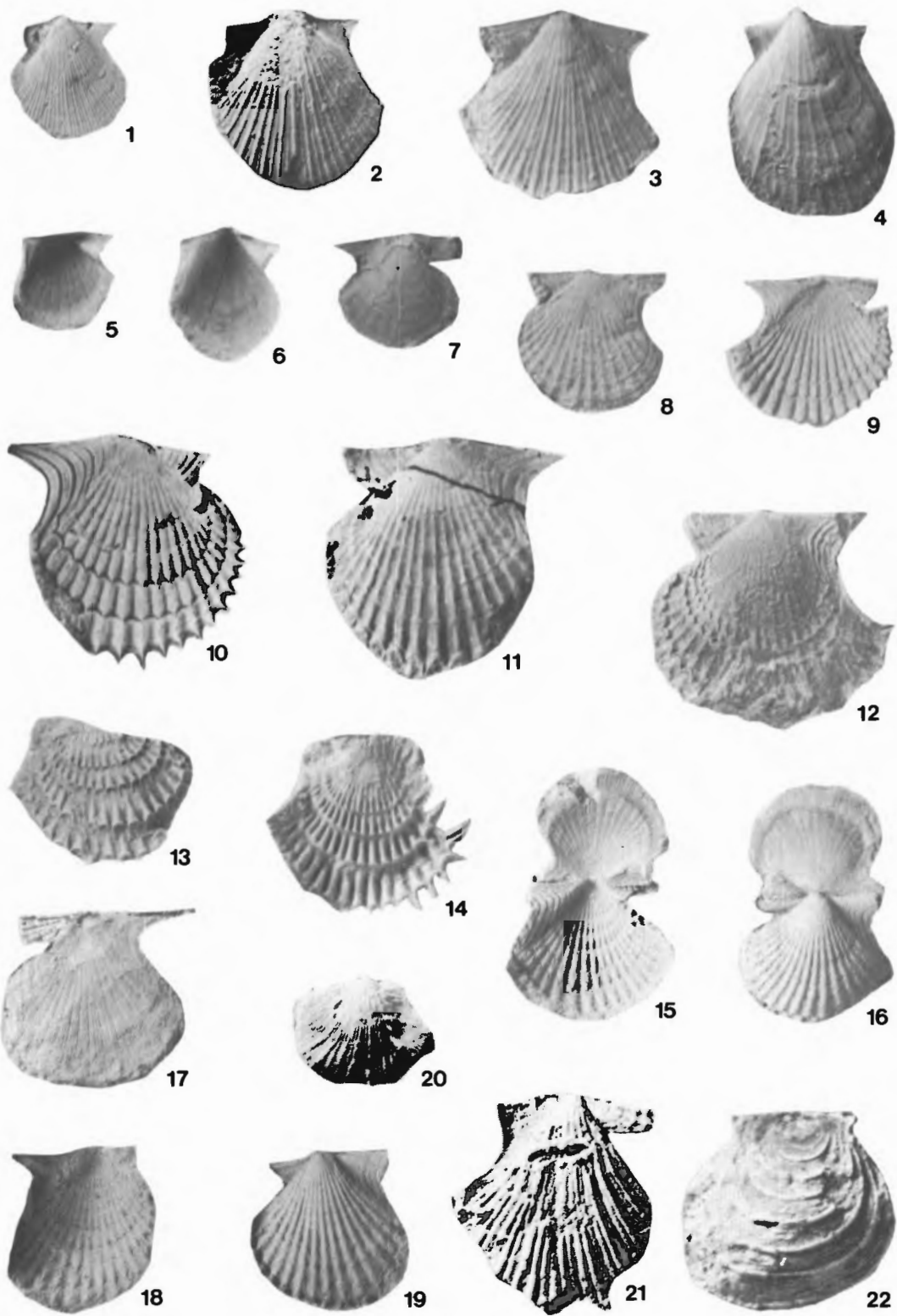


PLATE 9

(All figures X1 except where noted)

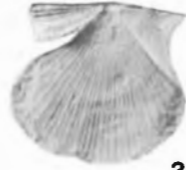
- FIGURES 1-4. *Fasciculiconcha scalaris* (Herrick).
1. Internal mold of left valve; Lower Mercer limestone, SCve-2; OSU-15287 (Morningstar, 1922, pl. 13, fig. 6).
 - 2, 4. Internal mold and interior view of left valve; Lower Mercer limestone, Vel-6; OSU-27292.
 3. Interior view of right valve; Lower Mercer limestone, LIho-4; OSU-27291.
- 5, 6. *Fasciculiconcha knighti* Newell. External mold with some adhering shell of left valve, and external mold of left valve with abnormally deep anterior sulcus; Putnam Hill limestone, Vel-15; OSU-27293, 27294.
- 7-9. *Fasciculiconcha providencensis* (Cox).
- 7, 8. View of hinge line showing parts of both valves, and fragmentary left valve; Putnam Hill shale, Vel-12; OSU-27295.
 9. Interior view of questionable fragmentary left valve, X2; Lower Mercer limestone, LIho-1; OSU-27296.
10. *Limipecten* sp. Interior view of fragment of a valve; Cambridge limestone, Ls-1; OSU-27297.
- 11-15. *Streblochondria hertzeri* (Meek).
11. External mold of left valve; Putnam Hill limestone, Vel-12; OSU-15246 (Morningstar, 1922, pl. 13, fig. 6).
 - 12, 14. Internal mold of left valve, X2, and external mold of right valve, X2; Lower Mercer limestone, LIm-1; OSU-27300, 27299.
 13. External mold of right valve; Lower Mercer limestone, MUc-5; OSU-27298.
 15. Internal mold of right valve; Lower Mercer limestone, LIho-1; OSU-27301.
- 16, 17. *Streblochondria stantonensis* Newell.
16. Internal mold of left valve, X3; Portersville limestone, Pb-1; OSU-14033 (Mark, 1912, pl. 15, fig. 3; Morningstar, 1922, pl. 13, fig. 3).
 17. Internal mold of left valve; Washingtonville shale, MUmu-1; OSU-27302.



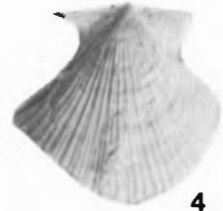
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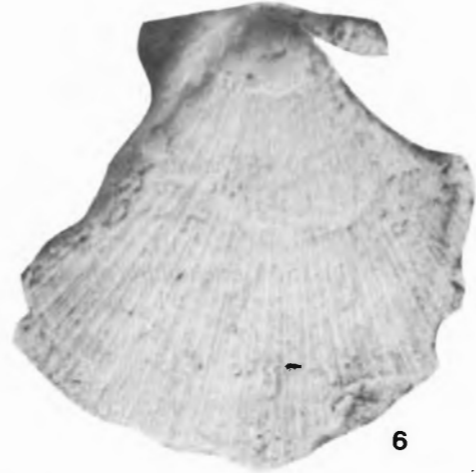
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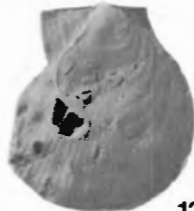
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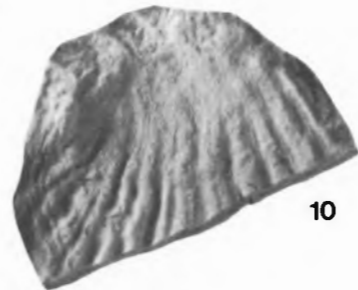
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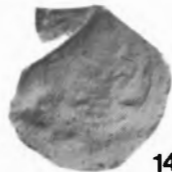
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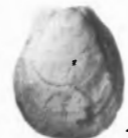
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PLATE 10

(All figures X1 except where noted)

- FIGURES 1-5. *Streblochondria tenuilineata* (Meek & Worthen).
1, 2. Left valve, partially distorted, X2, and left valve; Lower Mercer limestone, LIho-1; OSU-27304, 27305.
3. Right valve; Vanport limestone, Mg-4; OSU-27303.
4, 5. Right valves; Lower Mercer limestone, MUc-1; OSU-15289-1 (Morningstar, 1922, pl. 13, fig. 8), 15289-2.
- 6-8. *Streblopteria oklahomensis* Newell. Internal molds of right valve, X2, right valve, and left valve, X4; Brush Creek shale, Cfr-1; OSU-27307, 27306, 27308.
- 9, 10. *Chaenocardia ovata* Meek & Worthen.
9. Right valve, shell missing on dorsal area, X2; Putnam Hill shale, Mg-4; OSU-27310.
10. Left valve; Putnam Hill shale, Mc-1; OSU-27309.
- 11-15. *Euchondria ohioensis* (Mark).
11. Right valve, X4; Upper Brush Creek shale, Aw-48; OSU-27315.
12. Right valve, X2; Portersville limestone, Pb-1; topotype, OSU-27312.
13. Left valve, crushed, X3; Brush Creek shale, Cfr-1; OSU-27313.
14. Interior view of right valve, X3; Brush Creek shale, Aa-41; OSU-27311.
15. Exfoliated right valve, X3; Brush Creek shale, Cma-3; OSU-27314.
- 16-20. *Euchondria levicula* Newell.
16. Internal mold of left valve, X3; Poverty Run shale, MUho-1; OSU-27317.
17. Internal mold of left valve, X3; Putnam Hill shale, TI-4; OSU-27316.
18. Internal mold of left valve, X3; Brush Creek shale, Aa-41; OSU-27320.
19. Interior view of left valve, X3; Lower Mercer limestone, LIho-1; OSU-27318.
20. Interior view of right valve, X3; Lower Mercer limestone, LIho-4; OSU-27319.
- 21, 22. *Euchondria smithwickensis?* Newell. Interior view and internal mold of right valve; Columbiana limestone, Mg-2; OSU-27321.
- 23, 24. *Pseudomonotis carbonaria* (Meek & Worthen).
23. Interior view of left valve; Lower Mercer limestone, LIho-1; OSU-4609.
24. Interior view of left valve; Lower Mercer limestone, Pr-3; OSU-27322.
- 25-27. *Pseudomonotis* spp.
25. Internal mold of left valve, X2; Vanport limestone, MUho-3; OSU-27330.
26, 27. Internal mold of left valve, X2, and external mold of right valve; Lower Mercer limestone, MUc-5; OSU-27329, 27328.

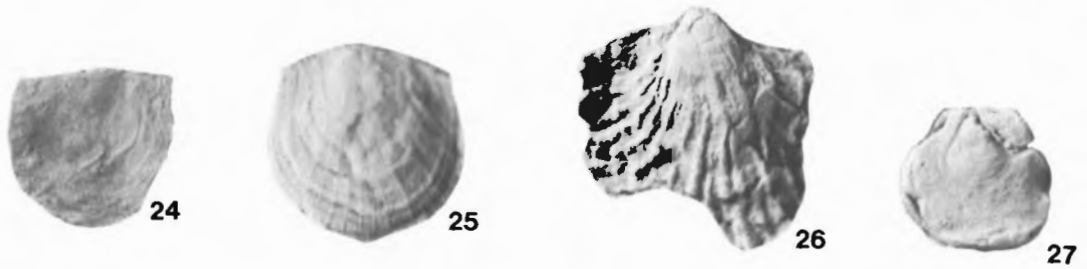


PLATE 11
(All figures X1 except where noted)

- FIGURES 1-4. *Pseudomonotis precursor* Mather.
- 1-3. Internal mold and external mold, X2, and internal mold of left valves; Putnam Hill shale, Hfg-6; OSU-27323, 27325, 27324.
 - 4. Interior view of left valve of questionable specimen; Putnam Hill limestone, Vel-15; OSU-27326.
- 5, 6. *Pseudomonotis millhorni* Hoare, Sturgeon & Kindt. Left and right valves; Washingtonville shale, CAr-2; holotype, OSU-27327.
- 7-10. *Posidonia fracta* (Meek). Internal molds of right valves; Lower Mercer shale, Vel-26; OSU-27333, 27332, 27331, 15274 (Morningstar, 1922, pl. 12, fig. 11).
- 11-13, 15. *Pernopecten attenuatus* (Herrick).
- 11, 12. Interior views of left valves, X2; Lower Mercer limestone, LIho-4; OSU-27340, 27341.
 - 13, 15. Interior views of right valve, X2, and left valve, X2; Vanport shale, Vel-20; OSU-27339, 27338.
- 14, 16-18. *Pernopecten ohioensis* Newell. Interior view and internal mold of left valves, and interior and exterior views of right valves; Lower Mercer limestone, LIho-1; OSU-27334 to 27337.
19. *Pernopecten prosseri* (Mark). Right valve; Ames limestone, MUu-2; OSU-27342.
- 20-22. *Palaeolima triplistriata* (Stevens). Internal molds, X2, external molds, X2, and internal molds, X2, of associated valves; Brush Creek shale, Cfr-1; topotypes, OSU-27347, 27346, 27348.

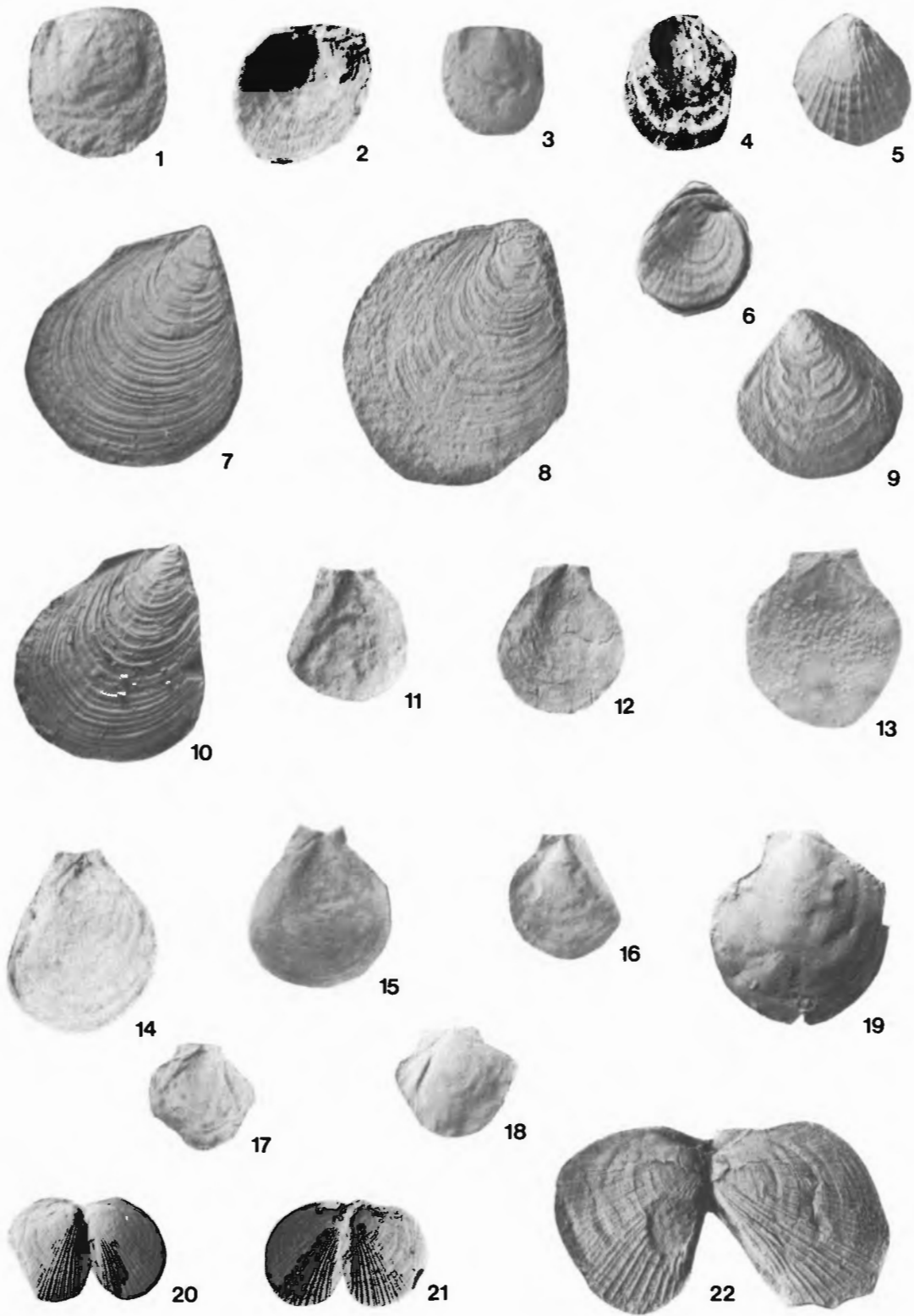
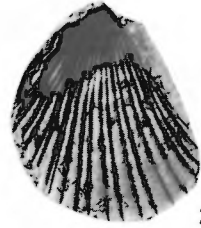


PLATE 12
(All figures X1 except where noted)

- FIGURES 1-3. *Palaeolima retifera* (Shumard).
1, 3. Interior view of right valve, X2, and internal mold of right valve, X2; Lower Mercer limestone, LHo-1; OSU-27345, 27344.
2. External mold of left valve, X2; Lower Mercer limestone, LIm-1; OSU-27343.
- 4, 5. *Schizodus subcircularis* Herrick. Internal molds of left valves, X2; Putnam Hill limestone, Jje-2; OSU-15282, 15284 (Morningstar, 1922, pl. 12, figs. 14, 16).
- 6-9. *Schizodus wheeleri* (Swallow).
6, 7. Dorsal view and right valve; Upper Brush Creek shale, Ale-18; OSU-27351.
8, 9. Dorsal and left valve views of internal mold; Brush Creek shale, Ale-35; OSU-27352.
- 10-14. *Schizodus cuneatus* Meek.
10, 11. Left and right valve views of internal molds; Lower Mercer limestone, LHo-1; OSU-4591.
12-14. Hinge line of left valve, and hinge line and exterior view of right valve; Putnam Hill shale, Vel-19; OSU-27350, 27349.



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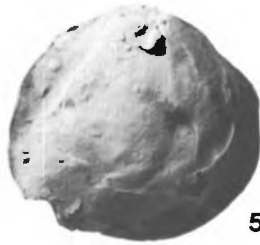
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PLATE 13

(All figures X1 except where noted)

- FIGURES 1, 2. *Schizodus affinis* Herrick.
1. Internal mold of left valve; Putnam Hill limestone, Ms-3; OSU-27357.
 2. Internal mold of left valve, X2; Vanport limestone, Vel-23; OSU-27358.
- 3, 4. *Permophorus tropidophorus* (Meek). Exterior and interior views of right valve; Putnam Hill shale, Ty-3; OSU-27361.
- 5, 6. *Schizodus acuminatus* Hoare, Sturgeon & Kindt. Dorsal and right valve views of internal mold with some adhering shell material; Lower Mercer limestone, LIho-4; holotype, OSU-27359.
- 7-11. *Schizodus amplus* Meek & Worthen.
7. Right valve; Vanport shale, MUho-3; OSU-27354.
 8. Hinge line of right valve; Putnam Hill shale, Vel-10; OSU-27355.
 - 9, 10. Exterior and interior views of left valve; Lower Mercer limestone, Hfg-5; OSU-27353.
 11. Hinge line of left valve; Putnam Hill limestone, Vel-19; OSU-27356.



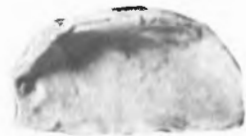
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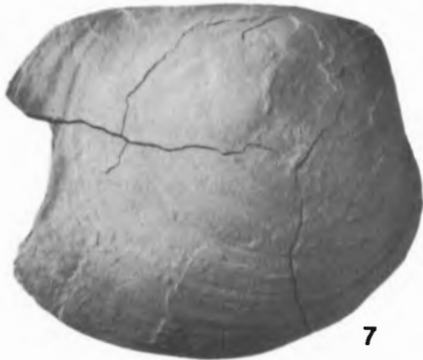
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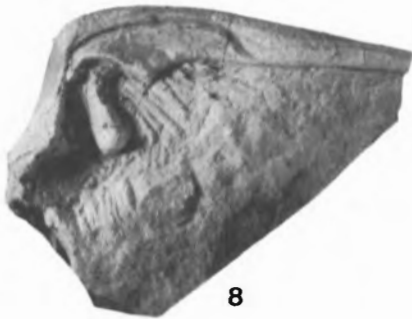
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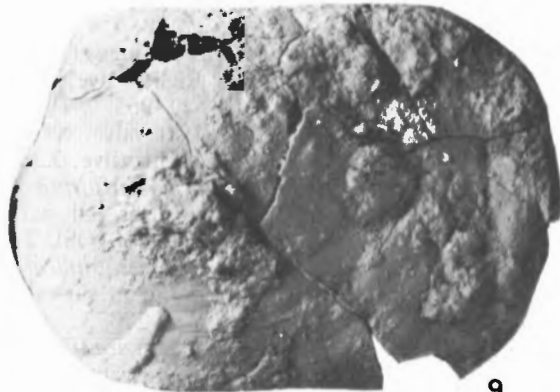
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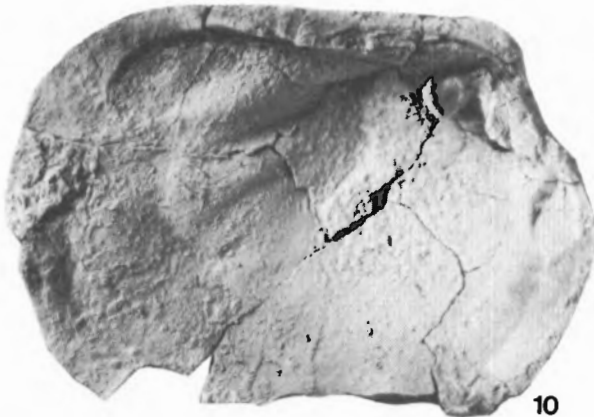
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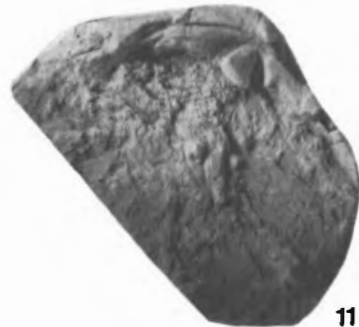
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PLATE 14

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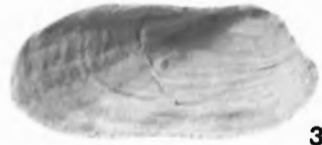
- FIGURES 1, 2. *Permophorus tropidophorus* (Meek).
1. Left valve; Cambridge limestone, La-1; OSU-27362.
2. Internal mold of right valve, X1; Lower Mercer limestone, MUC-2; OSU-27360.
- 3, 4. *Permophorus spinulosa* (Morningstar). External and internal molds, X1; Lower Mercer limestone, LIm-1; holotype (by designation), OSU-15248, 15249 (both from same specimen).
- 5-8. *Permophorus immaturus* (Herrick). Internal mold of right valve, X1, internal mold of left valve, right valve, and external mold of right valve, X1. Lower Mercer limestone, LIho-1; OSU-1503-1 (Morningstar, 1922, pl. 14, fig. 7), 27363, 27364, 1503-2.
- 9-11. *Permophorus oblongus* (Meek).
9. Right valve, X3; Washingtonville limestone, CAr-2; OSU-27365.
10. Left valve, X3; Putnam Hill limestone, Mg-3; OSU-27366.
11. Right valve, X3; Columbiana limestone, Cuc-1; OSU-27367.
- 12-14. *Permophorus costatiformis* (Meek & Worthen). Left, right, and right valves, all partially exfoliated, X1; Brush Creek shale, Ale-18; OSU-27368, 27370, 27369.
- 15-17. *?Pleurophorella sesquiplicata* Price. Internal molds of two left valves and a right valve; Lower Mercer shale, Vel-26; OSU-27371 to 27373.
- 18-23. *Astartella concentrica* (Conrad).
18. Right valve; Lower Mercer shale, Vel-6; OSU-27374.
19, 20. Dorsal view and right valve; Putnam Hill shale, Vel-12; OSU-27375.
21-23. Right valve, right valve, and dorsal view; Columbiana limestone, Cp-3; OSU-27376, 27377.
- 24, 25. *Astartella varica* McChesney. Dorsal view and right valve; Putnam Hill shale, Vel-12; OSU-27379.



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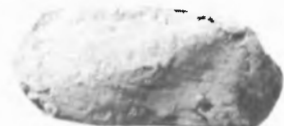
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PLATE 15

(All figures X1 except where noted)

- FIGURES 1, 2. *Astartella varica* McChesney.
1. Interior view of right valve, X2; Putnam Hill shale, HOc-1; OSU-27378.
 2. Interior view of left valve, X2; Putnam Hill shale, Ts-6; OSU-27380.
- 3-6. *Astartella newberryi* Meek.
3. Right valve, X2; Putnam Hill shale, Me-1; OSU-27381.
 4. Dorsal view, X2; Vanport shale, Vs-3; OSU-27383.
 5. External and internal molds of left and right valves, X2; Putnam Hill shale, Vel-10; OSU-27382.
 6. Hinge line of right valve, X2; Vanport shale, Vel-12; OSU-27384.
7. *Astartella compacta* Girty. Left valve, X2; Putnam Hill shale, Mc-2; OSU-27385.
- 8, 9. *Edmondia ovata* Meek & Worthen.
8. Right valve; Brush Creek limestone, Ale-19; OSU-27389.
 9. Left valve; Brush Creek shale, MEco-1; OSU-27390.
- 10, 11. *Edmondia reflexa* Meek.
10. Internal mold of right valve; Ames limestone, Aa-14; OSU-27393.
 11. Internal mold of right valve, X2; Portersville limestone, Pb-1; OSU-27394.
- 12-14. *Edmondia anodontooides* (Meek).
- 12, 14. Internal molds of right and left valves; Brush Creek shale, MEco-1; OSU-27397, 27396.
 13. Internal mold of left valve; Lower Brush Creek shale, Aa-41; OSU-27395.
- 15-17. *Cypricardina carbonaria* Meek.
- 15, 17. Dorsal and left valve views of internal molds, X2; Lower Mercer limestone, Lim-1; OSU-27388, 27387.
 16. Internal mold of right valve, X2; Lower Mercer limestone, Lho-4; OSU-27386.
- 18-20. *Edmondia nodulifera* Hoare, Sturgeon & Kindt.
18. Shell fragment showing distinctive nodose ornamentation; Cambridge limestone, La-1; paratype, OSU-28976.
 - 19, 20. Partial and weathered left valve, and interior of flattened right valve; Cambridge limestone, Ls-1; holotype, OSU-27399; paratype, OSU-27400.

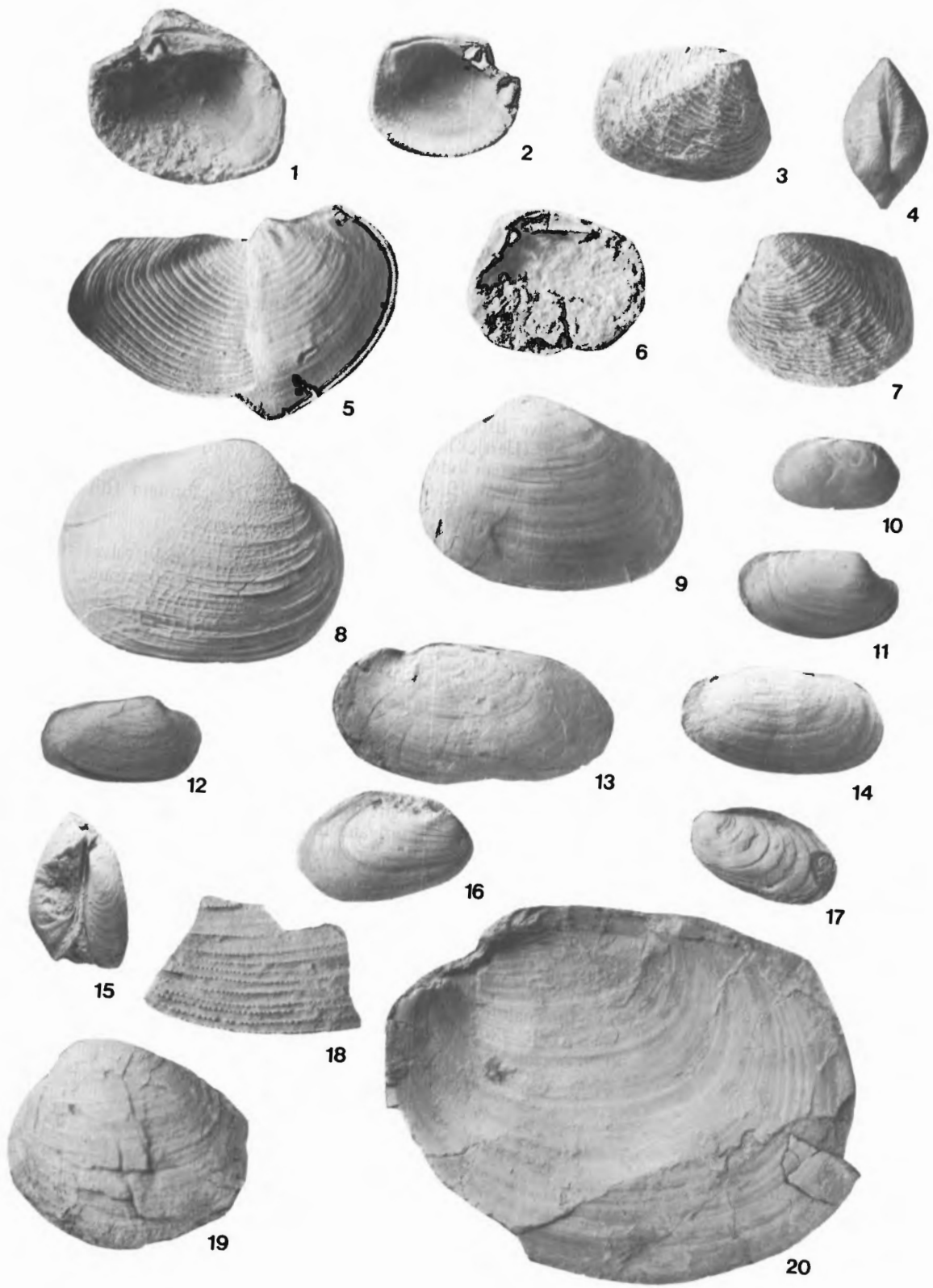


PLATE 16

(All figures X1 except where noted)

- FIGURES 1, 2. *Edmondia aspinwallensis?* Meek. Internal molds of associated and fragmentary left and right valves; Portersville limestone, Pb-1; OSU-27398.
- 3-5. *Edmondia gibbosa* (M'Coy).
- 3, 4. Dorsal view and right valve, X2; Brush Creek shale, MEco-1; OSU-27391.
5. Right valve; Brush Creek shale, Ale-18; OSU-27392.
- 6, 7. *Edmondia meekiana* (Herrick). Internal molds of right and left valves; Lower Mercer limestone, Lho-1; OSU-15259-1 (Morningstar, 1922, pl. 10, fig. 6), 15259-2.
8. *Cardiomorpha missouriensis* Shumard. Right valve, X2; Putnam Hill shale, Ms-3; OSU-28977.
- 9-11. *Prothyris (Prothyris) elegans* Meek.
- 9, 10. Interior views of exfoliated associated left and right valves and of a single left valve, X2; Putnam Hill limestone; Vel-15; OSU-28978, 28979.
11. Partial external mold of left valve, X2; Putnam Hill limestone, Mg-3; OSU-28980.
- 12, 13. *Exochorhynchus altirostratus* (Meek & Hayden).
12. Greatly deformed internal mold of left valve; Washingtonville shale, Aa-12; OSU-28983.
13. Partial internal mold of right valve, X2; Lower Mercer limestone, Hs-7; OSU-28984.
- 14, 15. *Solenomorpha? solenoides* (Geinitz).
14. Internal mold of right valve with some adhering shell material, X2; Columbiana limestone, Mg-7; OSU-28981.
15. Partial internal mold of right valve, X2; Columbiana limestone, Cs-8; OSU-28982.
- 16, 17. *Sanguinolites costata* (Meek & Worthen). External molds of left and right valves; Putnam Hill shale, Vs-3; OSU-28988.
- 18-20. *Wilkingia terminale* (Hall).
18. Internal mold of right valve; Ames limestone, Aam-7; OSU-28986.
19. Internal mold of right valve; Portersville limestone, Pb-1; OSU-28985.
20. Dorsal view of compressed specimen; Brush Creek shale, MEco-1; OSU-28987.



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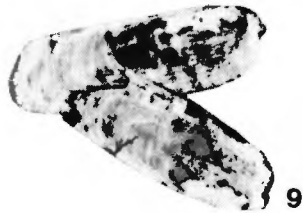
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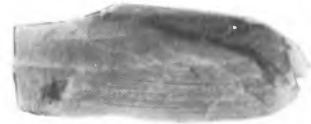
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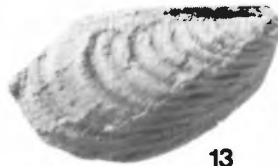
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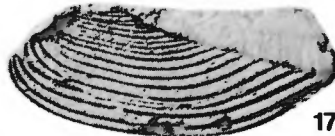
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PLATE 17

- FIGURES 1-6. *Pseudoconocardium parrishi* (Worthen).
- 1, 2. Posterior and anterior views of a partially crushed specimen; X15; Vanport shale, Vr-2; OSU-29269.
 3. Right valve of a crushed specimen, X15; Vanport shale, Vr-2; OSU-29270.
 - 4, 5. Dorsal and ventral views of a crushed specimen showing univalved cap-shaped larval shell, X15; Vanport shale, Vr-2; OSU-29271.
 6. Anterolateral view of a crushed specimen with larval shell perched on top, X15; Vanport shale, Vr-2; OSU-29272.
 7. *Pteronites americana* (Meek). Slab showing a death assemblage of crushed, articulated shells, X0.33; Brush Creek shale, MEco-1; Ohio University collection, Athens, Ohio.



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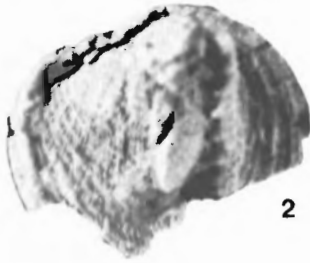
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PLATE 18

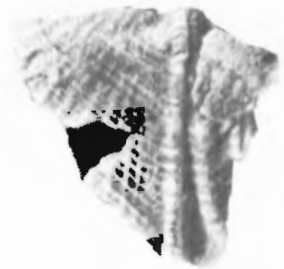
- FIGURE 1. *Pseudoconocardium parrishi* (Worthen). Left valve of a compressed specimen showing fine ornamentation of outer shell layer on anterior portion of valve; X15; Lower Mercer shale, Csl-1; OSU-30357.
- 2, 3. *Pseudoconocardium missouriensis* (Girty).
2. Oblique anterior view showing coarser reticulate ornamentation of outer shell layer on anterior portion of valve; X6; Putnam Hill shale, Vel-19; OSU-30352.
 3. Left valve of a compressed specimen showing coarse ornamentation of outer shell layer on anterior portion of valve; X15; Vanport shale, Vr-2; OSU-30353.
- 4, 5. *Parallelodon delicatus* (Meek & Worthen). Left valve and right valve of compressed specimens; X10; Columbiana shale, Ss-4; OSU-28998, 28999.
- 6, 7. *Permophorus occidentalis* (Meek & Hayden). Left valve and right valve of compressed specimens; X10; Ames shale, WVA:Pr-1; OSU-30351, 29000.
- 8, 9. *Unklesbayella geinitzi* (Meek). Right valve of compressed specimen and left valve; X10; Ames shale, WVA:Pr-1; OSU-30355, 30354.



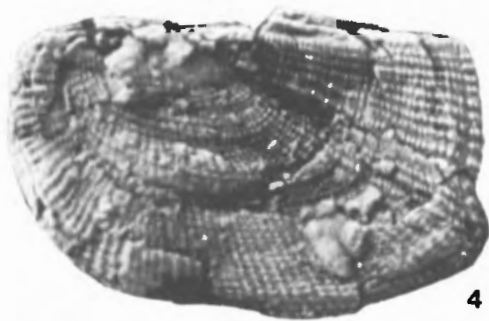
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